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Working Paper No. 4, 2025

Durham Business School working papers series ISSN 1749-3641

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**Optimal Macroprudential Policy and Bank Capital in Open Economies***

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**Abstract:** This paper studies macroprudential policy in a small open economy with financial intermediation and nominal rigidity. Fluctuations in bank deposit rates - which depend on the focus of monetary policy - create liability-side volatility, destabilize net interest margins, and reduce output. A macroprudential policy which shifts bank funding away from deposits towards equity enhances domestic risk-sharing and mitigates volatility. Optimal macroprudential policy generates bank capital ratios that differ by up to 5 percentage points depending on whether monetary policy stabilizes domestic prices or the exchange rate. Relative to an unregulated economy, macroprudential policy raises welfare by between 0.4 percent and 0.9 percent of steady-state consumption.

**JEL Classification:** E52, F41, G11, G15

**Keywords:** Bank Capital, Optimal Macroprudential Policy, Monetary Policy, Risk-Adjusted Steady State

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*Acnowledgments: We thank Martin Bodenstein, Laura Coroneo, Oliver de Groot, Paulo Santos Monteiro, and Christopher Thoenissen for helpful comments and suggestions. Previous versions of the paper were presented at the 2025 MMF Conference (Reading), the Centre for Applied Macro-Finance Research at the University of York, Trinity College Dublin, the University of Coimbra, the Banco de Portugal, and Durham University. Disclaimer: The views expressed in this paper are those of the authors and do not necessarily reflect those of Banco de Portugal or the Eurosystem.

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## 1. Introduction

This paper studies macroprudential policy in a small open economy with financial intermediation and nominal rigidity. The goal of the analysis is to understand how the focus of monetary policy affects the use of macroprudential policy. Our main finding is that optimal bank capital ratios differ considerably across monetary policy regimes - by as much as 5 percentage points, depending on whether monetary policy targets domestic price stability or exchange rate stability. When compared with an unregulated economy, macroprudential policy increases welfare by 0.4 percent of steady-state consumption when domestic prices are stabilized and by 0.9 percent when the exchange rate is stabilized. Our results suggest there is an important role for macroprudential policy in economies with limited exchange rate flexibility.[1]

The financial sector of the small open economy model we develop builds on Gertler *et al.* (2012). Banks fund lending to non-financial firms with a combination of their own net worth, short-term deposits (in domestic and foreign currencies), and outside equity. Borrowing constraints depend on Tobin's Q - the collateralizable value of bank charters - and a lower Q tightens constraints, weakening aggregate investment and output. While Gertler *et al.* (2012) emphasize volatility on the asset-side of bank balance sheets, we highlight a complementary channel: liability-side volatility from deposit rate fluctuations that are influenced by the focus of monetary policy. When the policy rate is volatile so are banks' net interest margins. This generates investment volatility, which increases adjustment costs, lowers Tobin's Q, tightens credit constraints, and reduces productive capital.

There are two reasons why the policy rate can be relatively volatile in our model. The first reason depends on the source of aggregate uncertainty and the focus of monetary policy. When aggregate uncertainty originates domestically, via technology (externally, via financial

[1]Our results are also consistent with recent empirical evidence that demonstrates macroprudential policy can dampen the macroeconomic impact of global financial shocks when exchange rate flexibility is limited. See Bergant *et al.* (2024).

markets), the real economy is less volatile if monetary policy focuses on stabilizing the exchange rate (domestic prices). Although both types of shocks generate recessions with lower output and elevated credit spreads, negative technology shocks cause the terms of trade to fall, whereas external interest rate shocks cause the terms of trade to rise.[2] This difference explains the relatively strong increase in the policy rate when there are technology (interest rate) shocks and monetary policy stabilizes domestic prices (the exchange rate).[3]

Policy rate volatility also reflects an interaction between bank net worth, the price of physical capital, and the exchange rate. This interaction creates an additional source of amplification onto the real economy and leads to a positive correlation between the local credit spread and an uncovered interest rate parity (UIP) premium - a key empirical regularity.[4] For example, when monetary policy acts to stabilize the exchange rate, the policy rate is required to rise more than one-for-one with the external interest rate. This is because raising the policy rate weakens banks' balance sheets (lowers banks' net worth) and raises the UIP premium. In this case, monetary policy has a smaller effect on the domestic currency than if the UIP premium were constant, the policy rate is used more aggressively, and banks' net interest margins are more volatile.

Macroprudential policy is beneficial in the model because individual banks do not internalize how their financing decisions affect economy-wide Tobin's Q. A macroprudential policy which shifts bank funding away from deposits towards equity reduces bank risk exposure and spread volatility. Equity-financed investment exhibits much lower spread volatility than deposit-financed investment because equity returns move closely with the return on

[2]Movements in the terms of trade are the source of expenditure switching effects commonly associated with sticky-price models of the business cycle. Our model features limited exchange pass-through due to local currency pricing.

[3]This result holds both with and without nominal rigidities. The latter is a useful benchmark because it allows us to isolate the effect of shocks onto the policy rate without feedback to the real economy.

[4]Akinci and Queralto (2024) emphasize this interaction and provide novel empirical evidence on the link between local credit spreads and deviations from UIP.

capital, whereas the deposit rate depends on monetary policy, and may even be negatively correlated with the return on capital. When the policy rate is volatile, so are banks' net interest margins, and macroprudential policy should be used more aggresively to stabilize the banking sector.

We determine optimal macroprudential policy - which we express in terms of the bank capital ratio - and the associated consumption-equivalent welfare gain numerically. Conditional on external financial shocks, when the exchange rate is stabilized, the optimal capital ratio is near 15 percent, whereas when domestic prices are stabilized, the optimal capital ratio is below 10 percent. The difference in the welfare gain between these two monetary policy regimes is 0.9 percentage points. Conditional on domestic technology shocks, when the exchange rate is stabilized, optimal bank capital is a little below 12 percent, whereas, when domestic prices are stabilized, the optimal bank capital ratio is also a little below 15 percent. In this case, the difference in the welfare gain between the two monetary regimes is 0.45 percentage points.

Our results suggest optimal macroprudential policy is sensitive to whether monetary policy stabilizes domestic prices or the exchange rate. We therefore specify monetary policy as an interest rate rule which nests the two polar monetary regimes.[5] If the source of aggregate uncertainty is primarily external and financial (domestic and non-financial) the optimal bank capital ratio rises (falls) as the stance of monetary policy becomes more exchange rate focused. When both shocks operate, the optimal bank capital ratio is U-shaped, with bank capital varying modestly between the two monetary policy extremes.[6] This U-shape result depends on the presence of both nominal price and wage rigidity which imply an aggressive use of macroprudential policy when there are domestic technology shocks and domestic prices

[5]This formulation we use is similar to that adopted by Gali and Monacelli (2016). Also see Itskhoki and Muhkin (2025).

[6]The difference in the consumption-equivalent welfare gain between the two monetary policy extremes is 0.5 percentage points (0.4 percent when domestic prices are stabilized and 0.9 percent when the exchange rate is stabilized) when both shock operate.

are stabilized. With only a single source of nominal rigidity macroprudential policy is more aggressive as monetary policy becomes more exchange rate focused even when both shocks operate.

We contribute to a growing literature on macroprudential policy in open economies.[7] The most closely related work is Aoki *et al.* (2021), who also study macroprudential policy in a small open economy with multiple sources of uncertainty. They show the welfare implications of prudential policies depend on the balance of external versus domestic shocks.[8] We focus on how the stance of monetary policy affects the optimal bank capital ratio. To do so we adapt the small open economy framework of Gali and Monacelli (2005, 2016) to incorporate endogenous bank risk-taking following Gertler *et al.* (2012). Conditional on technology shocks, domestic prices fluctuate more than the exchange rate, so price stability requires large changes in the policy rate, which affects the volatility of bank net interest margins, and raises the optimal capital ratio. Conditional on global interest rate shocks, the opposite occurs: exchange rate stability requires larger policy rate adjustments, raising volatility, with higher levels of bank capital required.

Our focus on bank capital is similar to Bonciani *et al.* (2023), who show in a closed economy setting that macroprudential tools can stabilize both cyclical fluctuations and long-run growth.[9] More broadly, our work also relates to studies of optimal capital requirements that balance the stability benefits of lower default risk against the cost of reduced lending to non-financial firms (e.g., Elenev *et al.*, 2021; Mendicino *et al.*, 2024). Unlike these studies, we emphasize that the monetary policy regime - particularly the extent of exchange rate

[7]See Forbes (2021) for an overview of the literature on macroprudential policy in open economies. Agénor *et al.* (2023) discuss the international gains from macroprudential policy cooperation, from which we abstract by focusing on a small open economy.

[8]Aoki *et al.* (2021) also find that monetary and cyclical macroprudential policies are complementary when external financial shocks are dominant.

[9]Liu (2016) also considers bank capital and the role of outside equity. He proposes an alternative macroprudential policy to that used in Gertler *et al.* (2012).

stabilization - plays a central role in determining optimal capital ratios. This complements findings by Mendicino *et al.* (2020), who show that accommodative monetary policy can offset the costs of tighter capital rules, and by Falasconi *et al.* (2024), who argue for combining capital requirements with exchange rate intervention.

We also contribute to the debate on whether macroprudential policy can insulate economies from external financial shocks, a role often attributed to floating exchange rates. While Obstfeld *et al.* (2019) find that fixed regimes amplify such shocks, Rey (2013) and Gopinath *et al.* (2020) argue that exchange rate flexibility may not provide full insulation because there is a global financial cycle. Cesa-Bianchi *et al.* (2025) provide a quantitative assessment of these ideas in a setting similar to ours. They show the volatility of output is an increasing function of the weight placed on the stabilization of the exchange rate in a monetary policy rule, arguing that even when there is a global financial cycle, the exchange rate regime matters. Our results show that a macroprudential policy which raises bank capital ratios and directly strengthens bank balance sheets can offer an alternative source of insulation from global financial shocks.

The rest of the paper is organized as follows. Section 2 presents the model of a small open economy with financial intermediation and nominal rigidity. Section 3 describes the risk-adjusted steady state and presents the parameterization. Section 4 analyzes the impact of aggregate shocks and the effects of macroprudential policy (with and without nominal rigidities). Section 5 determines the optimal bank capital ratio and discusses how the focus of monetary policy and the source of nominal rigidity shape optimal macroprudential policy. Section 6 concludes.

## 2. Model Economy

In this section we outline the model economy. There is a continuum of households of measure one in the home economy. Within each household, a fraction $1 - \mathfrak{w}$ workers and a fraction $\mathfrak{w}$ consists of financial intermediaries (banks). Workers supply differentiated types of labor, choosing the nominal wage, and then supply labor subject to demand; the income from wages is returned to the household. Banks fund the activities of non-financial firms. Within each household, there is perfect consumption insurance. The household consumes both domestically produced and imported goods. Households save by holding non-state-contingent deposits and by purchasing state-contingent outside equity issued by banks. The foreign economy (the rest of the world) is taken as exogenous, and we use asterisks to denote foreign variables.

### *2.1. Households*

Households have the following intertemporal utility function,

$$E_0 \sum_{t=0}^{\infty} \beta^t \ln \left\{ c_t - \frac{\chi}{1+\frac{1}{\varphi}} \left[ l_t(z) \right]^{1+\frac{1}{\varphi}} \right\} \tag{1}$$

where $c_t$ is total consumption and $l_t(z)$ is labor supply. The parameter $0 < \beta < 1$ is the discount factor and $\varphi \geq 0$ is the Frisch elasticity of labor supply.[10] The households period budget constraint (in units of consumption) is,

$$\begin{aligned} c_t + d_t + \frac{b_t}{p_t} + q_t e_t &= w_t(z) l_t(z) + \theta_t + R_{t-1} d_{t-1} + R^n_{t-1} \frac{b_{t-1}}{p_t} + R^e_t q^e_{t-1} e_{t-1} \\ &\quad - \frac{\theta_w}{2} \left[ \frac{w_t(z)}{w_{t-1}(z)} \pi_t - 1 \right]^2 \end{aligned} \tag{2}$$

The left-hand side of this expression consists of consumption, deposits, $d_t$, nominal risk-free bonds, $b_t$, and bank equity, $e_t$, which is sold at price $q^e_t$. The right-hand side consists of labor-income, $w_t(z) l_t(z)$, profits, $\theta_t$, and income from assets holdings. The terms $R_{t-1}$ and $R^n_{t-1}$ are returns on deposits and nominal bonds. The term $R^e_t = \left[ \psi_t + q^e_t (1-\delta) \right] / q^e_{t-1}$ is the return on bank equity, where $0 < \delta < 1$ is the rate of depreciation of physical capital, and $\psi_t$ is the gross profit per unit of physical capital (defined below). Finally,

[10] These preferences eliminate wealth effects on labor supply (Greenwood *et al.*, 1998). Our main results are unaffected by using seperable utility.

