Persistent Fiscal Expansion in a Financial Crisis Economy

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Abstract

This paper investigates the nonlinear fiscal multiplier effect during the financial crisis. First, in a small open economy model with a stock collateral constraint and involuntary unemployment, we find that a fiscal expansion effectively boosts asset prices and stimulates consumption during financial crises. More importantly, the impact of stimulus highly depends on agents' anticipation of future fiscal plans. Consistent with the cross-country empirical evidence, a positive spending shock generates a stronger multiplier effect on consumption and trade balance in financial crises as the fiscal expansion becomes more persistent. Lastly, we extend the model to show that the optimal spending policy requires the government's commitment ability. Even though the presence of *ex-post* optimal spending alleviates the financial constraint during a crisis, it necessitates a more restrictive macroprudential tax in *ex-ante* to preserve financial stability.

Keywords: Collateral constraint; State-contingent fiscal multipliers; Spending shock persistence; Optimal spending policy, Policy commitment.

JEL Classification: E62, F34, F41, F44

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1 Introduction

Is fiscal policy effective in stimulating the economy during financial crises? This question becomes particularly relevant considering the sluggish recovery in the aftermath of the Global Financial Crisis and the burst of European and emerging market crises. This paper shows that the international financial market imperfection plays a decisive role in the effectiveness of the fiscal stimulus.[1] Importantly, the impact of spending policy depends on people's anticipation of future financial conditions. We first provide a theoretical framework to analyze the transmission of fiscal policy in a debt-driven financial crisis. Consistent with the empirical evidence, the model indicates that a persistent fiscal expansion is more successful in boosting asset prices and stimulating real activities than a transitory spending shock.[2] In addition, we extend the model to an optimal policy environment to show that the government has incentives to raise its expenditure to combat the financial crisis when it happens, and the efficient use of financial intervention requires policy commitment.

The model is a small open economy with a stock collateral constraint. There are two sectors: tradable and nontradable sectors. Tradable goods follow an endowment process, while nontradable goods are produced by labor and capital. In the economy, agents supply labor, consume tradeable and nontradable goods, and transfer wealth across periods using either domestic capitals or short-term international bonds. Capitals have productive value and can also be used as collateral for international borrowings. The collateral constraint follows Kiyotaki & Moore (1997) and Mendoza (2010): in each period, agents' borrowing ability is restricted by the market value of their capital holdings. We assume that an exogenous process of government spending is financed through lump-sum taxes, and the government

[1] In a closed-economy setting, Eggertsson & Krugman (2012) and Fernández-Villaverde (2010) argue that the private debt overhang and Fisher's debt-deflation channel can explain the expansionary effect of fiscal policy during financial recessions.

[2] There is a group of papers demonstrating that the persistence of fiscal policy is crucial in determining the size of fiscal multipliers, especially in liquidity trap episodes. See, for example, Dupaigne & Fève (2016), Harms (2002), Woodford (2011), and Ngo (2021).

always balances its budget.

To consider the demand channel of government spending, we include a downward nominal wage rigidity à la Schmitt-Grohé & Uribe (2016a). DNWR implies a rationed labor market so that households may not be able to work the desired hours as they wish. In this environment, the previous-period wage shows up as an additional state variable, and our model has two occasionally-binding constraints. During economic downturns, when a county lacks the ability to float the exchange rate, the market-clearing wage falls below the wage state, and consequently, the economy is featured by involuntary unemployment.

We first use the model to generate large swings of boom-bust cycles and deep financial recessions. The sudden stop mechanism comes from the interaction between the two market-determined asset prices: the real exchange rate and capital price.[3] Because capital is only productive in the nontradable sector, while liabilities are denominated in tradables, a dynamic currency mismatch problem arises. In the model, the capital price is determined by the present value of future dividends, which depends on the expectation of future real exchange rates and the marginal product of capital. Under a negative and persistent tradable endowment shock, people adjust their expectations downwards. The adverse shock reduces people's incentive to consume, depreciating the current exchange rate. The lower consumption, in turn, reduces the discounting factor and depresses the capital price. If the shock is large enough, the collateral constraint becomes binding. The collapsing capital price further lowers the borrowing limit, reduces the consumption demand, and triggers a downward cycle à la Fisher (1933)'s debt-deflation mechanism.

The model predicts a result similar to Liu (2022): during the financial crisis, a fiscal expansion can effectively boost asset prices and cause capital inflows, thus generating a larger

[3]Our model combines the features of Mendoza (2010) and Bianchi (2011). Mendoza (2010) uses a single-sector sudden stop model with a stock collateral constraint where financial crises are driven by aggregate productivity shocks. Bianchi (2011) uses a two-sector model with a flow constraint. In his model, the crises are driven by a combination of sectoral shocks.

consumption multiplier. However, different from the previous work, in our model with the capital collateral constraint, the stimulating effect of government purchases highly depends on the shock persistence. During a sudden stop, a fiscal stimulus affects the capital price through two channels. First, the higher government spending appreciates the real exchange rate, creating a positive wealth effect on households (referred to as *wealth channel*). If this effect dominates the traditional negative effect associated with fiscal expansions, private consumption increases. The higher consumption lowers the rate at which households discount future dividends, increasing the capital price. In addition, if the fiscal expansion is persistent, an expectation of future real appreciations increases the value of dividends and boosts the current capital price further (labeled as *currency mismatch channel*). This paper highlights that in the model with a stock collateral constraint, the second channel is essential to generate a strong multiplier effect during financial crises.

The theoretical and quantitative analyses suggest that the state-contingent multipliers and the effect of shock persistence apply to both the floating and pegged exchange rate environments. Due to the unemployment channel, pegging the exchange rate makes the government spending policy more effective in stimulating output. Moreover, we find that even though wage rigidity is an intra-temporal constraint, the impact of government spending on employment still depends on the anticipation channel. The reason is that in our model, the shocks driving the economy into an unemployment crisis are almost the same ones that cause a financial crisis. So, these two constraints usually bind at the same time. Under persistent fiscal expansions, the expected real appreciations relax the current financial constraint and increase tradable consumption. The higher real absorption, in turn, increases the nontradable good price and stimulates labor demand. In our model, this expectation channel from the future fiscal policy augments the contemporaneous effect of the fiscal expansion. As a result, the multiplier effect on employment is stronger as shocks are more persistent.

We calibrate our baseline model to Mexico, a typical sudden stop economy, using the data between 1993 and 2016. The results indicate that fiscal multipliers highly depend on the economic state where the shock hits and the persistence of fiscal policy itself. Under our baseline persistence ($\rho_g = 0.95$) and a floating regime, the median consumption multiplier equals -0.4 in an economic boom but increases to 0.45 during an economic bust. However, with a less persistent government spending process ($\rho_g = 0.75$), the impact multiplier on consumption during a financial crisis is only 0.01.[4] Shifting to a pegged environment keeps most of our results unchanged, except that multipliers on output are significantly higher. The fiscal stimulus has a stronger impact on employment if the policy is more persistent. In the baseline simulation, a one-percent increase in government purchases raises the employment rate by 0.53% on impact during a sudden stop crisis. The number declines to 0.35% if the policy shock is less persistent.

We also provide empirical evidence in accordance with the above model predictions. The cross-country analysis in Liu (2022) shows that the consumption multiplier is significantly higher during sudden stop crises than in normal times, and the multiplier on the trade balance is significantly lower. In this paper, we use the same dataset to show that the capital flow channel of government spending becomes stronger if a country has a more persistent fiscal policy. To do that, we first extract the spending persistence of each country ($\rho_{g,i}$) by running a by-country SVAR. Then, we estimate the impact of government spending shocks using the local projection method, separately for the high- and low-spending-persistence economies. The persistence of fiscal policy indeed matters for the impact of government spending. We focus on the multiplier during sudden stops. For countries with a relatively high spending persistence, the averaged cumulative multiplier on consumption throughout the first eight quarters equals 1.54, and the averaged cumulative multiplier on trade balance equals -2.43. The corresponding numbers are 0.96 and -2.03 for the low-persistence economies.

[4] To examine the capital flow channel, we find that under a floating regime, the multiplier on trade balance equals -0.64 in the bust state and equals -0.13 in the boom. The capital flow channel is weaker if the shock is less persistent, with the multiplier during a crisis equalling -0.15.

Lastly, we extend the model to consider the optimal design of spending policy. We find that the government is incentivized to raise its expenditure to combat the collateral constraint when it binds. More importantly, the optimal design of spending policy requires commitment. Under a negative shock, committing a series of fiscal expansions allows the economy to relax its current financial constraint and front-load consumption. Next, we examine whether the *ex-post* optimal spending (as an instrument of financial intervention) invites more financial risk in *ex-ante* and requires stricter macroprudential regulations. Our numerical result shows that the presence of *ex-post* optimal spending incentivizes agents to borrow more, leading to a larger probability of crises. Consequently, without macroprudential policy, optimal spending alone generates a welfare loss relative to the laissez-faire economy. The result also indicates that the optimal spending policy necessitates a more restrictive macroprudential tax to preserve financial stability.

Related Literature Ever since the Global Financial Crisis, there has been a large strand of literature trying to examine how fiscal policy's effectiveness depends on credit market conditions. Using a model with financial friction and fiscal policy, Fernández-Villaverde (2010) find that government spending can cause a Fisher effect of inflation and stimulate real activities by reducing the credit spread charged to entrepreneurs. Similarly, Eggertsson & Krugman (2012) show that in a debt-constrained economy, the mechanism of Fisher's debt-deflation, together with the possibility of a liquidity trap, can account for the strong Keynesian multiplier effect during recessions. Carrillo & Poilly (2013) use a New-Keynesian framework to show that the credit market imperfection forcefully augments the stimulation effect of government spending during a liquidity trap.[5]

One novelty of our paper is highlighting that fiscal policy's strong impact during crises

[5] Other papers provide empirical evidence that fiscal policy's effectiveness depends on the credit market conditions or financial accelerator mechanism. See Corsetti et al. (2012b), Freedman et al. (2010), Bernardini et al. (2020), and Chian Koh (2017).

hinges on the anticipation of future fiscal policies, thus the shock persistence. For example, Corsetti et al. (2012a) show that an expectation of spending reversals strengthens the short-run impact of fiscal policy. In an imperfect competition environment, Harms (2002) also shows that whether the lowered markup following a fiscal expansion strengthens or weakens the labor supply highly depends on the spending persistence parameter. Moreover, Dupaigne & Fève (2016) find that spending persistence is crucial in determining short-run multipliers through the response of private investment. They also compare their capital-accumulation model with a constant-capital environment. Different from these two papers, our baseline model is a fixed-capital environment. The large fiscal multiplier during financial crises is due to the collateral constraint and the associated Fisher's debt-deflation mechanism.

This paper also contributes to the long-standing literature that examines the effectiveness of fiscal policy during periods of slack or debt overhang. The empirical result of Auerbach & Gorodnichenko (2012a,b) using the U.S. data shows that the government spending policy is considerably more effective in recessions than in expansions. In contrast, using the military spending "news" to identify government spending shocks, Owyang et al. (2013) find significantly higher multipliers during periods of slack in Canada but not in the United States.

A series of recent studies focus on the interaction between the fiscal multiplier and the leverage cycle of an economy, and they generally claim that government spending is more effective in stimulating real activities in periods of debt overhang (e.g., Bernardini & Peersman, 2018; Demyanyk et al., 2019; Klein et al., 2022). For example, based on the analysis of U.S. data, Bernardini & Peersman (2018) find that an increase in government purchases significantly crowds in private spending at times of private debt overhang. Klein et al. (2022) build a New-Keynesian model with an occasionally-binding collateral constraint to show that an increase in government spending induces a transfer of income from the unconstrained to the constrained households, leading to a multiplier above one in periods of high leverage.