$\theta_w \left[\pi_t w_t(z)/w_{t-1}(z) - 1\right]^2/2$ measures the real cost of wage adjustment, where $\pi_t = p_t/p_{t-1}$ is the gross rate of consumer price inflation.[11]

Households maximize expected lifetime utility, equation (1), subject to their budget constraint, equation (2), and the demand for their labor type, given by, $l_t(z) = [w_t(z)/w_t]^{-\varepsilon_w} l_t$ where $\varepsilon_w > 1$ is the elasticity of substitution across types.[12] Households choose $\{c_t, d_t, e_t, b_t\}$ and $w_t(z)$ and the first-order conditions imply,

$$E_t\Lambda_{t,t+1} = \beta E_t \left(\frac{\varrho_{t+1}}{\varrho_t}\right)^{-1} \qquad \text{where} \qquad \varrho_t \equiv c_t - \frac{\chi}{1+\frac{1}{\varphi}} l_t^{1+\frac{1}{\varphi}} \tag{3}$$

and,

$$E_t\left[\Lambda_{t,t+1}\left(R^e_{t+1} - R_t\right)\right] = 0 \qquad \text{and} \qquad E_t\left[\Lambda_{t,t+1}\left(\frac{R^n_t}{\pi_{t+1}} - R_t\right)\right] = 0 \tag{4}$$

and,

$$\left(\pi^w_t - 1\right)\pi^w_t = \frac{\varepsilon_w}{\theta_w}\left[\chi l_t^{1/\varphi} - \left(\frac{\varepsilon_w - 1}{\varepsilon_w}\right) w_t\right] l_t + E_t\Lambda_{t,t+1}\left[\left(\pi^w_{t+1} - 1\right)\pi^w_{t+1}\right] \tag{5}$$

Equation (3) defines the stochastic discount factor. The two equations in (4) are obtained by combining the household's intertemporal optimality conditions. They are no-arbitrage conditions between investing in deposits, bank equity, and nominal bonds, where $E_t\Lambda_{t,t+1}R_t = 1$. Finally, equation (5) is a forward-looking wage Phillips curve, where a symmetric equilibrium has been imposed. Absent adjustment costs, equation (5) implies $w_t = \left(\frac{\varepsilon_w}{\varepsilon_w - 1}\right)\chi l_t^{1/\varphi}$, where $\chi l_t^{1/\varphi}$ is the marginal rate of substitution, and $\frac{\varepsilon_w}{\varepsilon_w - 1} > 1$ is the flexible-wage markup. Finally, the evolution of the real wage is governed by $w_t/w_{t-1} = \pi^w_t/\pi_t$ such that real wage growth depends on the growth in nominal wages versus the growth in nominal prices.

### *2.2. Banks*

[11] Choosing the wage each period subject to a quadratic cost generates nearly identical implications to the case in which there is a Calvo-type wage setting restriction.

[12] This is derived labor demand, assuming each household $z$ provide a specific labor type, and competes under conditions of monopolistic competition, with aggregator $l_t = \left\{[l_t(w)]^{(\varepsilon_w - 1)/\varepsilon_w} dz\right\}^{\varepsilon_w/(\varepsilon_w - 1)}$.

Banks lend (capital, $k_t$) to non-financial firms, with total lending equal to $q^k_t k_t$, where $q^k_t$ denotes the real price of capital (Tobin's Q). Banks raise inside equity (net worth, $n_t$) exclusively through retained earnings; inside equity can be interpreted as common stock. Banks also borrow from the domestic market (via household deposits, $d_t$) and from the international financial market ($Q_t d^\star_t$). We use notation $\mathcal{E}_t$ for the nominal exchange rate, defined as units of domestic currency per unit of foreign currency, and $Q_t \equiv \mathcal{E}_t / p_t$ is the real exchange rate.[13] The balance sheet of a bank is,

$$(1+\tau_t)\, q^k_t k_t = n_t + d_t + (1+\tau^e_t) q^e_t e_t + Q_t d^\star_t \tag{6}$$

where $\tau_t \geq 0$ is a tax on bank assets - total lending - and $\tau^e_t \geq 0$ is a subsidy to outside equity - $q^e_t e_t$. Outside equity permits the bank to hedge against fluctuations in the return on its assets and can be interpreted as preferred stock or subordinate debt.

The net worth of a bank evolves according to,

$$n_{t+1} = R^k_{t+1} q^k_t k_t - R_t d_t - Q_{t+1} R^\star_t d^\star_t - R^e_{t+1} q^e_t e_t \tag{7}$$

where $R^k_t = \left[\psi_t + q^k_t (1-\delta)\right] / q^k_{t-1}$ is the return on capital, $\psi_t$ denotes the capital rent, and $R^\star_t$ is the foreign interest rate.

In each period banks continue operating with probability $\sigma$. With complementary probability, $1-\sigma$, they exit, return their net worth to households, and are replaced by an equal mass of new banks that start operating with a small transfer from households. The objective of banks is to maximize the expected value of terminal wealth,

$$V_t = E_t \Lambda_{t,t+1} \left[(1-\sigma)\, n_{t+1} + \sigma V_{t+1}\right] \tag{8}$$

where $\Lambda_{t,t+1}$ is the household stochastic discount factor defined in equation (3). The value of the bank can be expressed as the discounted value of future net worth: $V_t = E_t \Lambda_{t,t+1} \left[(1-\sigma) + \sigma \left(\frac{V_{t+1}}{n_{t+1}}\right)\right] n_{t+1}$, where the term $\Omega_{t+1} = (1-\sigma) + \sigma \left(\frac{V_{t+1}}{n_{t+1}}\right)$ is the bank-relevant discount factor.

[13] Since the foreign economy is large relative to the home economy, we normalize $p^\star_t = 1$.

Following Gertler *et al.* (2012) we introduce banks' valuation of future returns:

$$\mu_t^d = E_t \Lambda_{t,t+1} \Omega_{t+1} R_t \qquad \text{and} \qquad \mu_t^e = E_t \Lambda_{t,t+1} \Omega_{t+1} \left( R_t - R_{t+1}^e \right)$$

and,

$$\mu_t^k = E_t \Lambda_{t,t+1} \Omega_{t+1} \left( R_{t+1}^k - R_t \right) \quad \text{and} \quad \mu_t^{d^\star} = E_t \Lambda_{t,t+1} \Omega_{t+1} \left[ R_t - R_t^\star \left( \frac{Q_{t+1}}{Q_t} \right) \right]$$

We can then show that the value of the bank per unit of net worth is,

$$\frac{V_t}{n_t} = \left( \mu_t^k - \tau_t \mu_t^d \right) \phi_t + \mu_t^d + \phi_t x_t^e \left( \mu_t^e + \tau_t^e \mu_t^d \right) + x_t^{d^\star} \phi_t \mu_t^{d^\star} \tag{9}$$

where we further define $x_t^e \equiv \frac{q_t^e e_t}{q_t^k k_t}$ and $x_t^{d^\star} \equiv \frac{Q_t d_t^\star}{q_t^k k_t}$, which are outside equity and foreign borrowing as fractions of total bank assets, respectively, and bank leverage is defined as $\phi_t \equiv q_t^k k_t / n_t$.

There is an agency friction between financial intermediaries and depositors that generates an endogenous leverage constraint. Rational depositors limit their lending to ensure that bankers do not have an incentive to divert funds according to,

$$V_t \geq \Theta_t q_t^k k_t \tag{10}$$

where the absconding rate is given by,

$$\Theta_t = \theta \left[ 1 + \varepsilon x_t^e + \frac{\kappa^e \left( x_t^e \right)^2 + \kappa^{d^\star} \left( x_t^{d^\star} \right)^2}{2} \right] \tag{11}$$

This specification implies that the greater the reliance on outside equity, the more difficult it becomes to monitor banks' balance sheets (Calomiris and Kahn, 1991). In other words, agency frictions rise as banks shift funding from short-term debt to equity. Despite this, banks benefit from issuing outside equity, since we assume $\varepsilon < 0$, and calibrate the model so that $\Theta_{x_t^e} = \theta \left( \varepsilon + \kappa^e x_t^e \right) > 0$. The specification of $\Theta_t$ also implies that monitoring becomes harder as foreign borrowing grows. This assumption (where $\Theta_{x_t^{d^\star}} = \theta \left( \kappa^{d^\star} x_t^{d^\star} \right) > 0$) allows deviations from uncovered interest rate parity (UIP) to be linked to the local credit spread.[14].

[14] We follow Akinci and Queralto (2024). For an alternative specification, see Mimir and Sunel (2019)

When the incentive constraint binds, the bank-relevant discount factor depends on leverage $\Omega_{t+1} \equiv (1-\sigma) + \sigma\Theta_{t+1}\phi_{t+1}$, which is not internalized in current decision-making, as we assume the banker takes the value of exclusive access to assets, $\mu_t^{()}$ as given.

The bank's problem is to maximize (9) subject to (10), by choosing $\left\{\phi_t, x_t^e, x_t^{d^\star}\right\}$. The binding incentive constraint implies,

$$\phi_t = \frac{\mu_t^d}{\Theta_t - \left(\mu_t^k + \mu_t^e x_t^e + \mu_t^{d^\star} x_t^{d^\star}\right)} \tag{12}$$

The first-order conditions are,

$$\frac{\mu_t^k + \mu_t^e x_t^e + \mu_t^{d^*} x_t^{d^\star} + \mu^d\left(\tau_t^e x_t^e - \tau_t\right)}{\Theta_t} = \frac{\mu_t^e + \tau_t^e \mu_t^d}{\Theta_{x_t^e}} \tag{13}$$

and,

$$\frac{\mu_t^k + \mu_t^e x_t^e + \mu_t^{d^*} x_t^{d^\star} + \mu_t^d\left(\tau_t^e x_t^e - \tau_t\right)}{\Theta_t} = \frac{\mu_t^{d^*}}{\Theta_{x_t^{d*}}} \tag{14}$$

Equations (13) and (14) describe how banks substitute between domestic deposits, foreign currency debt, and equity. The macroprudential policy $\tau_t^e$ alters this margin directly. Moreover, absent macroprudential policy and foreign currency debt, using equation (13), it is straightforward to show that $x_t^e$ is an increasing function of $\frac{\mu_t^e}{\mu_t^k}$, which is the excess value from substituting outside equity for deposit finance versus the excess value on assets over the deposit. Equation (14) is more novel and it links equity and foreign debt. It is equally possible to show, however, that $x_t^{d^\star}$ is increasing in $\frac{\mu_t^{d^\star}}{\mu_t^k}$. For our purposes, the most important element of equation (14) is that it allows for endogenous deviations from uncovered interest rate parity (UIP).[15]

## *2.3. Non-Financial Firms*

[15] It also renders the net foreign asset position for the economy stationary (Akinci and Queralto, 2024). Without such a mechanism it would be necessary, for example, to introduce a small portfolio-adjustment cost for trading bonds to ensure stationarity of the net foreign asset position (Schmitt-Grohe and Uribe, 2003).

2.3.1. Final Good Producer

A final good is produced by a representative firm which combines an aggregate of domestic $(y_{h,t})$ and imported $(y_{f,t})$ goods. The technology is,

$$y_t = \left[\alpha^{1/\omega} y_{h,t}^{(\omega-1)/\omega} + (1-\alpha)^{1/\omega} y_{f,t}^{(\omega-1)/\omega}\right]^{\omega/(\omega-1)} \tag{15}$$

where $\alpha$ captures openness to international trade in goods and $\omega > 0$ is the elasticity of substitution (Armington elasticity). Firms maximize profits, $\{p_t y_t - p_{h,t} y_{h,t} - p_{f,t} y_{f,t}\}$, subject to technology, where $p_{h,t}$ $(p_{f,t})$ is the domestic currency price of the domestic (imported) good. The demand functions are,

$$y_{h,t} = (1-\alpha)\left(\frac{p_{h,t}}{p_t}\right)^{-\omega} y_t \quad \text{and} \quad y_{f,t} = \alpha \left(Q_t\right)^{-\omega} y_t \tag{16}$$

where the price index is such that $\Phi_t \equiv \frac{p_t}{p_{h,t}} = \left[(1-\alpha) + \alpha\left(\frac{p_{f,t}}{p_{h,t}}\right)^{1-\omega}\right]^{1/(1-\omega)}$ and $Q_t$ is the real exchange rate, defined above. We assume the law of one price holds for the imported good, such that $p_{f,t} = \mathcal{E}_t$ and $p_{f,t}^{\star} = p_t^{\star}$.

2.3.2. Intermediate Goods Producers

There are $j \in [0,1]$ firms producing a differentiated intermediate output. Each good is sold in the domestic and export market - $y_{h,t}(j)$ and $y_{h,t}^{\star}(j)$ - and firms set prices in local currency - $p_{h,t}(j)$ and $p_{h,t}^{\star}(j)$ - to maximize the net present value of profits. Firms face quadratic price adjustment costs and a downward-sloped demand curve.[16] The problem of the firm is,

$$\max_{\left\{p_{h,t}(j), p_{h,t}^{\star}(j)\right\}} E_t \sum_{s=t}^{\infty} \Lambda_{t,s}\left[\vartheta_{h,s}(j) + \vartheta_{h,s}^{\star}(j)\right] \tag{17}$$

where,

$$\vartheta_{h,s}(j) = \left[\frac{p_{h,s}(j)}{p_s} - mc_s\right]\left[\frac{p_{h,s}(j)}{p_{h,s}}\right]^{-\varepsilon_p} y_{h,s} - \frac{\theta_p}{2}\left[\frac{p_{h,s}(j)}{p_{h,s-1}(j)} - 1\right]^2$$

[16] Since intermediate firms supply a differentiated product we assume these firms compete under conditions of monopolistic competition with standard CES aggregation, $y_{h,s} = \left\{[y_{h,s}(j)]^{(\varepsilon_p-1)/\varepsilon_p} dj\right\}^{\varepsilon_p/(\varepsilon_p-1)}$, and similar for $y_{h,s}^{\star}$.

and,

$$\vartheta_{h,s}^{\star}(j) = \left[\frac{p_{h,s}^{\star}(j)}{p_s^{\star}} - mc_s\right]\left[\frac{p_{h,s}^{\star}(j)}{p_{h,s}^{\star}}\right]^{-\varepsilon_p} y_{h,s}^{\star} - \frac{\theta_p}{2}\left[\frac{p_{h,s}^{\star}(j)}{p_{h,s-1}^{\star}(j)} - 1\right]^2$$

and where $\varepsilon_p > 1$ is the elasticity of substitution across products, $mc_t$ are marginal costs, and the parameter $\theta_p \geq 0$ determines the real costs associated with price adjustment.[17]

The first-order condition for domestic sales implies,

$$(\pi_{h,t} - 1)\,\pi_{h,t} = \frac{\varepsilon_p}{\theta_p}\left[mc_t - \frac{\varepsilon_p - 1}{\varepsilon_p}\left(\frac{p_{h,t}}{p_t}\right)\right] y_{h,t} + E_t\Lambda_{t,t+1}\left[(\pi_{h,t+1} - 1)\,\pi_{h,t+1}\right] \tag{18}$$

where $\pi_{h,t} \equiv p_{h,t}/p_{h,t-1}$ is domestic price inflation. If we suppose $\theta_h \to 0$, so that price adjustment costs are absent, then $\frac{p_{h,t}}{p_t} = \left(\frac{\varepsilon_p}{\varepsilon_p - 1}\right) mc_t$, where $\frac{\varepsilon_p}{\varepsilon_p - 1} > 1$ is the flexible-price markup. The first-order condition for export sales implies,

$$\left(\pi_{h,t}^{\star} - 1\right)\pi_{h,t}^{\star} = \frac{\varepsilon_p}{\theta_p}\left[mc_t - \frac{\varepsilon_p - 1}{\varepsilon_p}\left(\frac{p_{h,t}}{p_t}\right) g_{h,t}\right] y_{h,t}^{\star} + E_t\Lambda_{t,t+1}\theta_h\left[\left(\pi_{h,t+1}^{\star} - 1\right)\pi_{h,t+1}^{\star}\right] \tag{19}$$

where $\pi_{h,t}^{\star} \equiv p_{h,t}^{\star}/p_{h,t-1}^{\star}$ is export price inflation and $g_{h,t} \equiv \mathcal{E}_t\left(p_{h,t}^{\star}/p_{h,t}\right)$ captures deviations from the law of one price for exported goods which reflects the (lack of) exchange rate pass-through.

There are $i \in [0,1]$ firms which combine capital and labor using a Cobb-Douglas technology,

$$y_{h,t}(i) + y_{h,t}^{\star}(i) = a_t\left[k_{t-1}(i)\right]^{\eta}\left[l_t(i)\right]^{1-\eta} \tag{20}$$

where $a_t$ is exogenous and is the only source of aggregate domestic uncertainty. Total costs of production are $w_t l_t(i) + \psi_t k_{t-1}(i)$ and taking prices as given cost minimization gives input demands. The ratio of input demands determines the capital/labor ratio,

$$\frac{l_t}{k_{t-1}} = \left(\frac{1-\eta}{\eta}\right)\frac{\psi_t}{w_t} \tag{21}$$

[17] We assume that price adjustment costs do not depend on total output. This assumption has no bearing on our results.

Factor demands also imply that a firm's marginal cost is given by,

$$mc_t = \frac{1}{a_t} \frac{w_t^{1-\eta} \psi_t^{\eta}}{\eta^{\eta} (1-\eta)^{1-\eta}} \tag{22}$$

which is common to all firms. Equations (21) and (22) can be used to determine gross profit per unit of physical capital, which is given by $\psi_t = \eta a_t \left( \frac{l_t}{k_{t-1}} \right)^{1-\eta} mc_t$.

2.3.3. Capital Good Producer

A representative firm produces capital which is sold at price $q_t^k$. In order to produce $i_t = k_t - (1-\delta) k_{t-1}$ units of new capital the firm needs to spend $\left[ 1 + \theta_i \left( \frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_s$ units of consumption. The firm maximizes the expected discounted value of profits, given by $E_t \sum_{s=t}^{\infty} \Lambda_{t,s} \left\{ q_s^k i_s - \left[ 1 + \theta_i \left( \frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_s \right\}$, and the optimality condition for investment is,

$$q_t^k = 1 + \frac{\theta_i}{2} \left( \frac{i_t}{i_{t-1}} - 1 \right)^2 + \theta_i \frac{i_t}{i_{t-1}} \left( \frac{i_t}{i_{t-1}} - 1 \right) - \theta_i E_t \Lambda_{t,t+1} \left( \frac{i_{t+1}}{i_t} \right)^2 \left( \frac{i_{t+1}}{i_t} - 1 \right) \tag{23}$$

which equates the price of capital goods (Tobin's q) to the marginal cost of investment goods.

### *2.4. The Rest of the World*

The rest of the world trades external financial securities (with domestic banks) and tradable goods (with domestic households). From the perspective of the small open economy, the rest of the world provides an international interest rate for external securities, foreign demand for the home tradable good, and foreign supply of the foreign tradable good.

For external financial securities, the small open economy faces perfectly elastic demand, with an interest rate in foreign currency, $R_t^{\star}$. In general terms, we consider the foreign interest rate as a proxy for the global financial cycle, and so changes in the foreign interest rate can be due to changes in foreign monetary policy and/or the risk premium foreign lenders require.

For tradable goods, we assume a perfectly elastic supply of the foreign good at a fixed price in foreign currency, and a downward-sloped foreign demand for the home tradable good, given by,

$$y^{\star}_{h,t} = \alpha \left(\frac{1}{T_t}\right)^{-\omega} y^{\star}_t \tag{24}$$

where $T_t \equiv p_{f,t}/\left(\mathcal{E}_t p^{\star}_{h,t}\right)$ are the terms of trade and $y^{\star}_t$ is foreign demand.[18] Finally, given this definition, the terms of trade and the real exchange rate are linked in the following way, $Q_t = \frac{T_t g_{h,t}}{\Phi_t}$.

### *2.5. Macroprudential Policy*

Macroprudential policy is a tax/subsidy scheme as outlined in equation (6). We assume the tax on bank assets is set to make the subsidy to outside equity revenue neutral where $\tau_t = \tau^e_t x^e_t$. We further assume the subsidy to outside equity is set to make the net gain to outside equity from reducing deposits constant in terms of consumption goods. The macroprudential policy rule is therefore,

$$\tau^e_t = \frac{\tau^e}{\mu^d_t} \qquad \text{where} \qquad \tau^e \geq 0 \tag{25}$$

where $\mu^d_t > 0$ is the shadow cost of bank deposits (defined above) and $\tau^e$ captures the strength of macroprudential policy. Since $\tau^e_t$ responds inversely to the shadow costs of deposits, equation (25) implies the incentive for the financial intermediary to rely on debt is high when $\mu^d_t$ is low. In this situation, the macro prudential policymaker would subsidize outside equity more strongly, and in this regard, the macroprudential policy is countercyclical.

### *2.6. Equilibrium*

[18] These conditions can be micro-founded from the problem of a representative foreign household that is risk neutral, has constant elasticity of substitution preferences over home and foreign tradable goods, and is infinitely large relative to the small open economy but the share of home tradable good consumption in its consumption basket is infinitely small.

Each period a fraction $\sigma$ of banks exit and are replaced by an equal mass of new banks which receive a startup transfer from the household. Aggregate net worth in the banking sector therefore evolves according to,

$$\begin{aligned}\frac{n_t}{n_{t-1}} &= \sigma\left\{\left(R_t^k - R_{t-1}\right) + \left(R_{t-1} - R_t^e\right)x_{t-1}^e + \left[R_{t-1} - R_{t-1}^{\star}\left(\frac{Q_t}{Q_{t-1}}\right)\right]x_{t-1}^{d^{\star}}\right\}\phi_{t-1} \\ &\quad + \sigma R_{t-1} + \xi\left(1-\sigma\right)\phi_{t-1} \qquad (26)\end{aligned}$$

where the net transfer to new banks is $\xi\left(1-\sigma\right)\phi_{t-1}$ and total lending is $s_t = k_t$.

Domestic goods markets clear and,

$$y_t = c_t + \left[1 + \theta_i\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right]i_t + \Xi_t \qquad (27)$$

where $\Xi_t \equiv \theta_w\left(\pi_t^w - 1\right)^2/2 + \theta_p\left[\left(\pi_{h,t} - 1\right)^2 + \left(\pi_{h,t}^{\star} - 1\right)^2\right]/2$ such that final output is equal to consumption, investment, and the real costs associated with wage and price adjustment.

Finally, net foreign liabilities (external debt) evolves according to,

$$d_t^{\star} = R_{t-1}^{\star}d_{t-1}^{\star} + \left(y_{f,t} - \frac{y_{h,t}^{\star}}{T_t}\right) \qquad (28)$$

where the domestic bond is in zero net supply and $b_{t-1} = 0$. The term in brackets in equation (28) is net exports which, using demand curves, we can re-express as $nx_t \equiv \alpha\left(Q_t^{-\omega}y_t - T_t^{\omega-1}y_t^{\star}\right)$.

## 3. The Risk-Adjusted Steady State and Model Parameterization

In this section we characterize the link between bank constraints, Tobin's Q, and bank profits (via the net interest margin). We also present the parameterization of the model. In doing so, we rely on the concept of a risk-adjusted steady state. In this economy, the household savings portfolio comprises bonds, bank deposits, and bank equity, all of which yield identical returns in the deterministic steady state. Consequently, the portfolio composition is determined from the risk-adjusted steady state, which incorporates the second moments and covariances of expected returns.[19]

*3.1. Bank Constraints, Tobin's Q, and the Net Rate Interest Margins*

The financial distortion in the model stems from moral hazard. This leads to a credit constraint on bank liabilities - equation (10) - which we express as,

$$\left(E_t\Lambda_{t,t+1}\Omega_{t+1}R^k_{t+1} - \Theta_t\right) q^k_t k_t \geq E_t\Lambda_{t,t+1}\Omega_{t+1}\left(Q_{t+1}R^\star_t d^\star_t + R_t d_t + R^e_{t+1} q^e_t e_t\right) \tag{29}$$

This constraint is binding. When the price of capital, $q^k_t$, increases, banks can borrow more and invest in capital. We determine the price of capital in the risk-adjusted steady state as follows,

$$q^k = 1 - \theta_i\beta\left[2var_t\left(\widehat{i}_{t+1}\right) + cov_t\left(\widehat{\Lambda}_{t,t+1}\widehat{i}_{t+1}\right)\right] \tag{30}$$

where a hat denotes the deviation of a variables from it's risk-adjusted steady state. Equation (30) shows that higher investment volatility increases transaction costs (captured by $\theta_i > 0$). This reduces the value of physical capital as an investment instrument.

The volatility of investment itself depends on the volatility of commercial bank profits for two reasons: commercial banks maximize expected profits when making investment decisions and the value of a bank charter is proportional to its net worth. The higher is net worth the more collateral banks can pledge. This allows banks to borrow more which raises investment. We use the growth of net worth to determine bank profits and the net interest margin of a bank is expressed in the following way [20]

$$\begin{aligned}\frac{n_t}{n_{t-1}} &= \sigma\left\{\left(R^k_t - R_{t-1}\right)\frac{d_{t-1}}{q^k_{t-1}k_{t-1}} + \left[R^k_t - \left(\frac{Q_t}{Q_{t-1}}\right)R^\star_{t-1}\right]x^e_{t-1} + \left(R^k_t - R^e_t\right)\right\}\phi_{t-1} \\ &\quad + \left[\sigma R^k_t + \xi\left(1-\sigma\right)\right]\phi_{t-1}\end{aligned} \tag{31}$$

[19] In Appendix A.1. we present the complete set of non-linear equations of the model. In Appendix A.2. we solve the deterministic steady state. In Appendix A.3. we describe the calculation of the risk-adjusted steady state.

[20] See deGroot and Hass (2023) for a similar definition.

A macroprudential policy which increases the share of bank equity in total assets, $x_t^e$, is particularly beneficial when the marginal product of capital is volatile, because the equity spread, $R_t^k - R_t^e$, remains relatively stable even if the deposit spread, $R_t^k - R_{t-1}$, is volatile. In this case, the higher the volatility in asset returns, the greater the benefit associated with macroprudential policy.

We highlight that the volatility of the net interest margin is the key factor in explaining the volatility of investment. Therefore, it is not only the volatility of asset returns that matters, but also the volatility of the return on liabilities - namely $R_{t-1}$ - and, in particular, its correlation with asset returns. In our model, the volatility of the deposit interest rate depends on how monetary policy responds to macroeconomic conditions. Aggressive monetary policy makes deposit rates more volatile, strengthening the case for macroprudential intervention. In an open economy, as we will show, the response of the policy rate differs considerably depending on the focus of monetary policy; for example, whether domestic prices or the exchange rate is stabilized, and this has implications for optimal macroprudential policy.

*3.2. Parameterization*

In this section we parameterize the model and report values for the risk-adjusted steady-state. We calibrate the model assuming there is no macroprudential policy (an unregulated economy with $\tau^e = 0$) and that the short-term nominal interest rate is set according to a Taylor rule that only targets domestic inflation; specifically, $R_t^n/R^n = (\pi_{h,t}/\pi_h)^{\nu_\pi}$ with a coefficient of $\nu_\pi = 1.5$.

We first assign parameter values that do not affect the risk-adjusted steady state. In particular, we suppose the annualized risk-free rates ($R$ and $R^\star$) in the home and foreign economy are 0.5 and 3 percent and we use $\beta < \beta^\star$ to hit these targets. We set $\varphi = 0.5$, which corresponds to a Frisch elasticity of labor supply of 2, which is in line with the macro labor literature (Keane and Rogerson, 2012), and we set $\omega = 1.5$, which determines the elasticity of substitution between home and foreign goods, and is in line with the international macro literature (Itskhoki and Mukhin, 2021). The elasticities of substitution between labor and product types are set at $\varepsilon_w = 3.8$ and $\varepsilon_p = 4.3$. These values correspond to flexible-wage and flexible-price markups of 35 and 30 percent. Finally, we set $\delta = 0.025$, which implies the rate of depreciation of physical capital is 10 percent annually, and we set $\sigma = 0.95$, which implies a bank survival rate of 6 years.

We then divide the remaining model parameters into those which are, in effect, a combination of New Keynesian parameters and other standard macroeconomic variables (Non-Bank Parameters), those associated directly with the banking sector (Bank-Related Parameters), and those which determine the sources of aggregate uncertainty in our model (Exogenous Processes). Table 1 lists all of these parameters and the relevant targets.