Road Map The paper proceeds as follows. Section 2 lays out the model and characterizes the properties of fiscal multipliers. Section 3 uses the simulation method to quantify the size of fiscal multipliers during a financial crisis and highlights the importance of policy shock persistence. Section 4 shows some data evidence of the role of the persistence of fiscal policy. Section 5 extends the baseline model and considers the consequences of optimal spending policy. The last section concludes.

2 Model

The model is a two-sector small open economy with a stock financial constraint that follows Mendoza (2010) and Bianchi & Mendoza (2018). We suppose the labor market is subject to DNWR, as introduced in Schmitt-Grohé & Uribe (2016a). The rationed labor market creates involuntary unemployment and generates a stimulating effect of government spending on output. There are two sectors in the economy: the tradable endowment follows an exogenous process, while the nontradable goods are produced using labor and capital. The international financial market is both incomplete and imperfect. Households can transfer wealth across periods using a short-term bond or physical capital. However, the total amount of borrowings is restricted by the market value of capital.

There is a continuum of representative households, with each one of them having a lifetime utility,

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \left[\beta^t u(c_t, h_t)\right]. \tag{1}$$

$\mathbb{E}_t(\cdot)$ denotes the conditional expectation. c_t is the final consumption, and h_t represents the labor service. $\beta \in (0,1)$ is the discount factor. The per-period utility follows $u(c_t, h_t) = \frac{c_t^{1-\sigma}-1}{1-\sigma} - \chi\frac{h_t^{1+\nu}}{1+\nu}$. Parameters σ, ν, χ represent the relative risk aversion, labor elasticity, and the weight on labor disutility, respectively. Private consumption consists of both tradable and nontradable goods,

$$c_t = \left(\omega c_{T,t}^{\frac{\theta-1}{\theta}} + (1-\omega) c_{N,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}},$$

where ω is the share of tradable goods in the consumption basket, and θ is the elasticity of substitution between the tradable and nontradable sectors.

The nontradable outputs are produced using the following technology,

$$y_{N,t} = z_t F(k_t, h_t^d) = z_t (k_t)^{\alpha_K} (h_t^d)^{\alpha_H}, \tag{2}$$

with the productivity following an AR(1) process. h_t^d denotes firms' labor demand that is distinct from the labor supply due to labor market rationing. We assume $\alpha_k + \alpha_H \leq 1$.

The households choose the supplied labor hours and make consumption and capital investment. They also issue debt in the international financial market to smooth consumption expenditure. Their optimization problem is given by

$$\max_{c_{T,t}, c_{N,t}, h_t, b_{t+1}, k_{t+1}} \mathbb{E}_0 \sum_{t=0}^{\infty} \left[\beta^t u(c_t, h_t)\right],$$

$$\text{s.t.} \quad c_{T,t} + p_t^N c_{N,t} + q_t^k (k_{t+1} - k_t) + b_t = y_{T,t} + w_t h_t + r_t^k k_t + \frac{1}{R^*} b_{t+1} - T_t + \pi_t, \tag{3}$$

$$\frac{1}{R^*} b_{t+1} \leq \kappa q_t^k k_{t+1}. \tag{4}$$

Equations (3) and (4) are respectively households' budget constraint and collateral constraint. Both equations are denominated in tradable units. Specifically, q_t^k is the market price of capital. p_t^N is the relative price of nontradable goods. w_t and r_t^k are respectively the wage rate and the capital rent. T_t is the lump-sum tax collected by the government, and π_t is the nontradable firms' profits. We assume the world interest rate (R^*) is constant. The tradable endowment follows an AR(1) process.[6]

Moreover, the real exchange rate can be defined as

$$RER_t = \left(\omega^\theta + (1-\omega)^\theta p_t^{N(1-\theta)}\right)^{\frac{1}{1-\theta}},$$

which is a monotone function of p_t^N. So, we use these two terms interchangeably.

The collateral constraint (4) indicates that the total amount of borrowings is restricted by the market value of capital.[7] The parameter κ governs the maximum leverage of the economy, which will be used to target the country's indebtedness. This collateral constraint represents the reduced form of an environment in which informational and institutional frictions affect the credit relationship between domestic and foreign agents. In economic downturns, the depreciating capital price restricts international borrowing and makes the private agents reduce their consumption levels. The lower aggregate consumption further reduces the capital price and brings about Fisher's debt-deflation mechanism. From the quantitative side, the severe economic recession driven by asset price deflation is a desirable feature of the model and provides a good laboratory to study government spending policy in financial crises.

A representative firm's objective is to maximize its profit,

$$\pi_t = \max_{k_t, h_t^d} \left\{ p_t^N z_t F(k_t, h_t^d) - w_t h_t^d - r_t^k k_t \right\}. \tag{5}$$

[6] Denote E_t as the nominal exchange rate (local currency price of foreign currency). Let P_t^N and P_t^T be the local-currency prices of nontradable and tradable goods. After normalizing the foreign price level ($P_t^* = 1$) and assuming the law of one price ($P_t^T = E_t$), we can express households' budget constraint in terms of local currencies: $E_t c_{T,t} + P_t^N c_{N,t} + Q_t^k(k_{t+1} - k_t) + E_t b_t = E_t y_{T,t} + W_t h_t + R_t^k k_t + \frac{1}{R^*} E_t b_{t+1} - E_t T_t + E_t \pi_t$. The capital letters represent nominal variables.

[7] Similar constraints have been used by many papers in the small open economy environment, such as in Mendoza (2010) and Fornaro (2015).

The solution of the model is characterized by the following set of Euler equations,

$$p_t^N = \frac{1-\omega}{\omega}\left(\frac{c_{T,t}}{c_{N,t}}\right)^{\frac{1}{\theta}}, \tag{6}$$

$$u_{cT}(t) - \mu_t = \beta R^* \mathbb{E}\left[u_{cT}(t+1)\right], \tag{7}$$

$$q_t^k\left(u_{cT}(t) - \kappa\mu_t\right) = \beta \mathbb{E}\left\{u_{cT}(t+1)\left[q_{t+1}^k + p_{t+1}^N z_{t+1} F_k(k_{t+1}, h_{t+1}^d)\right]\right\}, \tag{8}$$

$$w_t \geq -\frac{u_h(c_t, h_t)}{u_{cT}(c_t, h_t)}, \tag{9}$$

$$w_t = p_t^N F_h(k_t, h_t^d). \tag{10}$$

The first is the intra-temporal Euler equation that determines the consumption allocation between the two sectors. The second is the bond Euler equation: when the financial constraint binds ($\mu_t > 0$), the household is not free to borrow as much as they desire, and the marginal benefit of borrowing is larger than the marginal cost. The third equation says that the capital price is determined by the present discounted value of future dividends. Importantly, the next-period return on capital depends on the marginal product of the capital and its continuation value, which in turn depends on the fluctuation of future asset prices (p_{t+1}^N and q_{t+1}^k).[8]

The inequality (9) characterizes households' labor supply incentives. In a rationed labor market (due to DNWR as specified below), households may not be able to work the desired hours as they wish. So, the marginal benefit of working might be greater than the marginal cost. If households could work as many hours as they wish, the expression holds with equality. For the purpose of analysis, we use h_t^s to denote households' desired labor supply

[8] We define the rate of return on capital as $R_{t+1}^k = \left[q_{t+1}^k + p_{t+1}^N z_{t+1} F_k(k_{t+1}, h_{t+1})\right]/q_t^k$. Combining equations (7) and (8) yields the following relationship,

$$R_t^{ep} = \mathbb{E}_t\left[R_{t+1}^k - R^*\right] = \frac{(1-\kappa)\mu_t - cov(\Lambda_{t,t+1}, R_{t+1}^k)}{\mathbb{E}_t \Lambda_{t,t+1}}, \tag{11}$$

where $\Lambda_{t,t+j} = \beta^j \frac{u_{cT}(t+j)}{u_{cT}(t)}$ is the j-period ahead stochastic discount factor. Since R_t^{ep} is a good proxy for the financial status of the economy, in the calibration below, we will compare it to its counterpart in the data.

that satisfies the following,

$$w_t = -\frac{u_h(c_t, h_t^s)}{u_{cT}(c_t, h_t^s)}. \tag{12}$$

Lastly, equation (10) is the firm's labor demand. The labor market satisfies the relationship: $h_t^* = h_t^d \leq h_t^s$.

The economy is subject to DNWR as laid out in Schmitt-Grohé & Uribe (2016a). Specifically, the nominal wage is constrained by the last-period wage state,

$$W_t \geq \gamma W_{t-1}.$$

The parameter $\gamma \in (0, 1)$ controls the degree of wage rigidity. Then, the real wage satisfies

$$w_t^* \geq \gamma \frac{w_{t-1}}{\epsilon_t}, \tag{13}$$

where $\epsilon_t = \frac{E_t}{E_{t-1}}$ is the growth rate of the nominal exchange rate. The constraint says that the current equilibrium real wage is constrained by a wage floor that depends on the previous-period wage state and exchange rate policy. When the DNWR binds, a negative shock depresses labor demand and makes it fall short of the labor supply. So, we have $h_t^* = h_t^d < h_t^s$. In this case, the economy features involuntary unemployment. The unemployment rate is defined as $u_t = (h_t^s - h_t^*)/h_t^s > 0$. Moreover, the complementary slackness condition must hold,

$$(h_t^s - h_t^*)\left(w_t^* - \gamma \frac{w_{t-1}}{\epsilon_t}\right) = 0.$$

In the following analysis, we focus on two extreme exchange rate environments: a perfectly pegged exchange rate regime ($\epsilon_t = 1$) and a floating exchange rate regime. We assume that under the floating regime, the nominal exchange rate depreciates up to a point where the full-employment status is restored.[9]

The tradable endowment and productivity follow AR(1) processes,

$$\log(y_{T,t}) = (1-\rho_{y_T})\log(\bar{y}_T) + \rho_{y_T}\log(y_{T,t-1}) + \epsilon_{y_T,t}, \quad \epsilon_{y_T,t} \sim \mathbb{N}(-0.5\sigma^2_{y_T}, \sigma^2_{y_T}), \tag{15}$$

$$\log(z_t) = (1-\rho_z)\log(\bar{z}) + \rho_z\log(z_{t-1}) + \epsilon_{z,t}, \quad \epsilon_{z,t} \sim \mathbb{N}(-0.5\sigma^2_z, \sigma^2_z). \tag{16}$$

The persistence and volatility parameters will be calibrated to target data moments. Government spending is also exogenous,

$$\log(g_{N,t}) = (1-\rho_g)\log(\bar{g}_N) + \rho_g\log(g_{N,t-1}) + \epsilon_{g,t}, \quad \epsilon_{g,t} \sim \mathbb{N}(-0.5\sigma^2_g, \sigma^2_g). \tag{17}$$

$\bar{g}_N$ is the steady-state level of public consumption. In this paper, we vary ρ_g and consider how the fiscal multiplier during financial crises depends on the persistence of government spending shock.

We assume public consumption only comes from the nontradable sector. Besides, we assume the government keeps a balanced budget, $p^N_t g_{N,t} = T_t$, and there are always lump-sum taxes available. Therefore, we abstract from the government's fiscal financing problem and focus on the general equilibrium effect of government spending policy through the financial constraint.

Suppose the aggregate capital is in fixed supply: $k_t = 1$. Taking the firms' profits and the government's balanced budget into the household's budget constraint yields the following

[9] A more general setup is to assume a flexible exchange rate policy,

$$\epsilon_t = \max\left\{\frac{\gamma w_{t-1}}{w^f_t}, 1\right\}^{\gamma^E}, \quad \gamma^E \in [0,1]. \tag{14}$$

where w^f_t represents the full-employment wage solved under the condition that $h^*_t = h^d_t = h^s_t$. $\gamma^E = 0$ indicates the pegged exchange rate regime, while $\gamma^E = 1$ represents the floating regime (or full-employment exchange rate regime).

resource constraints of the economy,

$$c_{T,t} + b_t = \frac{1}{R^*} b_{t+1} + y_{T,t}, \tag{18}$$

$$c_{N,t} + g_{N,t} = y_{N,t} = F(1, h_t^*). \tag{19}$$

The competitive equilibrium is defined as follows. The full set of equilibrium conditions is described in Appendix B.

Definition 1 (**Competitive Equilibrium**)**.** Given initial conditions $\{b_0, w_{-1}, y_{T,0}, z_0, g_{N,0}\}$ and exogenous processes $\{y_{T,t}, z_t, g_{N,t}\}_{t=0}^{\infty}$, the competitive equilibrium consists of sequences of allocations $\{c_{T,t}, c_{N,t}, y_{N,t}, h_t, h_t^s, u_t, b_{t+1}, k_{t+1}\}_{t=0}^{\infty}$ and prices $\{w_t, q_t^k, p_t^N, \epsilon_t, \mu_t\}_{t=0}^{\infty}$, such that i) taking prices and policies as given, the representative household maximizes the expected lifetime utility (1) subject to the collateral and budget constraints (3)-(4); ii) the representative firm maximizes its profits (5); iii) the DNWR in equation (13) holds; iv) the government spending follows an exogenous process (17); v) the exchange rate fluctuation follows (14); vi) labor market satisfies $h_t^* = (1-u_t)h_t^s$, and capital market clears: $k_t = 1$; and vii) markets clearing conditions hold in the tradable and nontradable sectors as in equations (18)-(19).

2.1 Theoretical Results

This section presents a simplified version of the model and characterizes the properties of spending multipliers and shows the following three analytical results: i) the spending multiplier is higher during a sudden stop crisis than in normal times; ii) the sudden stop multiplier effect is stronger as the level of shock persistence increases; iii) the mechanism holds for both the pegged and floating exchange rate environments.

We assume the labor supply is inelastic and normalized to 1. Also, suppose there is only a financial constraint in the first period, and agents perfectly smooth consumption after the first period. The exogenous processes of y_T and z are kept at their steady-state values: we study a perfect foresight equilibrium. In this section, we use log-linearization to investigate the fiscal multiplier conditional on certain financial states (crisis time vs. normal time).

How does an increase in government spending (the current or the future) affect agents' borrowing ability during a financial crisis? To explore the channel of government spending on the collateral constraint, we iterate the capital price equation forward and derive the following expression of financial constraint,

$$\frac{1}{R^*}b_2 \leq \kappa q_1^k = \kappa \frac{\beta}{1-\beta}\alpha_K y_N \frac{u_{cT}(2)p_2^N}{u_{cT}(1)-\kappa\mu_1}. \tag{20}$$

The last equality uses the fact that agents can perfectly smooth consumption since the second period. The path of exchange rates is given by,

$$p_1^N = \frac{1-\omega}{\omega}\left(\frac{y_T - b_1 + \frac{1}{R^*}b_2}{y_N - g_{N,1}}\right)^{\frac{1}{\theta}}, \qquad p_t^N = \frac{1-\omega}{\omega}\left(\frac{y_T - \left(1-\frac{1}{R^*}\right)b_2}{y_N - g_{N,2}}\right)^{\frac{1}{\theta}} \quad \text{for } t \geq 2. \tag{21}$$

A fiscal stimulus affects the capital price through two channels. First, a positive spending shock appreciates p_1^N making the tradable goods relatively cheaper. The agent becomes wealthier, and the level of final consumption increases, especially when the elasticity of substitution θ is low. The higher consumption lowers the rate at which households discount future dividends, increasing the capital price. This contemporaneous effect is called the *wealth channel*. Second, because the debt is denominated in foreign currencies while the capital is productive only in the domestic sector, there is a currency mismatch problem. In principle, the current capital price, q_1^k, is linked to nontradable prices in all the future periods: p_t^N for $t = 2, 3, 4, \cdots$. An expectation of real appreciation in the future increases the value of dividends today and boosts the current collateral price. We call this inter-temporal effect *currency mismatch channel*. Through these two channels, the fiscal stimulus relaxes the financial constraint and reverses Fisher's debt deflation during a sudden stop crisis.

Figure 1: The effect of persistent government spending

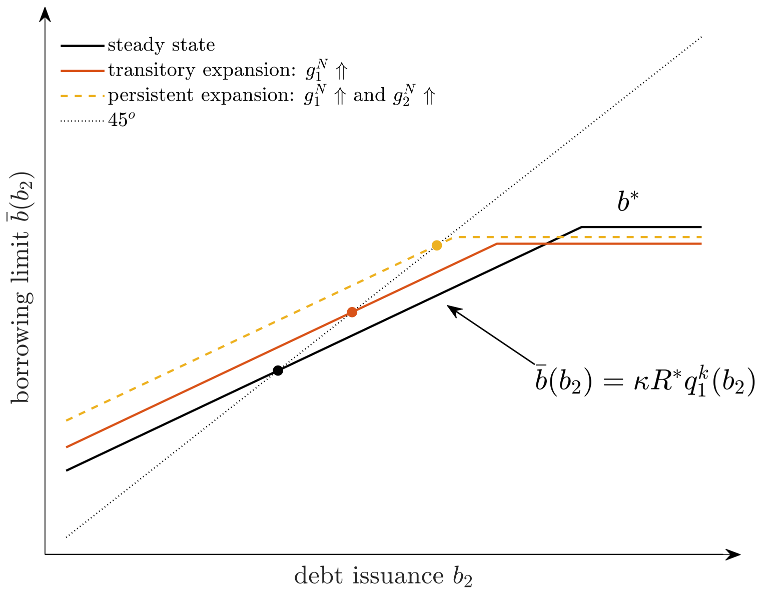


Figure 1 illustrates the conditional effect of government spending on agents' borrowing decisions. If the constraint is slack, the borrowing decision is determined by the bond Euler equation (7) (shown as the flat part of each line). The mechanism is different if the collateral constraint binds. In equilibrium, the borrowing decision is made at the intersection of the borrowing limit ($\bar{b}(b_2)$) and the 45-degree line. The intuition is that the agent's borrowing ability is restricted by the capital price, which in turn depends on the intended level of borrowing itself. In the model, an increase in either current or future government spending props up the capital price through the aforementioned channels, pushing up the borrowing limit and increasing the agents' ability to issue debt. An endogenous feedback loop is also present. In turn, the improved borrowing ability and the associated larger real absorption raise asset prices and further relax the collateral constraint.

The following assumption facilitates the derivation of closed-form solutions

Assumption 1. $\beta \times R^* = 1$

Assumption 2. *The government spending process follows* $g_{N,2} = (\bar{g})^{1-\rho_g}(g_{N,1})^{\rho_g}$ *and* $g_{N,2} = g_{N,3} = g_{N,4} = \cdots$, *where* $\bar{g}$ *is the steady-state level of government spending.*

Assumption 3. $\frac{1}{\theta} > 1$.

Assumptions 1 and 2 guarantee that agents can perfectly smooth tradable consumption since the second period, $c_{T,2} = c_{T,3} = c_{T,4} = \cdots$, and the level of consumption path is determined by $c_{T,t} = -\left(1 - \frac{1}{R^*}\right) b_2 + y_T$, for $t \geq 2$. In the following, we only consider impact multipliers. $\mathcal{M}^x = \frac{\hat{x}}{\hat{g}_{N,1}}$ represents the multiplier on endogenous variable x. We denote a variable x without a time subscript as the steady state and $\hat{x}$ as the percentage deviation from its steady state. First, we extend the result in Liu (2022) and show that in the model with a capital collateral constraint, the fiscal multiplier is still higher during sudden stops than in normal times. It is well-known from the literature (i.e., Schmitt-Grohé & Uribe, 2016b) that an endogenous collateral constraint may create multiplicity in the Fisherian model. The next assumption excludes this case.[10] We use $\mathcal{M}_N$ to denote the multiplier in normal time and $\mathcal{M}_C$ to denote the multiplier during crises.

Assumption 4. *Multiple equilibria cannot arise from the collateral constraint. That means the parameters satisfy*

$$\frac{b}{c_T}\left[\frac{1}{\theta}\left(\frac{1}{R^*} - \kappa\right) - \left(-1 + \frac{1}{\theta}\right)(1-\kappa)\omega^T\right] < 1 \ ,$$

where b and c_T denote the steady-state levels of borrowing and tradable consumption.

Figure F.1 in Appendix F shows the region of parameters that satisfies the regularity condition. The next proposition characterizes the state-dependent multiplier effects in a model with a floating exchange rate.

Proposition 1 (State-Dependent Multipliers). *Under assumptions, 1-4, the borrowing*

[10] In order to generate the binding state, we assume $y_{T,1}$ drops by a sufficient amount that it triggers the collateral constraint.

multipliers in normal time and crisis time are respectively given by

$$\mathcal{M}_N^b = -\frac{(1-\rho_g)\left(-1+\frac{1}{\theta}\right)\omega^N}{\frac{b}{c_T}\left[\frac{1}{\theta}-\left(-1+\frac{1}{\theta}\right)\omega^T\right]}\frac{g_N}{c_N} < 0, \tag{22}$$

$$\mathcal{M}_C^b = \frac{\rho_g\frac{1}{\theta}+\left(-1+\frac{1}{\theta}\right)(1-\kappa)\omega^N(1-\rho_g)}{1-\frac{b}{c_T}\left[\frac{1}{\theta}\left(\frac{1}{R^*}-\kappa\right)-\left(-1+\frac{1}{\theta}\right)(1-\kappa)\omega^T\right]}\frac{g_N}{c_N} > 0\ , \tag{23}$$

where $\omega^T = \omega c_T^{\frac{\theta-1}{\theta}}/c^{\frac{\theta-1}{\theta}}$ *and* $\omega^N = (1-\omega)c_N^{\frac{\theta-1}{\theta}}/c^{\frac{\theta-1}{\theta}} \in (0,1)$ *.*

Then, for each level of shock persistence, we have the following relationship in a model without unemployment,

$$\mathcal{M}_C^b > \mathcal{M}_N^b, \qquad \mathcal{M}_C^c > \mathcal{M}_N^c, \qquad \mathcal{M}_C^{p^N} > \mathcal{M}_N^{p^N}, \qquad \forall \rho_g \in (0,1).$$

Proof. See Appendix B.1. □

The result indicates that in normal times, a fiscal stimulus decreases the agent's borrowing incentives and crowds-out capital flows. On the contrary, a positive spending shock induces capital inflows when the external collateral constraint is binding. Next, we lay out the central result of this paper: the capital flow channel of government spending is stronger as the shock persistence increases.

Proposition 2 (**Persistence Effect**). *Suppose the collateral constraint is binding in* $t = 1$*. As the shock persistence rises, the magnitude of crisis multipliers on borrowing, consumption, and the real exchange rate all increase; that is* $\frac{\partial \mathcal{M}_C^b(\rho_g)}{\partial \rho_g} > 0$, $\frac{\partial \mathcal{M}_C^c(\rho_g)}{\partial \rho_g} > 0$, $\frac{\partial \mathcal{M}_C^{p^N}(\rho_g)}{\partial \rho_g} > 0$.

Proof. See Appendix B.2. □

This result is consistent with the intuition behind equation (20). If the constraint binds in $t = 1$, the anticipation of future fiscal expansions generates future real appreciations, which relaxes the current financial constraint.

Model with Unemployment To consider whether the baseline result can be extended to a pegged exchange rate environment, we introduce a one-time nominal wage rigidity. We suppose that, in the first period, the equilibrium wage cannot fall below a wage floor: that is

$$p_1^N F_h(1, h_1) = w_1^* \geq \underline{w}. \tag{24}$$

If the wage constraint is binding, labor demand falls short of labor supply, and the economy is subject to involuntary unemployment: $1 - h_1^*$.