**===== Table 1 Here =====**

For Non-Bank Related Parameters, given the price markup, we set $\eta = 0.28$ so that the labor share of output is 55% (Gali and Monacelli, 2016), and we set $\alpha = 0.09$ such that exports in output (trade openness) is 10%. We adjust $\chi$ so that the steady-state working time is about 30 percent of total time endowment (i.e., $l = 0.3$). With respect to nominal rigidities, we set the wage stickiness parameter, $\theta_w$, to a value that would replicate the slope of the wage Phillips curve derived using Calvo stickiness with an average wage duration of 3 quarters. We set the parameter $\theta_p$ such that the slope of the Phillips curve in our model is consistent with the slope of a Calvo-type Phillips curve with an average price duration of 2.5 quarters (Bils and Klenow, 2004). We discuss the role of $\theta_w$ and $\theta_p$ in our analysis below (section 5).[21] For investment adjustment costs, we set $\theta_i = 1.35$ such that the ratio of the standard deviation of output growth to investment growth is $\frac{\sigma_{\Delta i}}{\sigma_{\Delta y}} = 2.5$, which is a typical value observed in most economies.

[21]Our baseline values are typical in the literature; for example, see Fernández-Villaverde (2015). Born and Pfeifer (2020) provide a detailed discussion of how to map the Rotemberg parameter into the Calvo paramater in the wage Phillips curve.

For Bank Related Parameters, we set the diversion parameter, $\theta = 0.60$, and the startup transfer parameter, $\xi = 0.07$, to target a leverage ratio of 4 and an annualized domestic credit spread of 300 basis points.[22] We follow Gertler *et al.* (2012) and set $\kappa = 13.23$. This parameter is used capture bank deleveraging as the economy moves from low risk to high risk, something we do not focus on. We then set $\varepsilon = -1.04$ and $\varsigma = 13.27$ to target an 8% bank capital ratio and a 10% rate of foreign borrowing ($\frac{Qd^\star}{d}$).

We assume aggregate technology ($a$) and the world interest rate ($R^\star$) follow independent exogenous autoregressive processes, given by,

$$\lambda_t = \Lambda_0 + \Lambda\lambda_{t-1} + u_t \qquad \text{and} \qquad u_t \sim N(0, I) \tag{32}$$

where $\lambda_t = [\ln(a_t), \ln(R_t^\star)]^\intercal$ and $\Lambda_0 = [\ln(a), \ln(R^\star)]^\intercal$. The term $u_t = \left[u_t^a, u_t^{R^\star}\right]^\intercal$ is a vector of mean zero shocks. Since it is not our intention to determine the contribution of these shocks to the domestic economy we take the following approach. We use estimated values from Akinci and Queralto (2022) for the interest rate process and set the persistence parameter at $\rho_{R^\star} = 0.87$ with a standard deviation of $\sigma_{R^\star} = 0.0014$.[23] We assume standard values for the technology process and set the persistence at $\rho_a = 0.9$ with a standard deviation of $\sigma_a = 0.007$.

Our calibration also determines non-targeted moments that are of interest. In terms of first moments, our calibration implies that the ratio of outside to inside equity - i.e., $\frac{q^e e}{n}$ - is 32%, which approximates the ratio of common equity to the sum of preferred equity and subordinate debt.[24] In terms of second moments, the standard deviation of output

[22]We consider this to be conservative. For example, Gilchrist and Zakrajšek (2012) find an average credit spread of 241 basis points for the US.

[23]The estimate of shock size are considerably lower then those in Neumeyer and Perri (2005) and Uribe and Yue (2006).

[24]Tier 1 capital, which is the core measure of a bank's financial strength from a regulator's point of view, primarily consists of common stock and retained earnings. It may also include non-redeemable non-cumulative preferred stock. Tier 2 capital represents supplementary capital such as undisclosed reserves, general loan-loss reserves and subordinated debt.

growth is $\sigma_{\Delta y} = 0.009$, which is within the range of standard estimates, and the relative standard deviation of consumption is $\frac{\sigma_{\Delta c}}{\sigma_{\Delta y}} = 0.86$. Finally, net exports are countercyclical, and $corr\left(\Delta nx, \Delta y\right) = -0.61$.

## 4. Macroprudential Policy and Monetary Policy

In this section we use a series of impulse functions to explain the main mechanisms in the model. Ultimately, our model features two sources of frictions: those originating in the financial sector, through moral hazard, and those arising from nominal rigidities, which allow monetary policy to influence real variables. An important part of the paper rests in showing how the stance of monetary policy influences the use macroprudential policy. To build intuition for our results we therefore start by shutting-down the nominal rigidities channel in order to focus on how aggregate shocks affect real variables and the terms of trade. We then show how the policy rate differs depending on the focus of monetary policy, and finally, how macroprudential policy (as specified in section 2.5) affects the economy. After this, we reinstate nominal rigidities so that the monetary policy regime affects the response of real variables to shocks.

For this section only we focus on two monetary policy regimes. The first is one in which domestic prices are fully stabilized, $p_{h,t}/p_{h,t-1} = 1$, which we refer to as DIT. The second is one in which the nominal exchange rate is fully stabilized, $\mathcal{E}_t/\mathcal{E}_{t-1} = 1$, which we refer to as PEG.

### *4.1. Impulse Response Functions without Nominal Rigidities*

We first explain the response of real variables to a domestic technology shock and an external interest rate shock. A negative technology shock causes the marginal product of capital to decline and investment and production to contract. A lower return on assets reduces banks' net worth, while a fall in Tobin's Q tightens borrowing constraints, limiting credit supply. The reduction in production also leads to a deterioration in the terms of trade. When a recession occurs due to a rise in the global interest rate, higher borrowing costs tighten credit constraints, and widen the domestic credit spread. Whilst production contracts, reduced foreign borrowing strengthens the trade balance, which requires an improvement in the terms of trade. We illustrate these results in Figure 1 for a one-standard-deviation shock to technology (green - dashed line) and the foreign interest rate (black - solid line).

===== **Figure 1 Here** =====

Both a negative technology shock and a positive interest rate shock reduce GDP and consumption, pushing the economy into a recession. Financial frictions amplify these effects: net worth (and banks profitability) decline, capital accumulation slows, and higher expected credit spreads act as a wedge in the capital market that discourages investment. The crucial difference lies in the behavior of the terms of trade. The technology shock raises marginal costs, making domestic goods relatively more expensive, worsening the terms of trade. An external interest rate shock reduces foreign borrowing and forces an improvement in the trade balance, an adjustment which is only possible if import prices rise relative to domestic prices.

In Figure 2 we plot the impulse response of domestic inflation and the nominal interest rate (the policy rate). We note that, (i), since there are no nominal price rigidities, the law of one price holds, and $\pi_{h,t} = \Delta\mathcal{E}_t$, and (ii), since there are also no nominal wage rigidities, the response of real variables in Figure 1 are independent of what we assume about the monetary policy regime.

===== **Figure 2 Here** =====

Figure 2 shows that nominal interest rate dynamics differ considerably depending on the monetary policy regime. In particular, following a technology shock, DIT allows the exchange rate to depreciate, while PEG allows domestic prices to rise. This follows directly from the dynamics of the terms of trade, defined as the ratio of domestic to imported goods prices. Consequently, the policy rate increases more under DIT than under PEG. By contrast, after an interest rate shock, the relative price adjustment works in the opposite direction: import prices rise more than domestic prices, so the policy rate reacts more under PEG than under DIT. Thus, the choice of monetary policy regime determines whether the policy rate responds more strongly to domestic or external shocks. Finally, under the PEG regime, it is important to recall that the rise in the policy rate needs to be larger than the change in the foreign interest rate (which rises at an annualized amount by 0.56 percent upon impact) because endogenous deviations from UIP, which are linked to the domestic credit spread (see Figure 1), weaken the link between the expected change in the exchange rate and the policy rate.

For either of the monetary policy regimes we consider, when the economy experiences a shock, the rental rate of capital falls and prices rise. If monetary policy acts to keep domestic prices constant the policy rate moves in the opposite direction to the return on capital, increasing the volatility of the deposit spread, providing a strong case for macroprudential policy intervention. If monetary policy acts to stabilize the exchange rate, however, the response of the policy rate is modest, limiting the benefits associated with macroprudential policy. The opposite occurs when there is an interest rate shock. If policy acts to stabilize the exchange rate, a rise in the foreign interest rate is more than matched (since UIP fails to hold) by a rise in the policy rate. In contrast, if domestic prices are kept stable, the required rise in the policy rate is smaller. In this case, if the real return on capital is unchanged, a higher policy rate raises the spread, and renders exchange rate stabilization more volatile in terms of the effect on net interest margins. This enhances the benefits of macroprudential policy.

In Figure 3 we consider the impact of both shocks (separately) with and without macroprudential policy. The macroprudential policy instrument is $\tau^e$, as shown in equation (25), and we set $\tau^e = 0.01$ exogenously.

**===== Figure 3 Here =====**

Macroprudential policy influences the macroeconomy through two channels. First, it stabilizes banks' net interest margins. By construction, the fall in the return on equity financing $(R_{t+1}^k - R_{t+1}^e)$ is lower than the fall in the return on deposit financing $(R_{t+1}^k - R_t)$. Macroprudential policy increases the steady-state share of equity in banks' balance sheets, which reduces their reliance on deposits, and makes funding costs less sensitive to shocks. As a result, the net interest margin becomes less volatile, cushioning banks' net worth in recessions. Macroprudential policy is also countercyclical - see equation (25). During a recession, when the expected return on domestic deposits rises, the tax on bank assets declines, making the policy less invasive. This encourages banks to reduce their equity share, lowers moral hazard (measured by the share of divertible income, $\Theta_t$), relaxes credit constraints, and narrows credit spreads. Overall, the result is a smaller decline in investment and GDP.

Figure 3 also shows that macroprudential policy reduces the volatility of the UIP premium, an object of independent interest, which is linked to the local credit spread (Akinci and Queralto, 2024). To understand why, consider the first-order conditions of the banking optimization problem - equations (13) and (14) which together yield a log-linear relationship between the UIP premium and the after-tax credit spread,

$$\widehat{UIP}_t = \widehat{\mathrm{R}}_t + \frac{1 - \kappa^e (\bar{x}^e)^2}{\bar{g}} \widehat{x}_t^{d^\star} + \frac{\kappa^e (\bar{x}^e)^2}{\bar{g}} \widehat{x}_t^e \tag{33}$$

where $\mathrm{R}_t \equiv R_{t+1}^k - R_t (1 + \tau_t)$ is the after-tax credit spread and $\bar{g} \equiv 1 - \frac{1}{2}\kappa^e (\bar{x}^e)^2 - \frac{1}{2}\kappa^{d^\star} (\bar{x}^{d^\star})^2$. Equation (33) shows that the UIP premium depends on the after-tax credit spread and a financial wedge through $\hat{x}_t^e$ and $\widehat{x}_t^{d^\star}$. Because macroprudential policy is countercyclical, $\widehat{x}_t^e$ is negative and $\widehat{x}_t^{d^\star}$ is slightly positive, but only in the first period after the shock. At the same time, the after-tax credit spread is less volatile than the gross credit spread, $R_{t+1}^k - R_t$, and consequently, stronger macroprudential intervention reduces both the volatility of the UIP premium and its correlation with the expected gross credit spread such that macroprudential policy weakens the link between the UIP premium and global financial conditions.

*4.2. The Role of Monetary Policy for Real Variables*

In this section we reinstate nominal rigidities and the link between the stance of monetary policy and the response of real variables to aggregate shocks. Figure 4 shows the impulse responses of key variables to a one-standard-deviation negative technology shock under two regimes: domestic price stabilization (DIT - red-dashed line) and exchange rate stabilization (PEG - blue-solid line).

===== **Figure 4 Here** =====

In response to a technology shock, the real economy is less volatile when monetary policy stabilizes the exchange rate - a result which also holds without financial frictions (Gali and Monacelli, 2005). With a banking sector, however, financial frictions amplify the outcome. Higher deposit rates reduce banks' net worth and tighten borrowing constraints, which raises the credit spread and generates an amplification effect, deepening the recession. Under a PEG regime, domestic prices are allowed to rise; whereas under a DIT regime, a strong increase in the policy rate is required. Since CPI inflation reflects both domestic producer prices and import prices, a DIT policy produces CPI deflation, and the real interest rate on deposits rises even more than the policy rate. On the other hand, under a PEG regime, CPI inflation remains positive, and the real rate rises by much less. The combination of higher deposit rates and lower returns on capital compresses banks' net interest margins, erodes their net worth, and - together with a fall in Tobin's Q - tightens borrowing constraints and reduces investment. These adverse effects are smaller under PEG than under DIT.

Figure 5 presents impulse responses of key variables to an interest rate shock of one standard deviation under the two monetary policy regimes.

===== **Figure 5 Here** =====

When the foreign interest rate rises, tighter bank credit constraints increase domestic credit spreads and raise firms' marginal costs, reducing investment and output. Although the expenditure-switching effects of the currency depreciation can partially offset these losses, empirical evidence shows that the financial channel typically dominates (Cesa-Bianchi *et al.*, 2025). Our model is consistent with this result: a foreign interest rate shock triggers a sharp recession under both regimes. Under DIT, domestic prices are stabilized and the exchange rate depreciates to absorb part of the shock. Under PEG, however, the central bank must raise the policy rate more aggressively to maintain the peg and offset the increase in demand from expenditure switching. This more aggressive monetary stance amplifies the contraction.

## 5. The Welfare Effects of Macroprudential Policy

In this section we present comparative statics for the risk-adjusted steady state by varying the strength of macroprudential policy as described in Section 2.5. This allows us to determine the optimal level of bank capital. We then investigate how the design of monetary policy affects the use of macroprudential policy by specifying an interest rate rule which nests the polar cases of domestic price stabilization and exchange rate stabilization.

### *5.1. Optimal Bank Capital*

We focus on a revenue-neutral tax-subsidy scheme that operates like a countercyclical capital requirement for outside equity issuance.[25] The idea is straightforward: macroprudential policy encourages banks to substitute equity for short-term deposits. By issuing more equity, banks are able to stabilize their net worth, raise Tobin's Q, relax borrowing constraints, and as a result, attract more deposits and expand investment.