From the expression of p_t^N in equation (21), we find that an increase in government spending can stimulate nontradable output in the presence of DNWR. However, the stimulating effect weakens the real appreciation and the favorable impact on the collateral constraint.

To solve the model under DNWR, we first use equation (24) to derive the equilibrium labor hiring as,

$$\hat{h}_1 = \frac{\frac{1}{\theta}\hat{c}_{T,1} + \frac{1}{\theta}\frac{g_N}{c_N}\hat{g}_{N,1}}{1 - \alpha_H + \frac{1}{\theta}\frac{\alpha_H y_N}{c_N}}. \tag{25}$$

Then, taking equation (25) into the resource constraint gives us the following,

$$\hat{c}_{N,1} = \Omega_1 \hat{c}_{T,1} - \Omega_2 \frac{g_N}{c_N}\hat{g}_{N,1}, \tag{26}$$

where $\Omega_1 = \frac{1}{\theta}\frac{\alpha_H y_N}{c_N} / (1 - \alpha_H + \frac{1}{\theta}\frac{\alpha_H y_N}{c_N})$ and $\Omega_2 = 1 - \Omega_1 \in (0, 1)$.[11]

In the model with unemployment, we first make the following assumption to exclude multiple equilibria arising from the collateral constraint.

Assumption 5. *The collateral constraint does not create multiplicity in the simplified model with DNWR. That means the parameters have to satisfy*

$$\frac{b}{c_T}\left[\frac{1}{\theta}\left(\frac{1}{R^*} - \kappa\right) - \left(-1 + \frac{1}{\theta}\right)(1 - \kappa)\left(\omega^T + \omega^N \Omega_1\right)\right] < 1.$$

[11] When $\Omega_1 = 0$ and $\Omega_2 = 1$, the formula goes back to the model with flexible wage.

Then, the following proposition shows that the baseline result applies to the model with unemployment. We denote $\mathcal{M}_{C,DNWR}$ as the fiscal multiplier in the crisis.

Proposition 3 (**Model with Unemployment**). *Under assumptions 1-3 and 5, when both the collateral constraint and DNWR bind at $t = 1$, the economy features involuntary unemployment, and the borrowing multiplier in a crisis state is given by*

$$\mathcal{M}^b_{C,DNWR} = \frac{\rho_g \frac{1}{\theta} + \left(-1 + \frac{1}{\theta}\right)(1-\kappa)\omega^N\left(\Omega_2 - \rho_g\right)}{1 - \frac{b}{c_T}\left[\frac{1}{\theta}\left(\frac{1}{R^*} - \kappa\right) - \left(-1 + \frac{1}{\theta}\right)(1-\kappa)(\omega^T + \frac{1}{R^*}\omega^N\Omega_1)\right]} \frac{g_N}{c_N} > 0 \ . \tag{27}$$

Therefore, although introducing unemployment mitigates the capital flow channel of government spending ($\mathcal{M}^b_C > \mathcal{M}^b_{C,DNWR} > 0$), we still have the following relationships:

1. *The fiscal multipliers on borrowing, consumption, output, and employment are higher in a crisis state than in normal time,*

$$\begin{aligned} &\mathcal{M}^b_{C,DNWR} > \mathcal{M}^b_N, \qquad \mathcal{M}^c_{C,DNWR} > \mathcal{M}^c_N, \\ &\mathcal{M}^{y_N}_{C,DNWR} > \mathcal{M}^{y_N}_N, \qquad \mathcal{M}^h_{C,DNWR} > \mathcal{M}^h_N, \qquad \forall \rho_g \in (0,1). \end{aligned}$$

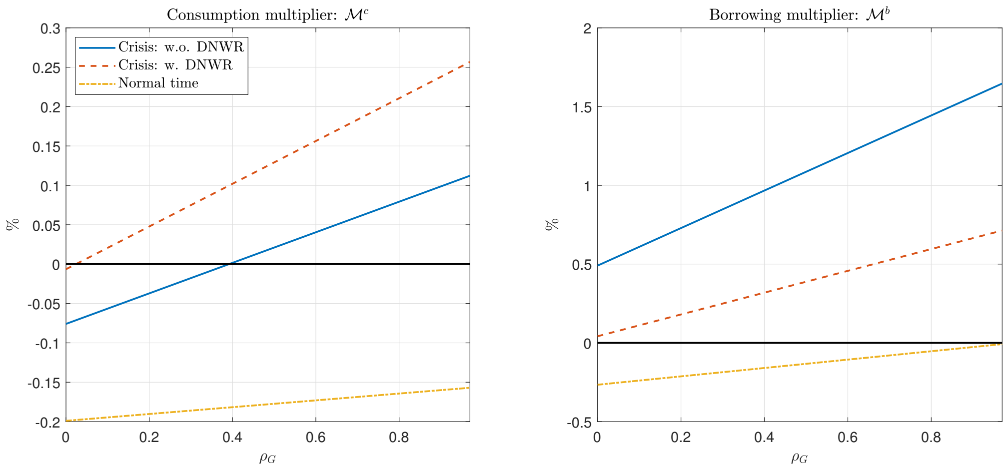
2. *As the shock persistence rises, the magnitude of crisis multipliers on borrowing, consumption, output, the real exchange rate, and employment all increase; that is,*

$$\frac{\partial \mathcal{M}^x_{C,DNWR}(\rho_g)}{\partial \rho_g} > 0, \qquad \textit{for} \quad x = b, c, y_N, p^N, h.$$

Proof. See Appendix B.3. □

Proposition 3 indicates that although the presence of DNWR weakens the capital flow channel, the financial-state-contingent effects of government spending still hold. Besides, even in the model with wage rigidity, the magnitude of the sudden stop multiplier still highly depends on the shock persistence. Figure 2 shows the spending multipliers at different levels

Figure 2: State-dependent multipliers for different shock persistence: ρ_g



NOTE: Parameters in the simplified model are set to the following: $\beta = 0.94$, $\theta = 0.45$, $\omega = 0.45$, $\kappa = 0.22$.

of ρ_g in normal times and financial crisis states. We find that the borrowing multiplier is always higher in a crisis state than in a normal state, although the unemployment channel weakens the capital flow channel through the collateral constraint. Meanwhile, as shown in the left panel, combining the financial and wage constraints lead to a higher consumption multiplier than under the financial constraint alone.

3 Quantitative Analysis

This section extends the analytical framework to a quantitative environment.

3.1 Calibration and Defining Fiscal Multipliers

The model is calibrated to the Mexican economy from 1993-Q1 to 2015-Q4. Most parameters follow standard values in the literature or are based on simple moment matches.[12] The tradable share ω is set to match the historical average of consumption ratio between the two sectors, $\frac{c_T}{p^N c_N} = 64.2\%$, as computed in Mendoza (2002). χ is chosen to normalize

[12] To solve the model with occasionally binding constraints, we use the collocation method with time iteration on Euler equations. The computational details can be found in Appendix C.

the steady-state value of labor as 1 in the model without unemployment. The government consumption-to-GDP ratio is based on the historical average of 11.7%. The degree of wage rigidity, $\gamma = (0.99)^{1/4}$, comes from Schmitt-Grohé & Uribe (2016a). The remaining six parameters, including the subjective discount parameter β, the collateral rate κ, and the shock parameters σ_z, σ_{y_T}, ρ_z, ρ_{y_T}, are jointly calibrated to match the following data moments: the debt service-to-GDP ratio, the average equity premium (or probability of a sudden stop), and the standard deviations and the first autocorrelations of the GDP and real exchange rate.[13] The persistence of government spending is set to 0.95 in the baseline setting based on the estimation of Mexican data. But we focus on how the different values of ρ_g lead to distinct multiplier effects during financial crises. Table E.1 in Appendix E shows the parameter values, and table E.2 shows the model fit.

As seen from table E.2, the baseline model does a decent job fitting the selected data moments, especially for the average debt service ratio and autocorrelations. Moreover, shocks of this size can generate sudden stop crises with the correct frequency. We notice that the model is able to reproduce some distinctive features of small open economies: private consumption is more volatile than output, the trade balance is countercyclical, and consumption is highly correlated with output. The model also predicts a countercyclical spread and a procyclical real exchange rate, which are widely observed in emerging countries. The unemployment rate is also countercyclical in the model with the pegged exchange rate: $\rho(u, y) = -0.80$.

Defining Fiscal Multipliers We calculate fiscal multipliers based on the method to compute generalized impulse response functions (GIRF). Starting from a certain state $\mathcal{S}_t$, we simulate the economy for a large number of paths of shocks and take this as the benchmark. In the second time, we simulate it again with the same set of shocks but increase the government spending shock in the first period by a certain amount. At each time horizon,

[13]We assume the fluctuations of its nontradable good price accounted for 50% of the fluctuations in the CPI-adjusted Mexico-US real exchange rate.

the spending multiplier is the median difference in the outcome between the path with a government spending shock and the path without it. Specifically, for the variable X, the cumulative multiplier of horizon H is defined as

$$\mathcal{M}^{X,H}(\mathcal{S}_t) = \frac{\sum_{j=0}^{H}\left(X_{t+j}^{Shock} - X_{t+j}^{No\ Shock}\right)}{\sum_{j=0}^{H}\left(G_{t+j}^{Shock} - G_{t+j}^{No\ Shock}\right)}, \qquad X \in \{Y, C, TB, \log(RER)\}$$

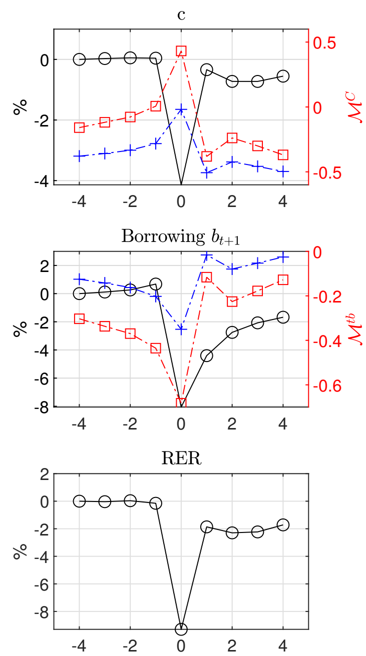
For consumption, output, and trade balance, the multipliers are interpreted in terms of final good volumes. For the real exchange rate, the multiplier is interpreted in terms of percentage deviations. We focus on the impact multipliers.

Crisis Event Figure 3 shows the averaged path of economic variables during an identified sudden stop event. During a sudden stop crisis, a large negative endowment shock reduces the tradable consumption and the demand for nontradable goods. The lower nontradable good price reduces the market value of income and tightens the collateral constraint, restricting agents' borrowing opportunities in the international financial market. The limited ability to borrow requires agents to cut consumption further to serve the existing debt. Meanwhile, real depreciation imposes a downward pressure on labor demand, reducing the production of nontradable goods. Figure 3 shows that sudden stop crises are featured by the big collapses of consumption, production, the real exchange rate, and a sudden current account adjustment.

We also simulate the paths of fiscal multipliers in the event window. The red lines in Figure 3 display the time-varying multipliers on consumption, output, and trade balance in the model with a high value of ρ_g (0.95), while the blue lines are fiscal multipliers in the model with a relatively low ρ_g (0.75)[14]. We find that for the high-ρ_g economy, the consumption multiplier jumps from a negative value before the crisis to a positive value in

[14]The value of 0.75 is chosen to be the threshold of high/low-persistence economies in the panel dataset in section 4.

Figure 3: Event path of crisis and time-varying multipliers



NOTE: The black lines show the average path of endogenous variables around the identified sudden stop episodes. The red lines show the time-varying fiscal multipliers (consumption, output, trade balance) around the event window in an economy with high spending persistence: $\rho_g = 0.95$. The blue lines are fiscal multipliers in an economy with low spending persistence: $\rho_g = 0.75$. Both economies are under the floating regime.

time-0. However, the consumption multiplier is consistently smaller around the crisis event if the spending process is less persistent. The same is true for the output multiplier, even though the difference is small. In the high-ρ_g economy, a positive spending shock invites a large capital inflow during the financial crisis because the fiscal stimulus boosts the capital price. That implies a largely negative trade balance multiplier. The impact on the trade balance is also weaker for a milder shock persistence.

3.2 Fiscal Multiplier Distribution and Shock Persistence

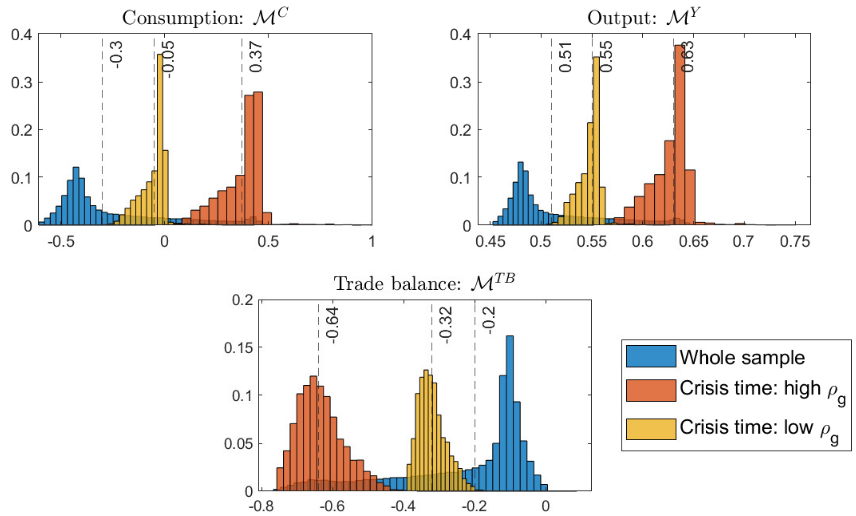
Figure 4 compares the conditional and unconditional fiscal multiplier distributions across the stationary distribution of the model. We first simulate the economy for long periods of time.

Then we compute fiscal multipliers conditional on 10,000 realizations of the state vectors. We have two insights from figure 4: i) in our model with the stock collateral constraint, the consumption multiplier during sudden stops is considerably higher than its value in normal times; ii) the lower shock persistence dampens the financial stimulation effect of governments spending, lowering the consumption multiplier during financial crisis.[15] The similar pattern holds hold for output multipliers, even though they are less dispersed across the business cycle.

The highlighted capital flow channel of government spending is evident in the lower panel of figure 4. We find that during a financial crisis, the trade balance sharply declines after an increase in government purchases, which is due to the relaxed collateral constraint. However, when the shock persistence is relatively low, the contemporaneous impact of the spending shock on capital price is milder due to the smaller expectation formation effect. Consequently, even though the government still initiates a stimulus policy during the financial crisis, the capital flow channel is not strong enough to make the consumption multiplier positive.

Figure F.3 in Appendix F shows how the fiscal multiplier depends on the financial market soundness and how the shock persistence matters for this relationship. Regardless of the shock persistence, the risk premium is close to zero in normal times, and consumption multipliers are mostly negative. But when the collateral constraint is binding, the risk premium on capital rises. At that time, a fiscal expansion boosts the capital price and relaxes the collateral constraint. More importantly, the financial acceleration effect highly depends on shock persistence. Only with a highly persistent fiscal expansion, the expectation channel of government spending is strong enough to generate a consumption boom on impact.

Figure 4: Conditional FM distributions: high vs. low shock persistence



NOTE: The graph shows the distributions of time-varying fiscal multipliers in models' long-run simulation. For each realized state, we calculate the fiscal multiplier on consumption ($\mathcal{M}_t^C(\mathcal{S}_t)$), output ($\mathcal{M}_t^Y(\mathcal{S}_t)$), and trade balance ($\mathcal{M}_t^{TB}(\mathcal{S}_t)$). The blue bars represent the unconditional distribution. The red and yellow bars represent crisis-period fiscal multipliers in the model with high ($\rho_g = 0.95$) and low ($\rho_g = 0.75$) shock persistence, respectively. Both economies are under the floating regime.

3.3 State-Dependent Multipliers and Shock Persistence

In this section, we compare the fiscal multipliers to a positive government spending shock conditional on different financial states and show the importance of shock persistence during financial crises.[16] Table 1 shows the state-dependent fiscal multipliers in an economy with either a high ρ_g or a low ρ_g. First, an increase in government purchases is more expansionary for consumption if the shock hits in the financial crisis state rather than the normal state. Output multipliers are also higher in a state of financial recession, although the difference is

[15] In the high-ρ_g economy, the unconditional average of the consumption multiplier equals to -0.30, but it increases to 0.37 in the sudden stop state. In the low-ρ_g economy, on the other hand, the impact multiplier is only -0.05 during the financial crisis.

[16] Specifically, to generate boom-bust states, we start the economy from the stochastic steady state and hit it with a sequence of four positive $y_{T,t}$ shocks of 0.5 standard deviations. The highly leveraged economy at the end of the fourth quarter is defined as a *boom* state. We get the *bust* state by imposing a large "sudden stop shock" on the leveraged economy, which is extracted from long-run simulations. Figure F.4 in Appendix F shows the realized path of a boom-bust cycle. In addition, we also define the *high/low-debt* state as the debt balance set to one standard deviation above/below its ergodic steady state.

Table 1: State-dependent multipliers: high vs. low shock persistence

Panel A: Floating exchange rate regime

	Boom	Bust	Low b	High b	Boom	Bust	Low b	High b
	High shock persistence: $\rho_g = 0.95$				*Low shock persistence:* $\rho_g = 0.75$			
$\mathcal{M}^C$	-0.40	0.45	-0.45	0.47	-0.53	0.01	-0.56	0.00
$\mathcal{M}^Y$	0.49	0.64	0.48	0.65	0.46	0.56	0.46	0.56
$\mathcal{M}^{TB}$	-0.13	-0.64	-0.08	-0.71	-0.02	-0.33	0.01	-0.36
RER (%)	18.8%	29.0%	17.0%	32.6%	15.4%	20.4%	14.0%	22.8%

Panel B: Pegged exchange rate regime

	Boom	Bust	Low b	High b	Boom	Bust	Low b	High b
	High shock persistence: $\rho_g = 0.95$				*Low shock persistence:* $\rho_g = 0.75$			
$\mathcal{M}^C$	0.05	0.68	-0.40	0.72	-0.22	0.14	-0.51	0.16
$\mathcal{M}^Y$	0.84	1.29	0.49	1.30	0.72	1.00	0.47	1.00
$\mathcal{M}^{TB}$	-0.23	-0.40	-0.13	-0.42	-0.07	-0.15	-0.04	-0.16
RER (%)	12.8%	7.9%	18.1%	7.9%	10.5%	6.1%	15.3%	6.1%
EM (%)	0.05%	0.53%	0.00%	0.54%	0.05%	0.35%	0.00%	0.36%

NOTE: For consumption, output, and trade balance, the reported numbers are the median multipliers conditional on being in the boom, bust, low-debt, and high-debt states. For the RER, the numbers represent the percentage difference between the path with a government spending shock and the path without it. EM reports the increase in employment rate on impact after a fiscal stimulus.

small under the floating regime. Second, when the financial constraint binds, a fiscal stimulus improves the country's borrowing ability and attracts more capital inflows. Therefore, although the fiscal stimulus always generates a real exchange rate appreciation, the degree of appreciation is stronger during a financial crisis.

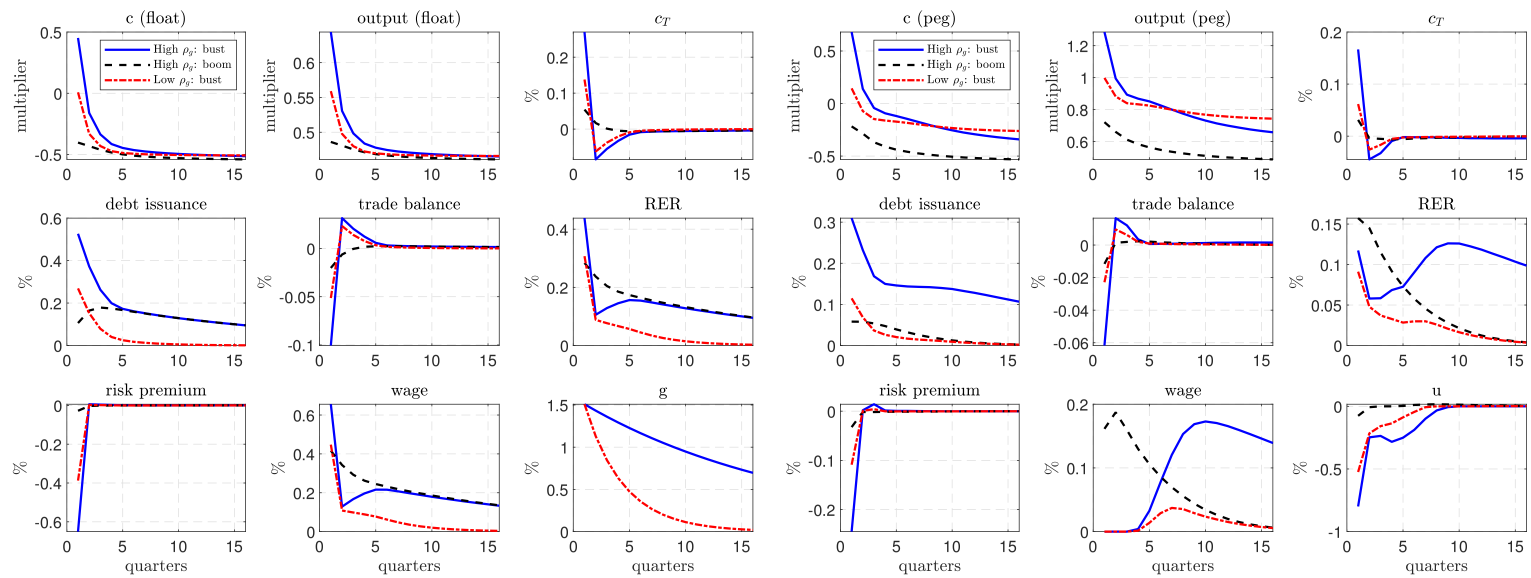
Since our model has a stock collateral constraint, the simulation effect of government spending highly depends on the shock persistence. By comparing the left and right panels of table 1, we find that the lower shock persistence considerably dampens the financial effect of fiscal expansion. If $\rho_g = 0.75$, the consumption multiplier is not significantly different from 0 during the financial crisis (bust or high-debt state). Moreover, if the shock is less persistent, the degree of real appreciation is downsized by half compared to the economy with a high shock persistence (20.4%-15.4% vs. 29%-18.8%). By comparing the multipliers on the trade balance (-0.33 vs. -0.64), we find that the strength of the capital inflow channel is also weaker if a less persistent fiscal expansion is used during financial crises.

Panel B of table 1 conducts the same exercises in a pegged exchange rate environment. We find that during the simulated financial crises (high-debt or bust state), the consumption and output multipliers are significantly smaller if the government uses a less persistent fiscal expansion. The smaller shock persistence also ameliorates the capital flow channel of government spending, making the trade balance multiplier closer to 0. One thing to notice is that under the pegged regime, part of the stimulation effect comes from the unemployment channel. The smaller shock persistence not only dampens the impact of government spending on capital price and thus on the collateral constraint, but it also makes the increase in employment milder. When $\rho_g = 0.75$, a unit stimulus only drives up employment rate by 0.35% in the bust state, compared to the stronger response of 0.53% in a model with $\rho_g = 0.95$.