To evaluate the welfare effects of macroprudential policy we use the unconditional steady-state value of the lifetime utility of the representative agent, as specified in equation (1), and

[25] An alternative is to subsidize equity issuance and pay for this by levying a lump-sum tax on the representative household. Akinci and Queralto (2022) take this approach with inside equity.

consider a second-order approximation of utility around the risk-adjusted steady state.[26] Welfare gains are computed in consumption-equivalent terms, defined as the percentage increase in consumption that would be required for the unregulated economy to attain the same level of welfare as the economy operating with the optimal macroprudential policy.

Figure 6 shows the effects of varying macroprudential policy for each monetary policy regime when aggregate uncertainty stems from domestic technology.

**===== Figure 6 Here =====**

In either monetary policy regime introducing macroprudential policy leads banks to issue more equity and rely less on deposits. The higher equity share reduces the volatility of the net interest margin, $\sigma_{n_t/n_{t-1}}$. A more stable net interest margin, in turn, lowers the volatility of investment, $\sigma_{\Delta i}$. With less investment volatility, and therefore a smaller cost of investment adjustment, steady state Tobin's Q rises. Finally, a higher Tobin's Q allows banks to expand borrowing and increase capital accumulation, provided the moral hazard parameter, $\Theta_t$, remains unchanged.[27] However, in this model, $\Theta_t$ rises as the share of equity increases in bank assets increases. A higher $\Theta_t$ tightens the credit constraint making it harder for banks to attract deposits. This effect offsets the benefit of a higher Tobin's Q and creates a hump-shaped relationship between macroprudential policy and the level of steady state physical capital. At low levels of physical capital, macroprudential policy is

[26] In particular, welfare is defined as $W_t = U_t + \beta E(W_{t+1})$, where $U_t$ is instantaneous utility and $E(W_{t+1})$ is computed in the risk-adjusted steady state. The unconditional expectation is $E(W_t) = \sum_s \pi(s) W_t(s)$, where $s$ indexes all possible realizations of states and $\pi(s)$ is the probability of those states. their associated probabilities. In this case, $E(W_t) = E(W_{t+1}) = E\{\ln(\varrho_t)\}/(1-\beta)$, where $\varrho_t \equiv c_t - \frac{\chi}{1+\varphi} l_t^{1+\varphi}$.

[27] As discuss above, the financial friction in this economy is summarized by the borrowing constraint, which is governed by the parameter $\Theta_t$. If $\Theta_t$ were zero, the banking sector would be frictionless and there would be no credit spreads. If $\Theta_t$ were a constant, the effect of macroprudential policy would remain uniformly positive, however, $\Theta_t$ is endogenous: as the share of bank equity rises, $\Theta_t$ also rises in a convex way, reflecting higher monitoring costs.

beneficial because it stabilizes investment and raises Tobin's Q. As macroprudential policy becomes more aggressive, the adverse effect of moral hazard grows disproportionately so that beyond some point, further policy tightening reduces capital.

Figure 6 shows how the optimal level of bank capital differs across the two monetary regimes. Consistent with the impulse response functions (see Figure 2) the DIT regime generates a more volatile policy rate ($\sigma_{R_t^n}$) in response to a technology shock. This higher variability feeds into greater fluctuations in the net interest margin, and therefore investment, making the economy more exposed to financial instability. By contrast, the PEG regime requires less frequent or aggressive interest rate adjustments, which results in lower volatility of both the net interest margin and investment. Because of this difference, the DIT regime benefits more from the stabilizing role of macroprudential policy. When monetary policy focuses on stabilizing domestic prices (red-dashed line) the optimal bank capital ratio is about 15 percent. This higher level of bank capital delivers a consumption-equivalent welfare gain, relative to the no-policy benchmark, of just over 0.4 percent. By comparison, when monetary policy instead stabilizes the exchange rate (blue-solid line), the optimal bank capital ratio is around 3 percentage points lower. In this case, the welfare gain is smaller - about 0.2 percent - because macroprudential policy adds less value when the policy rate itself is less volatile.

Figure 7 presents results of varying macroprudential policy when the source of aggregate uncertainty originates in global financial markets.

**===== Figure 7 Here =====**

Figure 7 shows that when domestic prices are stabilized the policy rate is much less volatile than compared to when the exchange rate is stabilized. Under this regime, the volatility of the net interest margin is low, Tobin's Q remains close to unity, and the benefits of macroprudential policy are small relative to the costs of higher moral hazard. Moreover, these costs are similar across both policy regimes. However, under the PEG regime the policy rate is volatile, for the reasons discussed in section 4. This translates into higher volatility of both the net interest margin and investment, as well as a lower Tobin's Q. In this case, macroprudential policy delivers a welfare gain, and the relationship between bank equity and the welfare gain is hump-shaped.

External financial shocks create a much larger divergence between the two monetary regimes than technology shocks. This divergence implies a potentially large welfare gain from raising bank capital when monetary policy focuses on stabilizing the exchange rate. In this case, a bank capital ratio of 15 percent yields a consumption-equivalent welfare gain of nearly 0.9 percent. By contrast, when monetary policy stabilizes domestic prices, the welfare gains from macroprudential policy are negligible. Finally, the impact of macroprudential policy on the risk-adjusted steady state is more pronounced under external financial shocks than under technology shocks. In particular, physical capital and asset prices move significantly with macroprudential policy - but only when monetary policy focuses on stabilizing the exchange rate.

### *5.2. The Exchange Rate Focus of Monetary Policy*

We have so far focused on two polar monetary regimes. We have shown that the source of aggregate uncertainty is an important determinant of the optimal level of bank capital. In this section we adopt a more general specification of monetary policy and consider an interest rate rule where the central bank is assumed to respond to a combination of the change in domestic prices and the nominal exchange rate. We postulate the following monetary policy rule,

$$R_t^n/R^n = (\pi_{h,t}/\pi_h)^{(1-\nu_e)/\nu_e} \left(\mathcal{E}_t/\mathcal{E}_{t-1}\right)^{\nu_e/(1-\nu_e)} \tag{34}$$

where $\nu_e \in [0,1]$ captures by how much the stance of monetary policy is exchange rate focused.[28] In figure 8 we plot the optimal macroprudential policy (as expressed in terms

[28] This formulation is also used by Gali and Monacelli (2016) and a similar approach is taken in Itskohki

of bank capital) and associated welfare gain as the focus of monetary policy changes.

===== **Figure 8 Here** =====

We relate the left-hand side ($\nu_e \to 0$) and right-hand side ($\nu_e \to 1$) of each graph in Figure 8 to the peak welfare gain and the optimal level of bank capital shown in Figures 6 and 7. The left-hand side of the graphs in Figure 8 corresponds to the monetary policy that stabilizes domestic prices - $p_{h,t}/p_{h,t-1} = 1$. In this case, with domestic technology (external financial) shocks, optimal bank capital is near 15 percent (around 9.5 percent), and the associated consumption-equivalent welfare gain is 0.4 percent (nil percent). The right-hand side of the graphs in Figure 8 corresponds to a fully stabilized nominal exchange rate - $\mathcal{E}_t/\mathcal{E}_{t-1} = 1$ - and we can make the same comparison of results with Figures 6 and 7.

Figure 8 shows that optimal bank capital is monotonic in $\nu_e$ when both shocks operate. This is because, if the source of aggregate uncertainty is primarily domestic technology (external financial), the optimal bank capital ratio falls (rises) as monetary policy becomes more exchange rate focused. For our particular parameterization of shocks the optimal bank capital ratio is U-shaped, such that optimal bank capital falls and rises as monetary policy becomes increasingly focused on stabilizing the exchange rate. It is important to note that whilst optimal bank capital varies very little between the two monetary policy extremes, the difference in the consumption-equivalent welfare gain is significant.

Because our model includes both price and wage rigidities, it is useful to assess how each type of rigidity affects the results. We therefore recalculate Figure 8 concentrating on two possibilities: sticky prices only (sticky prices: $\theta_p > 0$ and $\theta_w = 0$) or sticky wages only (sticky wages: $\theta_w > 0$ and $\theta_p = 0$).[29] These specifications are presented in the upper and lower panels of Figure 9, respectively.

and Mukhin (2025).

[29]We are also motivated to do this because of the arguments in Farhi and Werning (2012, 2016) which suggest the interaction of nominal rigidities and financial market imperfections are important for macroprudential policies.

===== **Figure 9 Here** =====

We find that the optimal level of bank capital is no longer U-shaped in $\nu_e$ when we allow for only a single type of nominal rigidity  This suggests the interaction of wage and price rigidity is an important factor in driving some of the results we find. To better understand this consider the case of nominal price rigidity only ($\theta_p > 0$ and $\theta_w = 0$) in which a DIT policy reproduces the case without nominal rigidity, as studied above - see Figure 1 for the response of real variables to the two shocks we consider. With technology shocks, changing the focus of monetary policy has little effect on macroprudential policy because the response of the policy rate is relatively unaffected. As such, interest rate shocks play the dominant role in determining how macroprudential policy should be used. Since interest rate shocks have a strong effect on the economy when the exchange rate is stabilized, overall, the optimal level of bank capital rises with the parameter $\nu_e$.

In the lower panel of Figure 9 we consider the case in which only wages are sticky ($\theta_w > 0$ and $\theta_p = 0$). When sticky-wages are the only only source of nominal rigidity optimal bank capital is nearly invariant to the stance of monetary policy when both shocks operate. This is because, with sticky-wages, when monetary policy focuses on price stability (lower values of $\nu_e$), macroprudential policy needs to be aggressive when there are technology shocks. Moreover, for any value of $\nu_e$, macroprudential policy is always more aggressive than when only prices are sticky. At the same time, because goods prices are flexible, movements in the exchange rate are not as important when there are external financial shocks, so macroprudential policy need not be used so aggressively when the exchange rate is stabilized. The net impact of these two forces is that optimal bank capital varies relatively little with stance of monetary policy and the welfare gain also rises only modestly with $\nu_e$.

## 6. Conclusion

This paper studies macroprudential policy in a small open economy with financial intermediation and nominal rigidities. Our main argument is that volatility in the policy rate affects the net interest margin of banks, and consequently, their profitability. Volatile profits lead to fluctuations in bank net worth and investment. When there are investment adjustment costs, volatile investment raises transaction costs, reduces Tobin's Q, and tightens borrowing constraints. We demonstrate how this mechanism operates by comparing the case of domestic price stability and exchange rate stability in a small open economy. When the policy rate is more volatile so is investment and a macroprudential policy that targets stability in the net interest margin - by raising the share of bank equity - delivers welfare gains.

Our results show that, under technology shocks, there are modest welfare gains from raising bank capital across the full spectrum of monetary policy - from domestic price stabilization to exchange rate stabilization. Under external financial shocks, however, raising bank capital ratios too aggressively can lower welfare when domestic prices are stabilized and the exchange rate is flexible. On the contrary, when the exchange rate is fully stabilized, higher bank capital ratios provide significant benefits. In this case, the optimal bank capital ratio is nearly 5 percentage points higher than with a flexible exchange rate, and the associated consumption-equivalent welfare gain is about 0.9 percent.

## Appendix

In the appendix, we present the complete system of non-linear equations, we solve the deterministic steady state, and we explain our calculation of the risk-adjusted steady state.

*A.1. Complete System of Non-Linear Equations*

Households asset pricing equations are,

$$E_t\left(\Lambda_{t,t+1}\right)R_t = 1,\;\; E_t\left(\Lambda_{t,t+1}R^e_{t+1}\right) = 1,\;\; R_t = \frac{R^n_t}{E_t\pi_{t+1}},\;\; \text{and}\;\; E_t\Lambda_{t,t+1} = \beta E_t\left(\frac{\varrho_{t+1}}{\varrho_t}\right)^{-1}$$

where,

$$\varrho_t \equiv c_t - \frac{\chi}{1+\varphi}l_t^{1+\varphi} \;\; \text{and} \;\; R^i_t = \frac{\psi_t + (1-\delta)\,q^i_t}{q^i_{t-1}} \;\; \text{for } i \in \{k, e\}$$

The wage-Phillips curve is,

$$\left(\pi^w_t - 1\right)\pi^w_t = \frac{\varepsilon_w}{\theta_w}\left[\chi l_t^{1/\varphi} - \left(\frac{\varepsilon_w - 1}{\varepsilon_w}\right)w_t\right]l_t + E_t\Lambda_{t,t+1}\left[\left(\pi^w_{t+1} - 1\right)\pi^w_{t+1}\right]$$

where $\pi_t = \pi^w_t\left(\frac{w_{t-1}}{w_t}\right)$ is consumer price inflation. For firms that produce a homogenous good,

$$mc_t = \frac{1}{a_t}\frac{w_t^{1-\eta}\psi_t^{\eta}}{\eta^{\eta}\left(1-\eta\right)^{1-\eta}} \;\; \text{and} \;\; \psi_t k_{t-1} = \left(\frac{\eta}{1-\eta}\right)w_t l_t$$

For firms that sell a differentiated product in the domestic and export market.

$$\left(\pi_{h,t} - 1\right)\pi_{h,t} = \frac{\varepsilon_p}{\theta_p}\left[mc_t - \frac{\varepsilon_p - 1}{\varepsilon_p}\left(\frac{p_{h,t}}{p_t}\right)\right]y_{h,t} + E_t\Lambda_{t,t+1}\left[\left(\pi_{h,t+1} - 1\right)\pi_{h,t+1}\right]$$

and,

$$\left(\pi^\star_{h,t} - 1\right)\pi^\star_{h,t} = \frac{\varepsilon_p}{\theta_p}\left[mc_t - \frac{\varepsilon_p - 1}{\varepsilon_p}\left(\frac{p_{h,t}}{p_t}\right)g_{h,t}\right]y^\star_{h,t} + E_t\Lambda_{t,t+1}\theta_h\left[\left(\pi^\star_{h,t+1} - 1\right)\pi^\star_{h,t+1}\right]$$