Figure 5 shows the impulse response functions to a positive government spending shock. We compare the responses in the boom and the bust states and consider the response at the bust state in an economy with a low ρ_g. First, relative to the boom state, a fiscal expansion in the bust state lessens the collateral constraint and improves a country's borrowing opportunities. The greater ability to borrow creates a big surge in tradable consumption and a deep decline in the trade balance (blue lines). More importantly, the less persistent shock (red lines) mitigates the initial impact of stimulus on consumption and output. Even though the collateral constraint is binding, the smaller real exchange rate appreciation after a spending shock improves the borrowing ability by a less amount. This point is evident by seeing the milder responses of risk premium, debt issuance, and trade balance in the bust state. Panel B shows the pegged exchange rate environment. The smaller ρ_g also weakens the impact on the unemployment rate, leading to less pronounced consumption and output

Figure 5: Generalized impulse response functions conditional on boom and bust states

Panel A: Floating Regime **Panel B:** Pegged Regime



NOTE: The figure shows the impulse response functions to a positive government spending shock conditional on boom and bust states. The blue and black lines are simulated in a high-persistence economy ($\rho_g = 0.95$), while the red lines are in a low-persistence economy ($\rho_g = 0.75$). For the consumption and output, the y-axis represents the cumulative multiplier. In other figures, the y-axis shows the percentage deviation from their ergodic means. The risk premium and unemployment are in annual percentage points, and the trade balance is reported as the percentage of GDP.

multipliers.[17]

3.4 Varying the Shock Persistence

One important implication from the analytical model is that the financial impact of fiscal expansion highly depends on the persistence of fiscal expansion itself. That is because the expected future expansions and the associated real appreciations increase the current asset price and relax the collateral constraint when it binds. The relaxed constraint, in turn, improves the borrowing ability and stimulates production, leading to bigger multipliers. In this section, we focus on this expectation channel by simulating a continuum of economies with different values of fiscal shock persistence. In each economy, we create fiscal multipliers in the corresponding boom and bust states. To consider the welfare impact of government spending, we also consider a welfare multiplier defined as $\mathcal{M}^V = \frac{\Delta V}{\Delta g/\bar{g}}$. The measure can be interpreted as the percentage of permanent private consumption the households are willing to sacrifice for a one-percent increase in public consumption.[18] Figure 6 displays the results. Panel A shows the floating exchange rate regime, while Panel B shows the pegged regime.

First, we find that as the shock persistence gets larger, the capital flow channel becomes stronger such that the gap in multipliers between the bust and the boom is bigger. As ρ_g approaches 1, the expectation channel forcefully feedbacks into the current period and significantly increases the multipliers in the bust state. We notice that the response of trade balance turns to a large negative number when the shock is very persistent. In that case, an expectation of future fiscal stimulus strongly drives capital inflows. The bottom-right panel shows the difference in welfare multipliers between the two financial states. The relative

[17] Figure F.5 in Appendix F shows the impulse response functions at the high-debt and low-debt states.

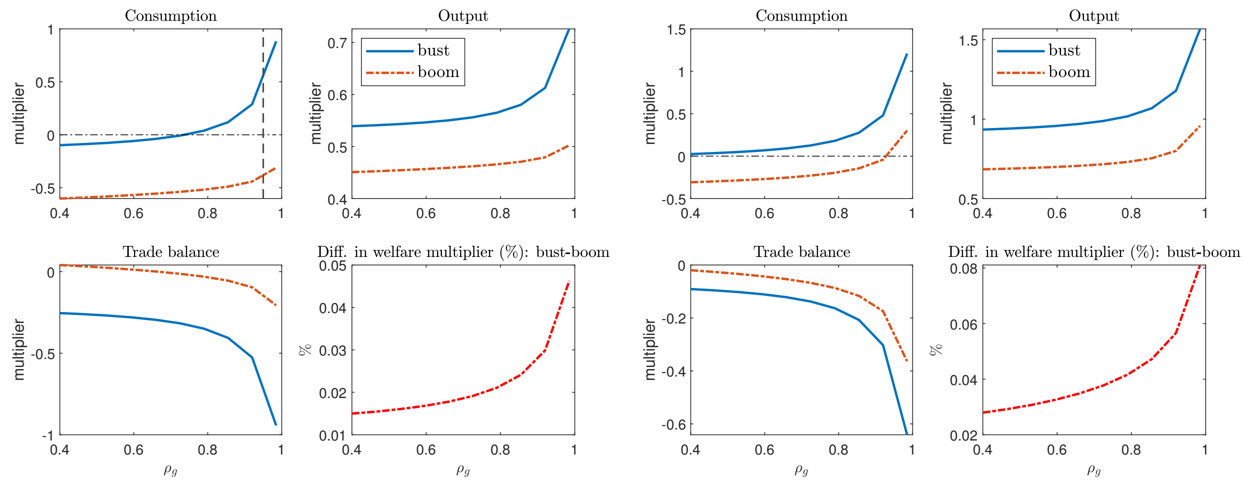
[18] Using the model's solutions, we can define the welfare function of the economy as

$$V(\mathcal{S}) = u\left(c(\mathcal{S}), h(\mathcal{S})\right) + \beta \mathbb{E} V(\mathcal{S}'),$$

where $\mathcal{S}$ and $\mathcal{S}'$ are respectively the current-period and the next-period state vectors.

Figure 6: Fiscal multipliers at different levels of shock persistence

Panel A: Floating Regime **Panel B:** Pegged Regime



NOTE: The graph shows the impact multipliers for different values of shock persistence (ρ_g) at the simulated boom and bust states. Panel A is under the floating exchange rate regime, while panel B is under the Pegged regime. We also report the difference in welfare multipliers between a bust state and a boom state; that is $\mathcal{M}^V_{bust} - \mathcal{M}^V_{boom}$.

welfare impact is positive and monotonically increases in ρ_g. It indicates that there exists a relative welfare benefit of implementing a stimulus policy during the financial crisis, and this relative welfare benefit becomes more substantial if the shock is more persistent.

Panel B shows the multipliers under the pegged regime. The persistence effect is still present in this environment. Compared with the floating regime, the unemployment channel generates a larger multiplier on consumption and output during financial crises. Moreover, as ρ_g gets larger, the relative welfare benefit of fiscal expansion in the bust state ($\mathcal{M}^V_{bust} - \mathcal{M}^V_{boom}$) increases more sharply.

4 Testable Implications

To show the empirical relevance of our channel, we estimate the impacts of government spending during the financial crises. Also, we show how this financial-state-dependent effect is amplified through a more persistent fiscal policy. We use the same sample of countries and econometric method as in Liu (2022). Specifically, a sudden stop crisis is defined as the period when i) GDP falls more than one standard deviation below its trend; and ii) the year-to-year current account adjustment is larger than 1.5 standard deviations. In addition, we use an 8-quarters event window to bracket the sudden stop period to create a "sudden stop episode." That provides a clear-cut way for us to consider the state-dependent impacts of government spending in normal times and in financial crises.

In the first stage of the by-country SVAR, we get the government spending persistence ($\hat{\rho}_{g,i}$) from the estimated coefficient matrix in each country.[19] The cross-country median of the parameter equals 0.77 (with a standard deviation of 0.17). Then, we divide our sample into two groups based on whether a country's spending persistence is higher or lower than this number. In the second stage, we estimate the fiscal multipliers using the local projection method of Jordà (2005) separately for the high- and lower-persistence economies.

We consider the following linear and non-linear regressions:

$$\sum_{j=0}^{h} x_{i,t+j} = c + trend_t + \alpha_i + m^{x,h} \sum_{j=0}^{h} g_{i,t+j} + \Phi_h(L) z_{i,t-1} + u_{i,t+h}, \tag{28}$$

$$\begin{aligned} \sum_{j=0}^{h} x_{i,t+j} = c + trend_t + I_{i,t-1} \times \left[\alpha_{C,i} + m_C^{x,h} \sum_{j=0}^{h} g_{i,t+j} + \Phi_{C,h}(L) z_{i,t-1} \right] \\ + (1 - I_{i,t-1}) \times \left[\alpha_{N,i} + m_N^{x,h} \sum_{j=0}^{h} g_{i,t+j} + \Phi_{N,h}(L) z_{i,t-1} \right] + u_{i,t+h}. \end{aligned} \tag{29}$$

where i is the country index, and t is the time indicator. x represents the variable of our interests, including GDP, private consumption, trade balance, and the real exchange rate. The control vector $z_{i,t-1}$ includes the past GDP, public consumption, the real exchange rate, and currency account ratio. The term $\Phi_h(L)$ indicates the polynomial of the lag operator of

[19]We extract the estimated residuals from the first-line equation of the SVAR and consider them as government spending shocks ($\hat{u}^g_{i,t}$). We treat these shocks as instruments in the second-stage panel regression to estimate fiscal multipliers.

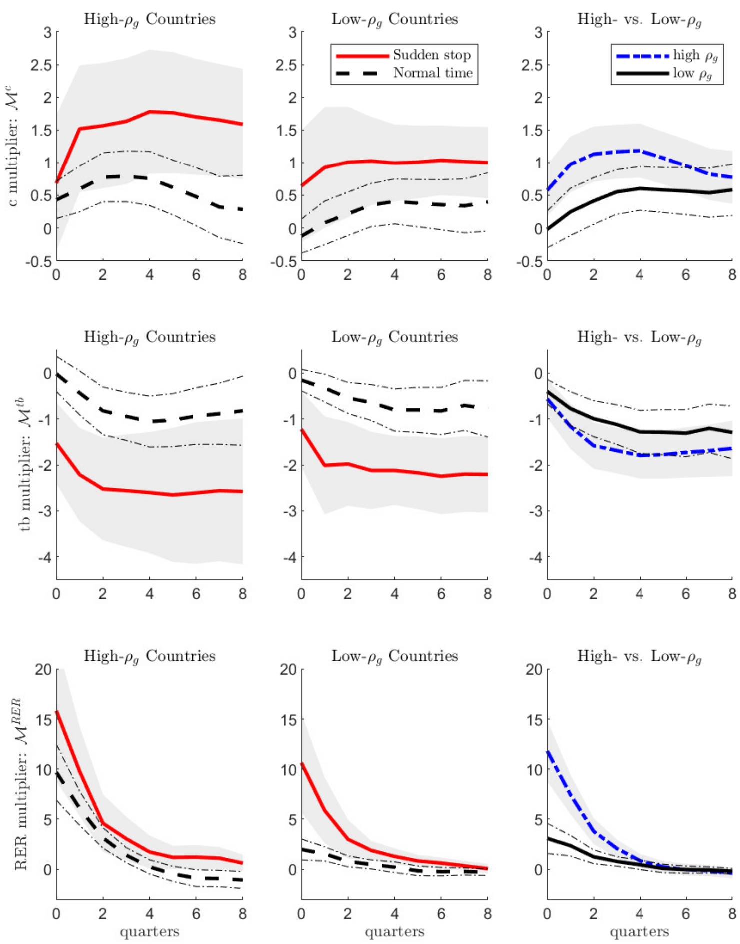
degree four. The endogenous regressor is instrumented by the government spending shock extracted from the first-stage SVARs. In the nonlinear estimation (29), the dummy variable $I_{i,t-1} = 1$ if the shock hits in a sudden stop, or $I_{i,t-1} = 0$ otherwise.

The advantage of using this specification is that the estimate of $m^{x,h}$ can be interpreted as the cumulative multiplier of variable x at horizon $h = 1, \ldots, 8$. In the state-dependent estimation, $m_N^{x,h}$ and $m_C^{x,h}$ are respectively the multipliers in normal times and financial crises. Figure 7 reports the financial-state-multipliers separately for the countries with high and low fiscal persistence. The right column of figure 7 shows the estimation of the linear model in these two groups of countries.

First, from the right column, we notice that although a highly-persistent fiscal rule generally implies a larger multiplier and a stronger capital flow channel, the difference between the two groups of countries is small, especially for the multipliers on the trade balance. However, by comparing the first two columns, we find that a more persistent policy tends to generate a stronger multiplier effect during financial crises than a less persistent policy. If we only look at the first column, the difference in multipliers between the sudden stop and normal time is substantial. But this difference gets narrower when the government spending policy is less persistent (the second column). The evidence validates our conjecture that the expectation of future fiscal policy is an important factor for the efficiency of government spending during the financial crisis.

Existing studies (e.g., Corsetti et al., 2012a) suggest that the transmission of current fiscal policy highly depends on agents' anticipation of the future fiscal plan. Here, we provide evidence about how such an anticipation channel interacts with the sudden stop crisis. When fiscal expansions are strong enough, a current stimulus causes optimistic expectations of the future exchange rate. These positive expectations boost the asset price and improve agents' borrowing opportunities when the financial market is distressed.

Figure 7: State-dependent multipliers under the high and low shock persistence



NOTE: The graph shows multipliers on private consumption, trade balance, and the real exchange rate. In the right column, the blue (black) lines report the average multipliers in the countries with high (low) fiscal persistence. The first two columns compare fiscal multipliers during crises and normal times. We run regression separately for the high-ρ_g and the low-ρ_g countries.

5 The Design of Optimal Spending Policy

This section extends the baseline environment to consider the optimal design of spending policy. We are interested in the following questions: What does the optimal spending policy look like when the government faces a collateral constraint? Is that possible that providing fiscal stimulus during the financial crisis invites more financial risk over the long run? Can *ex-post* optimal spending policy replace the *ex-ante* macroprudential tax for the purpose of financial regulations?

To make things transparent, we simplify the model in section 3. We first assume that the labor is inelastically supplied and there is no unemployment. The only endowment shock happens in the first period ($y_{T,1}$) when the collateral constraint occasionally binds. We assume $\beta R = 1$. Since the second period, there is no collateral constraint, and agents can perfectly smooth consumption. We further assume that households enjoy the utility of public consumption. The lifetime utility becomes

$$V_1 = u(c_0) + \beta \mathbb{E}\left\{ [u(c_1) + v(g_{N,1})] + \sum_{t=2}^{\infty} \beta^{t-1} [u(c_t) + v(g_{N,t})] \right\}, \tag{30}$$

where the per-period utility function is $u(c_t) = \log(c_t)$ and $v(g_{N,t}) = \eta^g \log(g_{N,t})$. η^g controls the average level of public consumption.

To examine the implication of optimal spending policy on private agents' over-borrowing incentive à la Bianchi (2011) and the design of *ex-ante* financial regulation (macroprudential tax), we introduce a time-0 problem. In time 0, agents only decide the level of debt issuance. The resource constraints are $c_{T,0} + b_0 = \frac{1}{R} b_1 (1 - \tau_0) + y_T$ and $c_{N,0} = y_N$, where b_0 is the level of legacy debt. τ_0 is the macroprudential tax. This environment allows us to consider whether the *ex-post* stimulation policy of $\{g_{N,t}\}_{t=1}^{\infty}$ alleviates the necessity to impose the *ex-ante* macroprudential tax to stabilize financial market.

Ex-post optimal spending policy To consider the net effect of optimal spending policy, we compare three policy environments. In the baseline case, we assume the government spending follows the Samuelson rule; that is

$$v'(g_{N,t}) = u_{cN}(t), \quad \text{for} \quad t \geq 1. \tag{31}$$

In addition, we also consider the government's discretionary optimal spending policy and the optimal policy under commitment.[20]

First, we notice that the first-period collateral constraint may give the government an additional incentive to increase government spending. The capital price is rewritten as

$$q_1^k = \frac{\beta \mathbb{E} u_{cT}(2) \left[q_2^k + p_2^N \alpha_K y_N \right]}{u_{cT}(1) - \kappa \mu_1} = \frac{\mathbb{E} \left[\beta u_{cT}(2) p_2^N \alpha_K y_N + \beta^2 u_{cT}(3) p_3^N \alpha_K y_N + \dots \right]}{u_{cT}(1) - \kappa \mu_1}, \tag{32}$$

where $\mu_1 = \max\{u_{cT}(1) - \beta R u_{cT}(2), 0\}$. When the collateral constraint binds, the agents' borrowing ability is smaller than the unconstrained amount they would like to borrow. In this case, the government has an incentive to increase the current spending $g_{N,1}$ since the higher level of government spending boosts the asset price: $\frac{\partial u_{cT}(1)}{\partial g_{N,1}} < 0$. Hence, optimal spending under discretion is characterized by the following Euler equation,

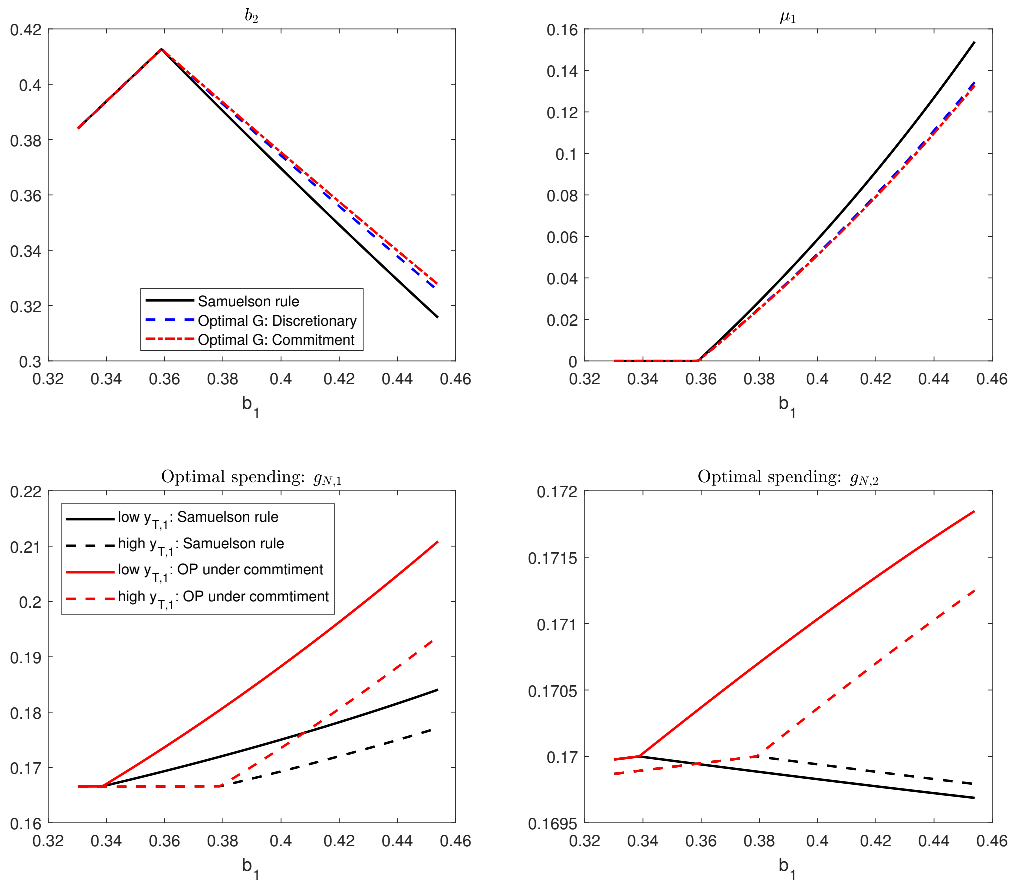
$$v'(g_{N,1}) + \frac{\kappa \mu_1^{sp}}{u_{cT}(1) - \kappa \mu_1} q_1^k (1 - \kappa) \frac{\partial u_{cT}(1)}{\partial c_{N,1}} = u_{cN}(1). \tag{33}$$

where μ_1^{sp} represents the policymaker's Lagrangian on the collateral constraint. The left-hand side represents the discretionary policymaker's marginal benefit of increasing $g_{N,1}$, while the right-hand side is her marginal cost. We notice that during a financial crisis ($\mu_2^{sp} > 0$), the presence of collateral constraint incentivizes the policymaker to deviate from the Samuelson rule.

More importantly, a time-inconsistency problem arises. If the government can commit, she would like to elevate the path of spending in the future, $\{g_{N,2}, g_{N,3}, \dots\}$, since an expectation of future fiscal expansions can stimulate the current capital price: $\frac{\partial \left[u_{cT}(t) p_t^N \right]}{\partial g_{N,t}} > 0$ for

[20] Appendix D shows the optimality conditions in the three environments.

Figure 8: Optimal spending policies and implications on the collateral constraint



NOTE: The figure shows the *ex-post* optimal spending policies and their implication on agents' borrowing decisions. The upper panel compares the decision rules in three environments: the spending level following the Samuelson rule, the optimal discretionary spending, and the optimal spending under commitment. The lower panel shows the optimal spending schedules in the model with policy commitment (red lines) and compares them with the Samuelson rule (black lines).

$t \geq 2$.[21][22] The optimally committed government spending follows the first-order condition,

$$v'(g_{N,2}) - \frac{\kappa\mu_1^{sp}}{u_{cT}(1) - \kappa\mu_1}\alpha_K y_N \frac{\partial\left[u_{cT}(2)p_2^N\right]}{\partial c_{N,2}} = u_{cN}(2). \tag{34}$$

[21]To simplify the commitment problem, we restrict the government's choice space by assuming that the second-period government spending persists into the future; that is $g_{N,2} = g_{N,3} = g_{N,4} = \cdots$. The assumption allows us to avoid the infinite-dimensional choice problem under the commitment policy and guarantees that agents can perfectly smooth consumption since the second period.

[22]However, when the time comes to the second period, the benefit of fiscal stimulus on the past collateral constraint is sunk, and the government decides the optimal spending only based on its current debt state.

Equation (34) says that the period-1 government would like to commit to a higher level of spending in the future whenever its constraint binds because future fiscal stimuli can also boost the asset price today. The left-hand side of equation (34) represents the policymaker's marginal benefit of raising $g_{N,2}$, while the right-hand side is the marginal cost.

Ex-ante macroprudential tax Agents' only decision in period 0 is to choose the optimal level of borrowing. In the absence of macroprudential tax, their first-order condition is

$$u_{cT}(0) = \beta R \mathbb{E} u_{cT}(1). \tag{35}$$

To measure the degree of over-borrowing externality and highlight the effect of *ex-post* optimal spending policy on that, we consider an environment where a policymaker chooses the borrowing level on behalf of the private agents. In period 0, the policymaker internalizes that the larger debt balance will accelerate the collapse of aggregate consumption and capital price when the collateral constraint binds in period 1, generating a financial amplification. The policymaker's time-0 borrowing incentive can be described by the following Euler equation

$$u_{cT}(0) = \beta R \mathbb{E} \lambda_{T,1}^{sp} = \beta R \mathbb{E} \left[u_{cT}(1) - \frac{\kappa \mu_1^{sp}}{u_{cT}(1) - \kappa \mu_1} q_1^k (1-\kappa) \frac{\partial u_{cT}(1)}{\partial c_{T,1}} \right]. \tag{36}$$

where $\lambda_{T,1}^{sp}$ is the policymaker's marginal value of wealth in period 1. μ_1^{sp} is her Lagrangian on the collateral constraints. We notice that when the constraint is binding, the policymaker's marginal value of wealth is bigger than the private one $\lambda_{T,1}^{sp} > u_{cT}(1)$. So, the policymaker has incentives to constrain agents' debt issuance in period 0 to mitigate the pecuniary externality from the collateral constraint. The different borrowing incentives between private agents and the policymaker allow the government to use a macroprudential tax to restore the efficient amount of borrowing,

$$\tau_0 = -\frac{1}{u_{cT}(0)}\mathbb{E}\left[\beta R\frac{\kappa\mu_1^{sp}}{u_{cT}(1)-\kappa\mu_1}q_1^k(1-\kappa)\frac{\partial u_{cT}(1)}{\partial c_{T,1}}\right]. \tag{37}$$