For firms that produce capital,

$$q^k_t = 1 + \frac{\theta_i}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 + \theta_i\frac{i_t}{i_{t-1}}\left(\frac{i_t}{i_{t-1}} - 1\right) + \theta_i E_t\Lambda_{t,t+1}\left(\frac{i_{t+1}}{i_t}\right)^2\left(\frac{i_{t+1}}{i_t} - 1\right)$$

where $i_t = k_t - (1-\delta)\, k_{t-1}$. For banks,

$$\Theta_t = \theta \left[ 1 + \varepsilon x_t + \frac{\kappa x_t^2 + \varsigma \left(x_t^d\right)^2}{2} \right] \quad \text{and} \quad x_t^d \equiv \frac{T_t d_t^\star}{Q_t k_t},\ \phi_t \equiv \frac{Q_t k_t}{n_t},\ x_t^e = \frac{q_t e_t}{Q_t k_t}$$

with leverage,

$$\phi_t = \frac{\mu_t^d}{\Theta_t - \left(\mu_t^k + \mu_t^e x_t^e + \mu_t^{d^\star} x_t^{d^\star}\right)} \quad \text{and} \quad \Omega_{t+1} \equiv (1-\sigma) + \sigma \Theta_{t+1} \phi_{t+1}$$

asset pricing equations,

$$\begin{aligned}
\mu_t^d &= E_t \Lambda_{t,t+1} \Omega_{t+1} R_t,\ \ \mu_t^k = E_t \Lambda_{t,t+1} \Omega_{t+1} \left(R_{t+1}^k - R_t\right), \\
\mu_t^e &= E_t \Lambda_{t,t+1} \Omega_{t+1} \left(R_t - R_{t+1}^e\right), \ \text{ and } \ \mu_t^{d^\star} = E_t \Lambda_{t,t+1} \Omega_{t+1} \left[ R_t - R_t^\star \left( \frac{Q_{t+1}}{Q_t} \right) \right]
\end{aligned}$$

and first-order conditions,

$$\frac{\mu_t^k + \mu_t^{d^\star} x_t^{d^\star} + \left(\mu_t^e + \tau_t^e \mu_t^d\right) x_t^e - \tau_t \mu_t^d}{\mu_t^e + \tau_t^e \mu_t^d} = \frac{\Theta_t}{\Theta_{x_t^e}} \quad \text{and} \quad \frac{\mu_t^d}{\mu_t^e + \tau_t^e \mu_t^d} = \frac{\Theta_{x_t^{d^\star}}}{\Theta_{x_t^e}}$$

where the aggregate law of motion for net worth is,

$$\begin{aligned}
\frac{n_t}{n_{t-1}} &= \sigma \left\{ \left(R_t^k - R_{t-1}\right) + \left(R_{t-1} - R_t^e\right) x_{t-1}^e + \left[ R_{t-1} - R_{t-1}^\star \left( \frac{Q_t}{Q_{t-1}} \right) \right] x_{t-1}^{d^\star} \right\} \phi_{t-1} \\
&\quad + \sigma R_{t-1} + \xi (1-\sigma)\, \phi_{t-1}
\end{aligned}$$

Goods market clearing implies,

$$a_t k_{t-1}^\eta l_t^{1-\eta} = y_{h,t} + y_{h,t}^\star \quad \text{and} \quad y_t = c_t + \left[ 1 + \theta_i \left( \frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t + \Xi_t$$

where the net liabilities, international relative prices, and demand curves are,

$$\begin{aligned}
d_t^\star &= R_{t-1}^\star d_{t-1}^\star + \left( y_{f,t} - \frac{y_{h,t}^\star}{T_t} \right),\ \ T_t g_{h,t} = \Phi_t Q_t,\ \ \frac{Q_t}{Q_{t-1}} = \frac{\Delta \mathcal{E}_t}{\pi_t} \\
\Phi_t &= \left[ (1-\alpha) + \alpha \left(T_t g_{h,t}\right)^{1-\omega} \right]^{1/(1-\omega)},\ \ \frac{\pi_{h,t}}{\pi_{h,t}^\star} = \frac{\Delta \mathcal{E}_t g_{h,t-1}}{g_{h,t}},\ \ \frac{\pi_{h,t}}{\pi_t} = \frac{\Phi_{t-1}}{\Phi_t} \\
y_{h,t} &= (1-\alpha)\, \Phi_t^\omega y_t,\ \ y_{f,t} = \alpha \left(Q_t\right)^{-\omega} y_t,\ \text{ and } \ y_{h,t}^\star = \alpha T_t^\omega y_t^\star
\end{aligned}$$

These 39 equations explain allocations $\{z_t, w_t, l_t, c_t, k_t, i_t, y_t, \psi_t, mc_t\}$ and $\left\{y_{h,t}, y_{f,t}, y_{h,t}^\star\right\}$, international relative prices $\{g_{h,t}, \Phi_t, T_t, Q_t\}$, discount factors $\{\Lambda_{t,t+1}, \Omega_t\}$, growth rates of nominal variables $\left\{\pi_t^w, \pi_t, \pi_{h,t}, \pi_{h,t}^\star, \Delta\mathcal{E}_t\right\}$, financial prices and returns $\left\{R_t^k, q_t^k, R_t^e, q_t^e, R_t, R_t^n\right\}$, bank allocations $\{n_t, \phi_t, e_t, d_t^\star, x_t^e, x_t^{d^\star}\}$, excess returns $\{\mu_t^d, \mu_t^k, \mu_t^e, \mu_t^{d^\star}\}$, and the tightness of the leverage constraint, $\Theta_t$. The system is determined by a policy equation (as specified in the main text) and $\{a_t, R_t^\star, y_t^\star\} = 1$ are exogenous.

*A.2. Deterministic Steady State*

The stochastic discount factor implies $\Lambda = \beta$ and $R = 1/\Lambda$. We also have $\Lambda^\star = \beta^\star$ and $R^\star = 1/\Lambda^\star$. We treat $R$ and $R^\star$ as exogenous. The households first-order condition for equity implies $R = R^e$ such that $\mu_e = 0$. We write the bank equations for deposits and capital as,

$$\frac{\mu^{d^\star}}{\Omega} = \beta\left(R - R^\star\right) \quad \text{and} \quad \frac{\mu^k}{\Omega} = \left(\frac{\Theta}{\Theta_{x^{d^\star}}} - x^{d^\star}\right)\left(\frac{\mu^{d^\star}}{\Omega}\right) \tag{35}$$

from which we define the ratio $\widetilde{\mu} \equiv \left(\frac{\mu^{d^\star}}{\Omega}\right) / \left(\frac{\mu^k}{\Omega}\right)$ and then solve for the return on capital, $R^k = R + \frac{R - R^\star}{\widetilde{\mu}}$ where $Q = 1$. Given the return on capital we determine leverage as,

$$\phi = \frac{1 - \sigma R}{\sigma\left[\left(R^k - R\right) + \left(R - R^\star\right) x^{d^\star}\right] + \xi\left(1 - \sigma\right)} \quad \text{and} \quad \Omega = (1 - \sigma) + \sigma\Theta\phi \tag{36}$$

and from this we recover $\mu^k = \Omega\beta\left(R^k - R\right)$ and $\mu^{d^\star} = \Omega\beta\left(R - R^\star\right)$. We then use,

$$\tau^e = \mu^{d^\star}\left(\frac{\Theta_{x^e}}{\Theta_{x^{d^\star}}}\right) \quad \text{and} \quad \Omega = \phi\left(\Theta - \mu^k - \mu^{d^\star} x^{d^\star}\right) \tag{37}$$

to determine $x^e$ and $x^{d^\star}$ (imposing $\mu^e = 0$ and $\Omega = \mu^d$). With these 10 equations we determine $\frac{\mu^{d^\star}}{\Omega}, \frac{\mu^k}{\Omega}, \widetilde{\mu}, R^k, \phi, \Omega, \mu^k, \mu^{d^\star}, x^{d^\star}, x^e$ as a closed system.

Assume $a = 1$ and zero inflation such that $\pi = 1$ (along with all other $\pi$ terms). We also know $q^k = g_h = 1$. Given the return on capital ($R^k$) we can determine allocations and relative prices. We have,

$$\begin{aligned}
\frac{k}{l} &= \left(\frac{\eta}{1-\eta}\right)\frac{\varepsilon_w}{\varepsilon_w - 1}\frac{\chi}{\psi} l^\varphi, \;\; \psi = \frac{\eta}{\Phi}\left(\frac{\varepsilon_p - 1}{\varepsilon_p}\right)\left(\frac{k}{l}\right)^{\eta - 1}, \;\; \psi = R^k - (1 - \delta) \\
c &= y - \delta k, \;\; \Phi^{1-\omega} = \left[(1-\alpha) + \alpha T^{1-\omega}\right], \;\; d^\star = \frac{k\Phi x^{d^\star}}{T}, \;\; n = \frac{k}{\phi} \\
k &= \left(\frac{k}{l}\right)^{1-\eta}\left[(1-\alpha)\Phi^\omega y + \alpha T^\omega y^\star\right], \;\; \text{and} \quad (1 - R^\star)\, d^\star = \alpha\left[\left(\frac{\Phi}{T}\right)^\omega y - \left(\frac{1}{T}\right)^{1-\omega} y^\star\right]
\end{aligned}$$

which determine allocations $\{y, c, l, k\}$ and $\{n, d^\star\}$ and prices $\{T, \Phi, \psi\}$. We solve for output as follows. The capital/labor ratio is, $\frac{k}{l} = \left[\frac{\psi\Phi}{\eta}\left(\frac{\varepsilon_p}{\varepsilon_p - 1}\right)\right]^{1/(\eta-1)}$. We use the resource constraint to generate an expression for capital by eliminating the capital/labor ratio. The balance of payments then provides a second equation in the capital stock and combining both expressions we find,

$$y = \frac{\alpha\left(1-\kappa_1\right)y^\star}{\left(1-\alpha\right)\kappa_1 + \alpha T^{1-\omega}}\left(\frac{T}{\Phi}\right)^\omega \quad \text{where} \quad \kappa_1 \equiv \eta\left(\frac{R^\star - 1}{\psi}\right)\left(\frac{\varepsilon_p - 1}{\varepsilon_p}\right)x^{d^\star} \tag{38}$$

where $y^\star$ and $R^\star$ are exogenous. Since $\Phi = \left[(1-\alpha) + \alpha T^{1-\omega}\right]^{1/(1-\omega)}$, then equation (38) provides a solution for steady state output conditional on the terms of trade and the fraction of foreign assets in the bank balance sheet. With a conditional solution for output we determine capital by re-using the resource constraint and use the labor supply equation to determine, $l = \left(\frac{\psi}{\chi}\frac{1-\eta}{\eta}\frac{\varepsilon_w - 1}{\varepsilon_w}k\right)^{1/(1+\varphi)}$, which we target at 0.3 adjusting the value of $\chi$.

*A.3. Risk-Adjusted Steady State*

Our approach to risk-adjusting the steady state follows Gertler *et al.* (2012). Our model consists of a system of backward-looking and forward-looking equations,

$$F(x_t, x_{t-1}, u_t) = 0 \quad \text{and} \quad E_t G(x_t, x_{t+1}) = 0 \tag{39}$$

where $x_t$ is a vector of variables and $u_t$ is a vector of white noise with zero mean. The specific equations are given in Appendix A.1. To compute the risk-adjusted steady state of we follow the algorithm outlined below. Step 1: we solve for the deterministic steady state, $\overline{x}$, which is the solution to the system,

$$F(\overline{x}, \overline{x}, 0) = 0 \quad \text{and} \quad G(\overline{x}, \overline{x}) = 0$$

This specific equations are presented in Appendix A.2. Step 2: we solve (39) using a first-order approximation around $\overline{x}$ for which we obtain the transition matrix,

$$x_{t+1} = Ax_t + Bu_{t+1}$$

This further implies $E_t x_{t+1} = Ax_t$ and allows us to compute the one-period-ahead covariance of $x_{t+1}$, which is given by,

$$E_t x_{t+1} x'_{t+1} = Ax_t x'_t A + Bu_{t+1} u'_{t+1} B'$$

The variance-covariance matrix is,

$$cov_t\left(x_{t+1}\right) = E_t x_{t+1} x'_{t+1} - E_t x_{t+1}\left(E_t x_{t+1}\right)' = Bu_{t+1} u'_{t+1} B'$$

Step 3: we update the steady state by replacing the second equation in (39) with,

$$E_t G(x, x^e_{t+1}) = 0$$

where $x^e_{t+1}$ is a vector of expected variables. We then take the following second-order approximation with respect to the expected variables,

$$E_t G(x, x^e_{t+1}) = G(x, x) + \frac{1}{2}\sum_{i,j} \frac{\partial^2 G(x, x)}{\partial x^e_i \partial x^e_j} cov_t\left(x^e_i, x^e_j\right) = 0 \tag{40}$$

and solve the system of equations $F(\overline{x}, \overline{x}, 0) = 0$ and (40). We denote the new solution as $x^{s,1}$ ($s$ for stochastic steady state and 1 for the first iteration). Step 4: we solve the modified system,

$$F(x_{t,} x_{t-1}, u_t) = F(x^{s,1}, x^{s,1}, 0) \text{ and } E_t G(x_{t,} x_{t+1}) = G(x^{s,1}_t, x^{s,1})$$

and update the covariances as in Step 2 and then repeat Step 3 to obtain a new steady-state solution $x^{s,2}$. We repeat this process until the system converges.

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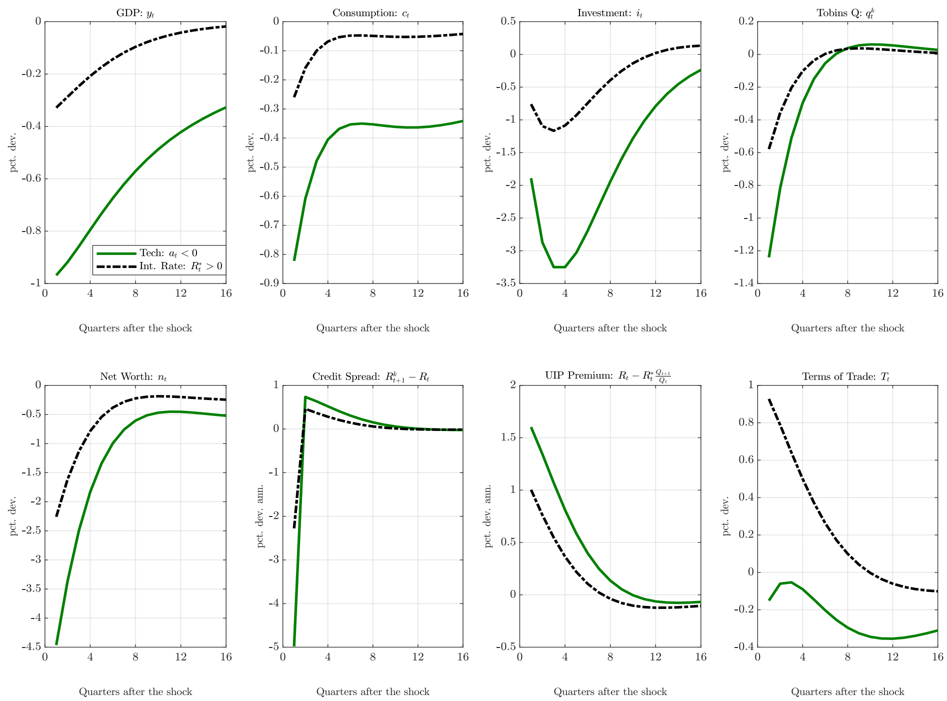
**Table 1: Parameter Values**

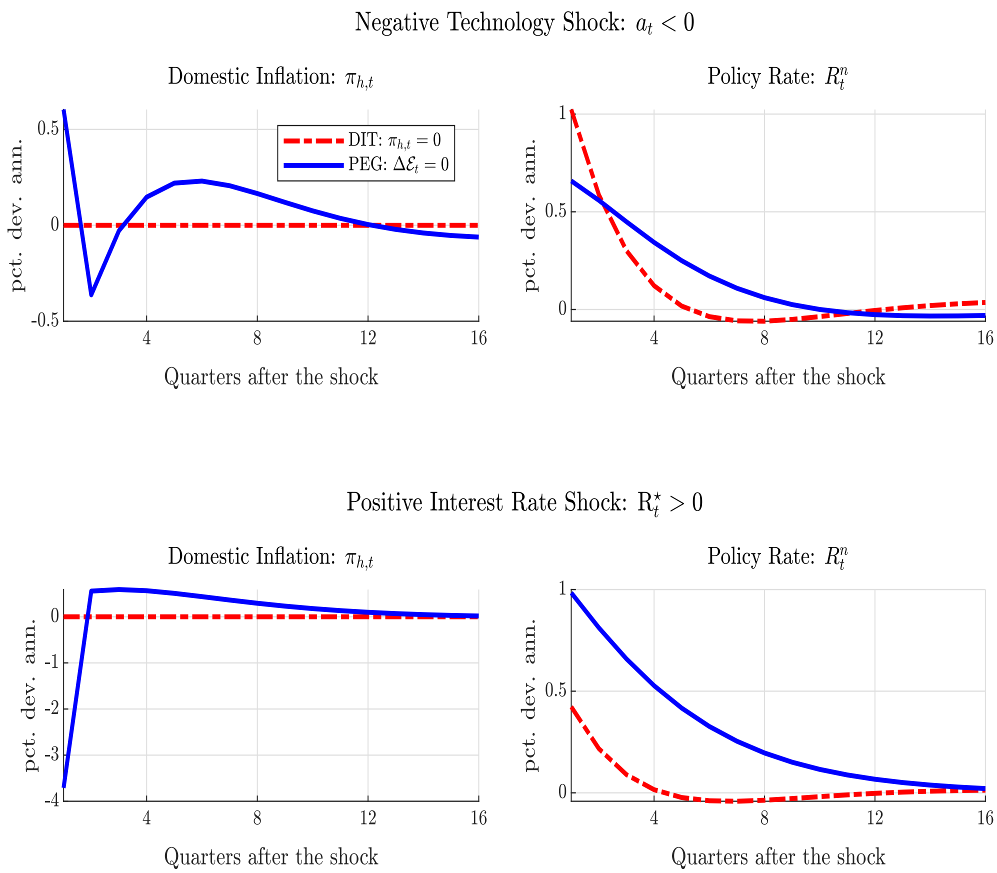
| Non-Bank Parameters | | | |
|---|---|---|---|
| Parameter | Description | Value | Target |
| $\eta$ | Labor Share | 0.28 | $\frac{wl}{y} = 0.55$ |
| $\alpha$ | Exports/GDP | 0.09 | $\frac{g_h y_h^\star}{\Phi y} = 0.1$ |
| $\chi$ | Hours Worked | 9.45 | $l = 0.3$ |
| $\theta_w$ | Wage Adjustment Cost | 32.76 | 3 quarters duration |
| $\theta_p$ | Price Adjustment Cost | 12.36 | 2.5 quarters duration |
| $\theta_i$ | Investment Adjustment Cost | 1.35 | $\frac{\sigma_{\Delta i}}{\sigma_{\Delta y}} = 2.5$ |
| **Bank-Related Parameters** | | | |
| Parameter(s) | Description | Value(s) | Target |
| $\theta$ | Bank Leverage | 0.60 | $\phi = 4$ |
| $\xi$ | Ann. Credit Spread | 0.07 | $R^k - R = 300$ b.p. |
| $\kappa^e, \varepsilon$ | Bank Capital | $13.23, -1.04$ | $\frac{q^e e}{q^k k} = 0.08$ |
| $\kappa^d$ | Foreign Liabilities | 13.27 | $\frac{Qd^\star}{d} = 0.1$ |
| **Exogenous Processes** | | | |
| Parameters | Variable | Values | Source |
| $\rho_a, \sigma_a$ | Technology Shifter | $0.9, 0.007$ | Standard Values |
| $\rho_{R^\star}, \sigma_{R^\star}$ | Foreign Interest Rate | $0.87, 0.0014$ | Akinci and Queralto (2022) |

## Figure 1. Impulse Responses without Nominal Rigidities (Real Variables)[30]



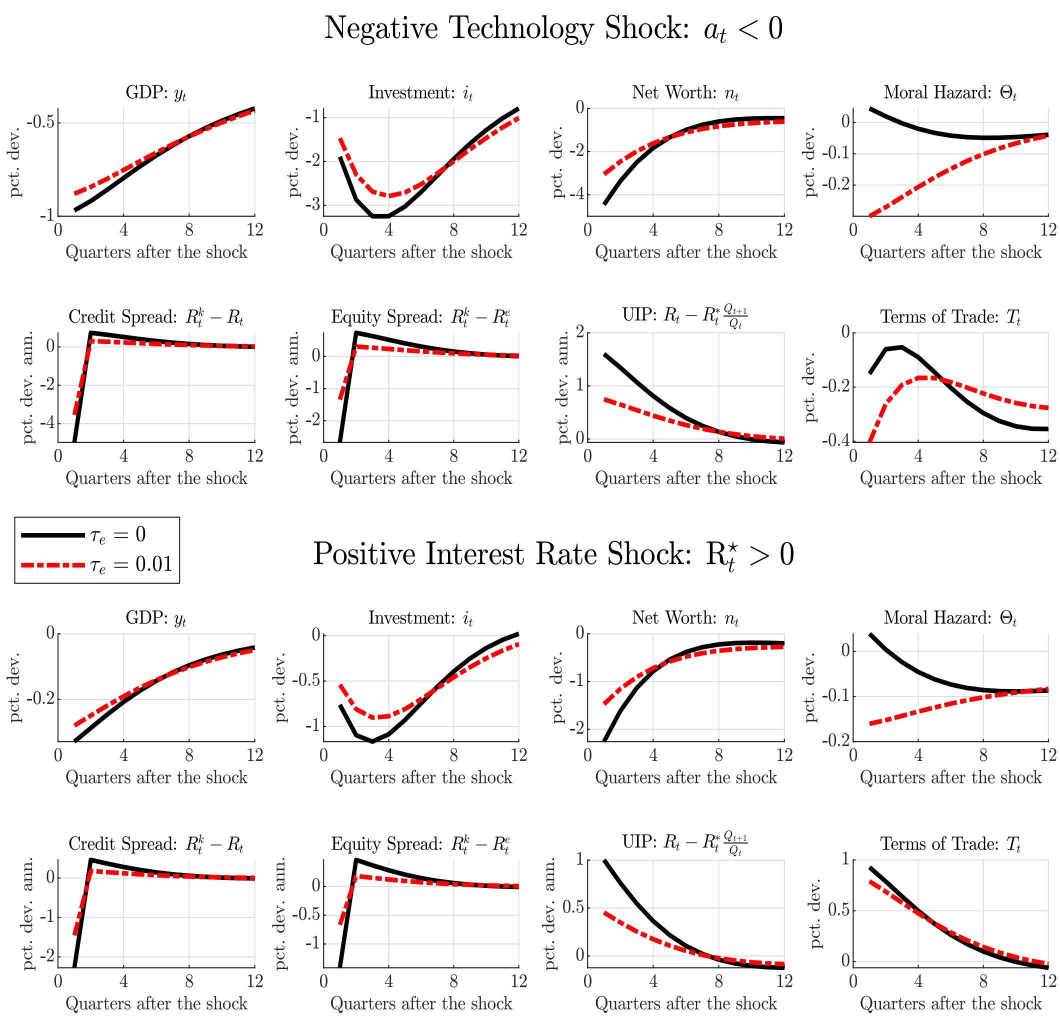

[30]Notes: The vertical axis reports deviations from the risk-adjusted steady state (percent and percentage points); the horizontal axis shows quarters. The technology shock and the foreign interest rate shock are each one standard deviation, as reported in Table 1.

**Figure 2. Impulse Responses without Nominal Rigidities (Domestic Inflation and Policy Rate)**[31]



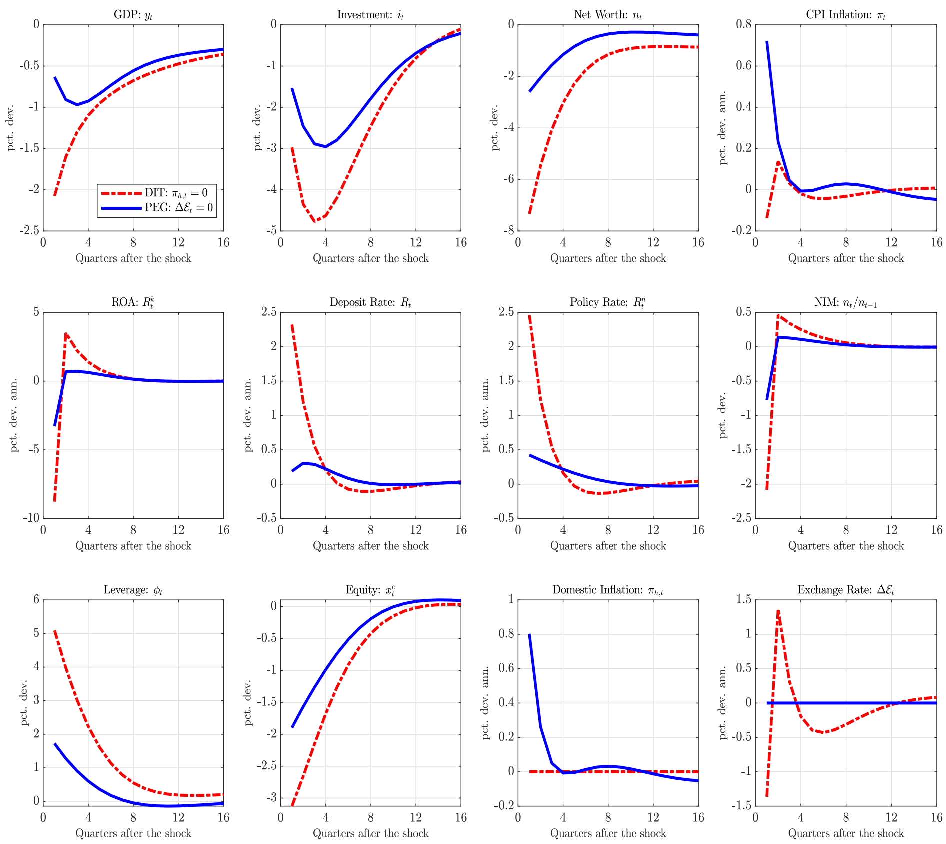

[31]Notes: The vertical axis reports deviations from the risk-adjusted steady state (percent and percentage points); the horizontal axis shows quarters. The technology shock and the foreign interest rate shock are each one standard deviation, as reported in Table 1.

**Figure 3. Impulse Responses and the Effect of Macroprudential Policy without Nominal Rigidities**[32]



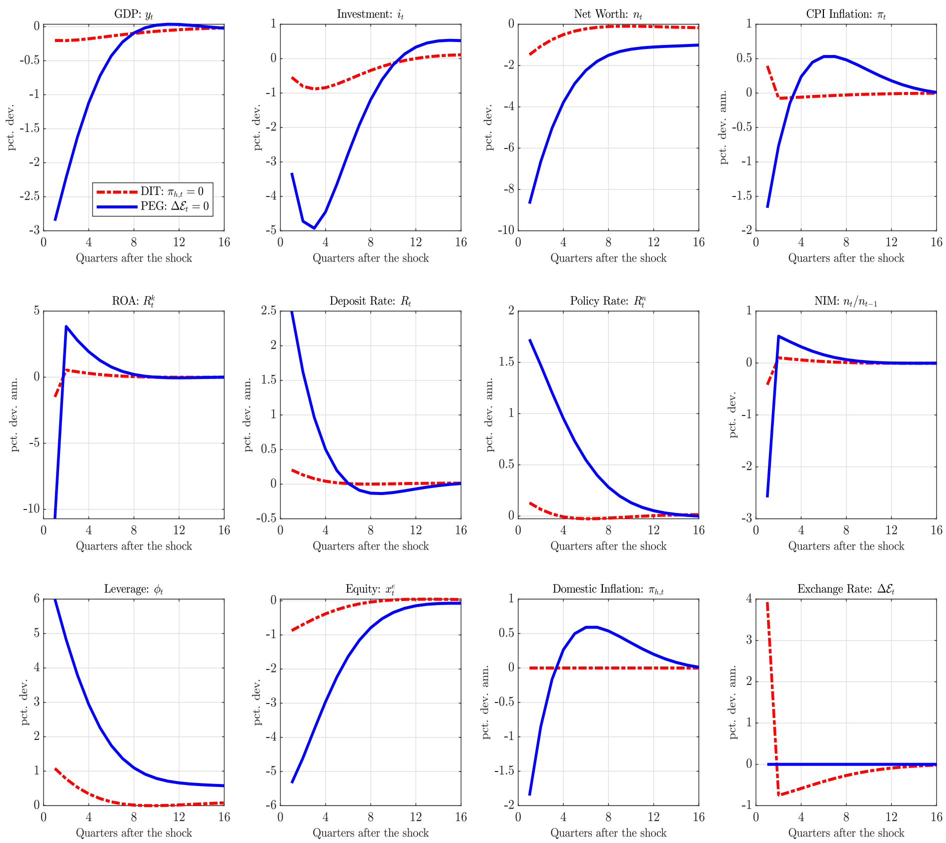

[32]Notes: The vertical axis reports deviations from the risk-adjusted steady state (percent and percentage points); the horizontal axis shows quarters. The technology shock and the foreign interest rate shock are each one standard deviation, as reported in Table 1.

**Figure 4. Impulse Responses with Nominal Rigidities (Domestic Technology Shock and $\tau^e = 0$)**[33]



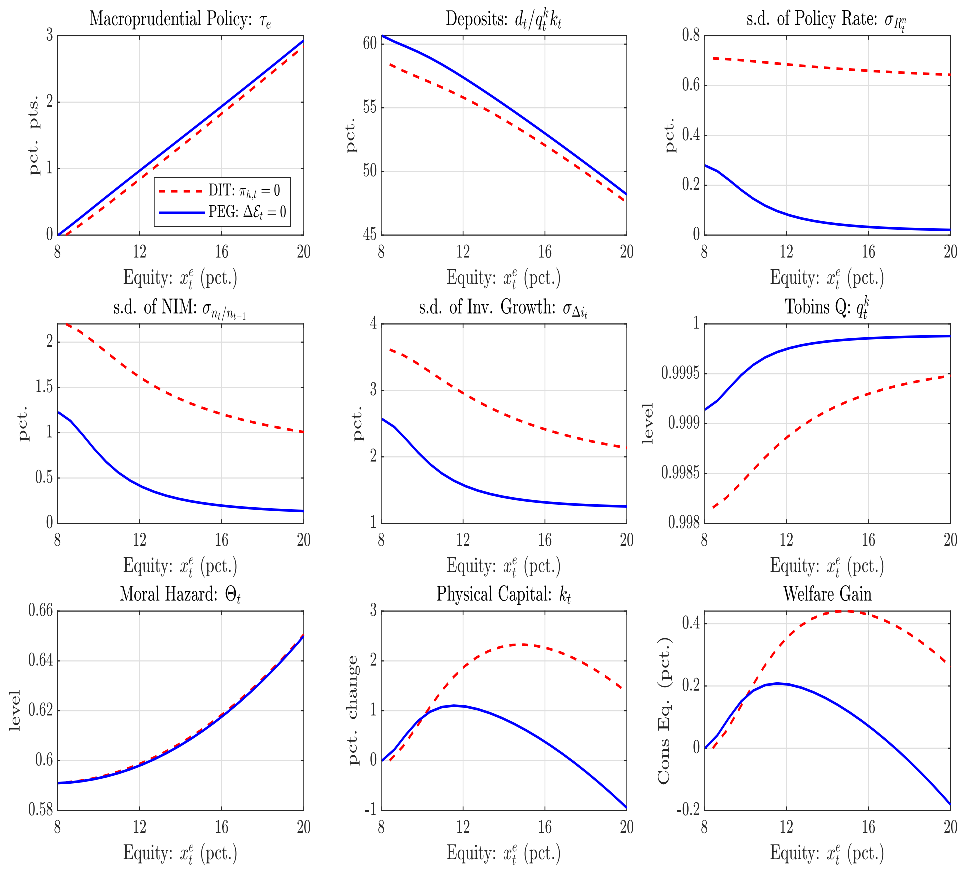

[33]Notes: The vertical axis shows deviations from the risk-adjusted steady state (percent and percentage points); the horizontal axis shows quarters. The technology shock is one standard deviation (see Table 1).

**Figure 5. Impulse Responses with Nominal Rigidities (External Financial Shock and $\tau^e = 0$)**[34]



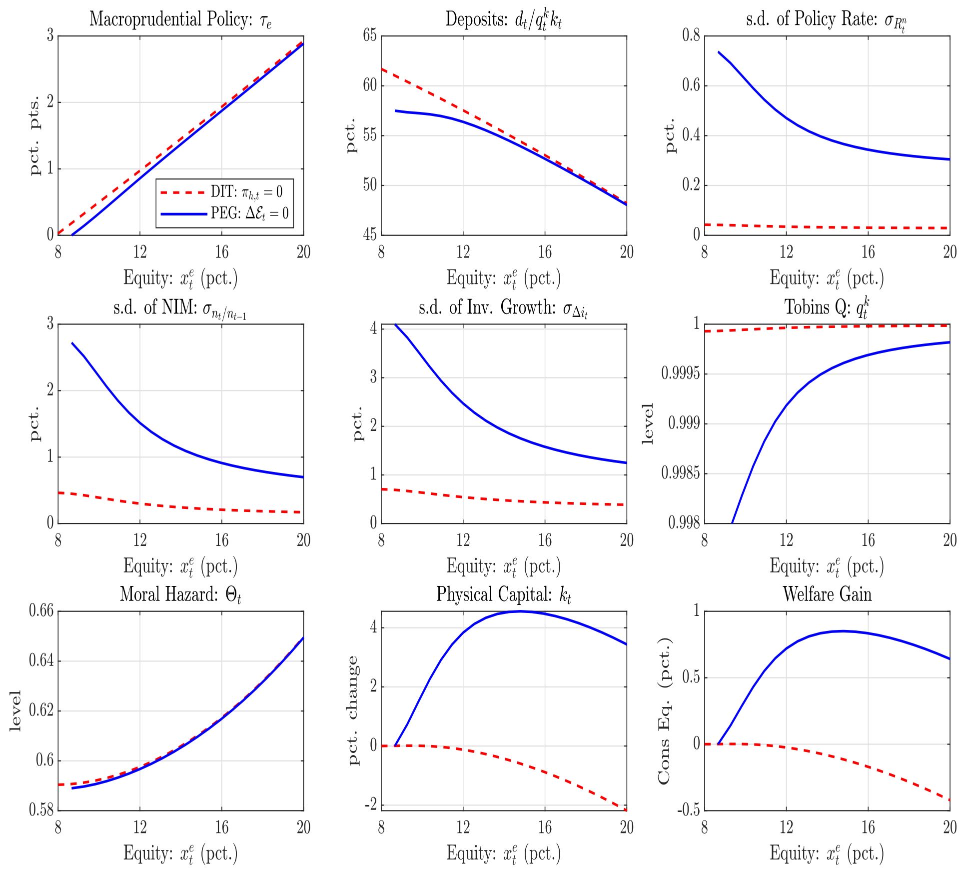

[34]Notes: The vertical axis shows deviations from the risk-adjusted steady state (percent and percentage points); the horizontal axis shows quarters. The foreign interest rate shock is one standard deviation (see Table 1).

**Figure 6. Macroprudential Policy and the Risk-Adjusted Steady State (Domestic Technology Shocks)**[35]



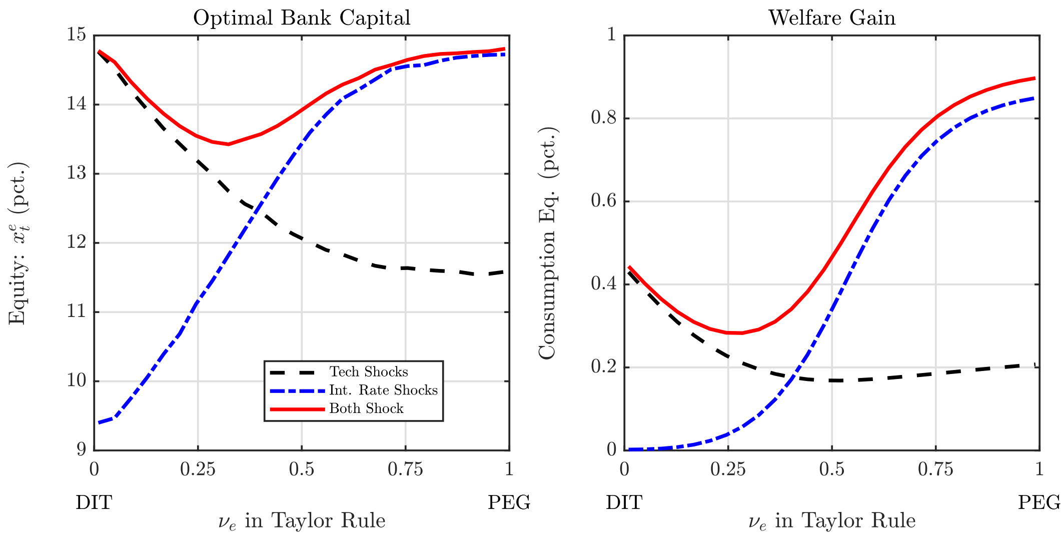

[35]Notes: The figure presents risk-adjusted steady state values, volatilities, and the welfare gain from macroprudential policy as the policy parameter $\tau^e$ is varied conditional on domestic technology shocks. Each variable is plotted against the level of bank capital corresponding to a value of $\tau^e$. The welfare gain is computed as the percentage increase in consumption that would be required for the unregulated economy to reach the same level of welfare as the one with the optimal macroprudential policy.

**Figure 7. Macroprudential Policy and the Risk-Adjusted Steady State (External Financial Shocks)**[36]



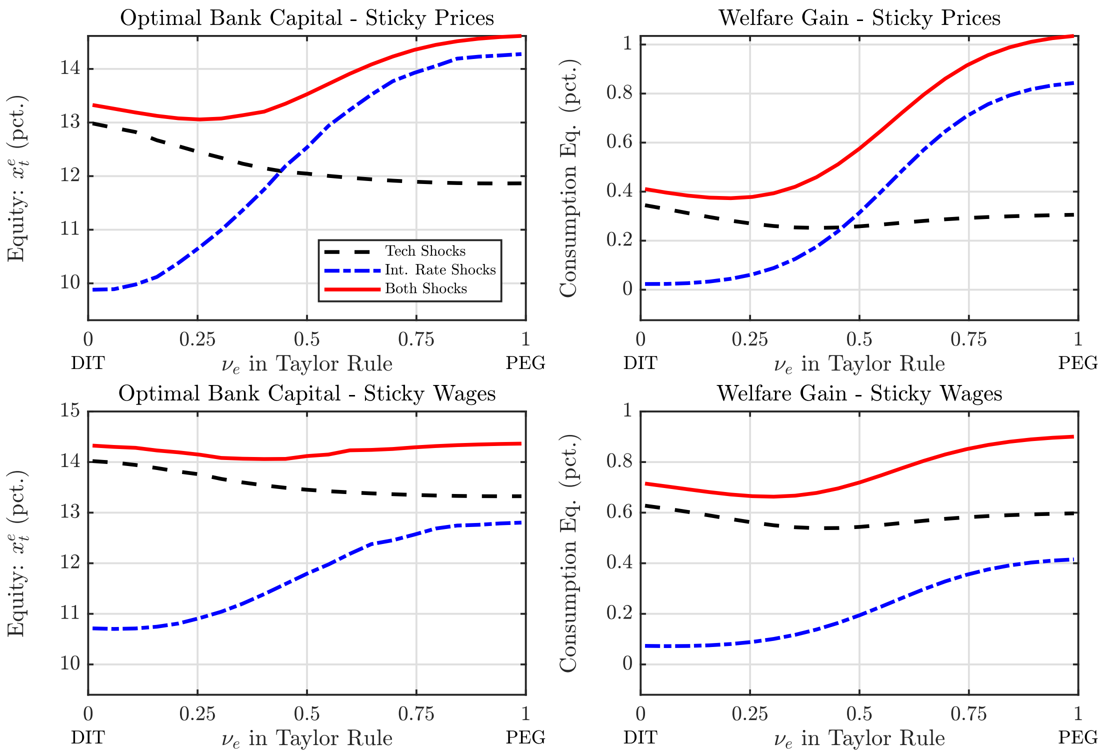

[36]Notes: The figure presents risk-adjusted steady state values, volatilities, and the welfare gain from macroprudential policy as the policy parameter $\tau^e$ is varied conditional on foreign interest rate shocks. Each variable is plotted against the level of bank capital corresponding to a value of $\tau^e$. The welfare gain is computed as the percentage increase in consumption that would be required for the unregulated economy to reach the same level of welfare as the one with the optimal macroprudential policy.

**Figure 8. The Stance of Monetary Policy and Optimal Bank Capital** [37]




[37]Notes: The left panels report the risk-adjusted steady state level of optimal bank capital. The right panels report the (consumption equivalent) welfare gain, as computed in Figures 6 and 7. The upper (lower) panels correspond to the case with nominal price (wage) rigidity only. In all panels, the horizontal axis is the parameter $\nu_e \in [0, 1]$ used in the Taylor rule, as reported in the text.

**Figure 9. The Role of Nominal Rigidities for Optimal Bank Capital** [38]




[38]Notes: The left panels report the risk-adjusted steady state level of optimal bank capital. The right panels report the (consumption equivalent) welfare gain, as computed in Figures 6 and 7. The upper (lower) panels correspond to the case with nominal price (wage) rigidity only. In all panels, the horizontal axis is the parameter $\nu_e \in [0, 1]$ used in the Taylor rule, as reported in the text.