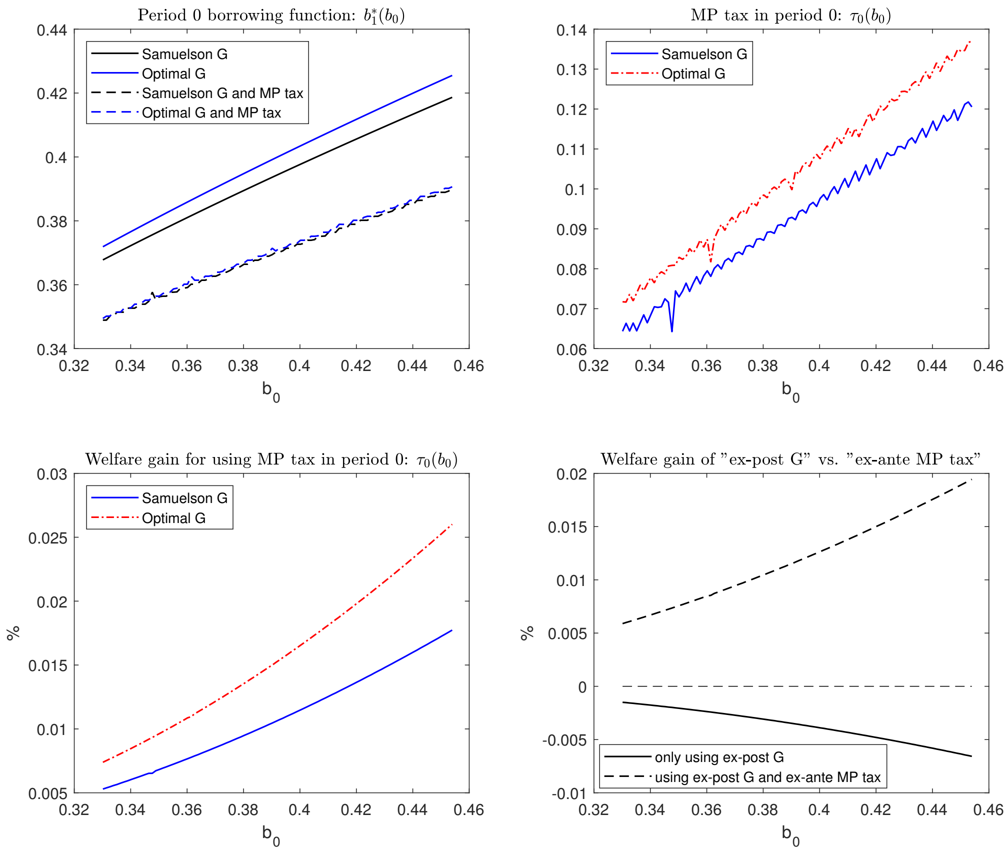
5.1 Results

Figure 8 shows the *ex-post* optimal spending policies and their effect on agents' borrowing ability in period 1. The bottom figures display the state-contingent government spending schedules in the policy environment with commitment.[23] We find that only in states where the financial constraint binds, the optimal spending level deviates from the Samuelson rule. When agents' borrowing ability is restricted by the capital price, the government has incentives to raise the current and future consumption because the higher path of consumption can boost the capital price and relax the constraint. In the upper panel of figure 8, we notice that the presence of an optimal spending policy can improve agents' borrowing ability in the binding states. Thus, the Lagrangian on the borrowing constraint is reduced.

Is that possible the *ex-post* optimal spending policy (as an instrument of financial intervention) invite more financial risk in *ex ate* and requires stricter macroprudential regulations? The answer is yes! Figure 9 displays the period-0 solutions under the competitive equilibrium and the optimal policy environments. In the upper-left panel, we find that without macroprudential tax, the presence of *ex-post* optimal spending incentivizes private agents to borrow more (blue solid vs. black solid line). The reason is that optimal government spending ameliorates the financial amplification when a negative shock hits in period 1, reducing agents' borrowing costs. In *ex-ante*, the policymaker always has the incentive to restrict borrowings either with or without the tool of optimal spending (blue and black dashed lines). However, with the optimal spending policy in place, the policymaker needs to put a more

[23]Here, we only show the spending schedule in the model with commitment. Figure F.7 in Appendix F displays the full schedule of government spending policies under discretion and commitment.

Figure 9: Implications of optimal spending on the over-borrowing and macroprudential tax



Note: The upper-left panel shows the period-0 borrowing decisions with and without the *ex-post* optimal spending policies (with commitment). The solid lines represent private agents' borrowing incentives, while the dashed lines show the policymaker's borrowings when internalizing the pecuniary externality. The upper-right panel displays the schedules of macroprudential tax levied on the period-0 debt issuance to correct the pecuniary externality. The bottom-left and bottom-right panels show the relative welfare impacts of optimal spending and macroprudential tax policies.

restrictive constraint on borrowings, implying a larger macroprudential tax on the period-0 debt issuance (the upper-right panel).

The bottom panel in figure 9 shows the welfare impact of optimal policies. The bottom-left figure indicates that the optimal *ex-ante* tax on debt should be larger in the environment with the optimal stimulus than in the environment without it. This is because the optimal spending policy motivates agents to borrow more and invites more financial risk, although the severity of financial collapse is mitigated. Notably, the bottom-right panel shows that

Table 2: Summary statistics in the model with and without optimal spending

	Samuelson G	Optimal G	Samuelson G	Optimal G
	(1)	(2)	(3)	(4)
	without MP tax		*with MP tax*	
b_1^*	0.403	0.409	0.376	0.378
Prob.(binding)	0.72	0.74	0.58	0.59
$c_{T,1}$ crash	-0.080	-0.084	-0.031	-0.025
$\mathbb{E}(\mu_2^*)$	0.083	0.079	0.053	0.047
MP tax: τ_0			0.104	0.115
welfare gain of τ_0			0.0128%	0.0186%
welfare gain (relative to (1))	-	-0.0045%	-	0.0141%

NOTE: "Optimal G" represents the optimal spending policy with commitment. The welfare gain of policy environment i relative to j is measured as $(V_0^i - V_0^j)/|V_0^j|$. The numbers can be interpreted as the percent of permanent consumption (CE) that households would like to sacrifice for moving from model j to model i. The initial debt is set to its steady-state value.

without the macroprudential tax, the presence of optimal spending policy alone generates a welfare loss. The optimal-policy model can generate a welfare gain relative to the baseline economy only equipped with an *ex-ante* tool of financial regulation. In sum, our results indicate that our optimal spending policy necessitates the more restrictive macroprudential tax to preserve financial stability.

Table 2 provides some detailed statistics on the crisis probability and crisis severity in different model environments. First, we notice that without the capital control tax, the *ex-post* stimulus policy slightly reduces the crisis severity (0.079 vs. 0.083) but introduces a larger probability of binding states (0.74 vs. 0.72). More importantly, without the *ex-ante* financial regulation, optimal spending alone generates a small welfare loss (-0.0045%) relative to the Laissez-faire economy in column (1). From columns (3)-(4), we find that the macroprudential tax significantly reduces the level of borrowings and lowers the probability of crisis, which is the goal of the macroprudential tax. The welfare gain achieved by the tax is larger in the model with optimal spending than in the model without it (0.0186% vs.

0.0128%). Overall, the *ex-ante* financial regulation and the *ex-post* financial intervention policy together indicates a welfare gain of 0.014%.[24]

6 Conclusion

This paper investigates the open-economy fiscal multiplier through Fisher's debt-deflation channel. Using a real production economy with a fixed amount of capital, we find that increasing government purchases can boost asset prices and relax the financial constraint when it binds, leading to greater borrowing capacities and higher consumption. The improved borrowing ability further stimulates the capital price in the collateral constraint and increases the real absorption of the economy. We find that in the model with a stock collateral constraint, consumption multipliers are higher during financial crises than during normal times, and a fiscal expansion reduces the trade balance by a larger amount.

However, different from the mechanism in Liu (2022), our stock collateral constraint implies that the impact of government spending in financial crises depends on the anticipation of future fiscal plans. The more persistent fiscal expansions generate a stronger path of real appreciation in the future, stimulating the current asset price by a larger amount. So, during financial crises, the impact multiplier increases in the level of shock persistence. We also find that the model's prediction about shock persistence is consistent with the cross-country data evidence. Our panel data estimation shows that a more persistent fiscal policy makes government spending more powerful to boost consumption and drives capital inflows during financial crises. The real exchange rate also appreciates more after a positive spending shock.

Lastly, we extend the model to an optimal policy environment. We find that the *ex-post* government spending policy cannot replace the *ex-ante* macroprudential tax as a tool to

[24]The values of welfare gain are relatively small here since our model only has a one-time collateral constraint. The welfare benefit of using fiscal stimulus to alleviate the financial constraint is spread throughout the entire lifetime.

regulate financial market. The presence of optimal spending alone induces more borrowing and financial risk relative to the laissez-faire economy. Consequently, it necessitates a more restrictive macroprudential tax to preserve financial stability.

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A Appendix

A Equilibrium Conditions

This section lists the equilibrium conditions for the quantitative model as follows,

$$p_t^N = \frac{1-\omega}{\omega}\left(\frac{c_{T,t}}{c_{N,t}}\right)^{\frac{1}{\theta}} \tag{A.1}$$

$$u_{cT}(t) - \mu_t = \beta R^* \mathbb{E} u_{cT}(t+1) \tag{A.2}$$

$$q_t^k \left(u_{cT}(t) - \kappa\mu_t\right) = \beta\mathbb{E}\left\{u_{cT}(t+1)\left[q_{t+1}^k + p_{t+1}^N z_{t+1} F_k(1, h_{t+1})\right]\right\} \tag{A.3}$$

$$\frac{1}{R^*} b_{t+1} \leq \kappa q_t^k \tag{A.4}$$

$$w_t \geq -\frac{u_h(c_t, h_t)}{u_{cT}(c_t, h_t)} \tag{A.5}$$

$$w_t = -\frac{u_h(c_t, h_t^s)}{u_{cT}(c_t, h_t^s)} \tag{A.6}$$

$$w_t = p_t^N z_t F_h(1, h_t) \tag{A.7}$$

$$w_t \geq \frac{\gamma w_{t-1}}{\epsilon_t} \tag{A.8}$$

$$\mu_t\left(\kappa q_t^k - \frac{1}{R^*} b_{t+1}\right) = 0 \tag{A.9}$$

$$\left(w_t - \frac{\gamma w_{t-1}}{\epsilon_t}\right)(h_t^s - h_t) = 0 \tag{A.10}$$

$$c_{T,t} + b_t = \frac{1}{R^*} b_{t+1} + y_{T,t} \tag{A.11}$$

$$c_{N,t} + g_{N,t} = y_{N,t} = z_t F(k_t, h_t^d) \tag{A.12}$$

$$\epsilon_t = \max\left\{\frac{\gamma w_{t-1}}{w_t^f}, 1\right\}^{\gamma^E}, \quad \gamma^E \in [0,1]. \tag{A.13}$$

where μ_t is the Lagrange multipliers on the collateral constraint.

The full-employment wage and the market-clearing hours are determined by the following,

$$w_t^f = -\frac{u_h(c_t, h_t^*)}{u_{cT}(c_t, h_t^*)} = p_t^N z_{N,t} F_h(1, h_t^*). \tag{A.14}$$

Lastly, the exogenous processes are given by

$$\log(y_{T,t}) = (1-\rho_{y_T})\log(\bar{y}_T) + \rho_{y_T}\log(y_{T,t-1}) + \epsilon_{y_T,t}, \tag{A.15}$$

$$\log(z_t) = (1-\rho_z)\log(\bar{z}) + \rho_z\log(z_{t-1}) + \epsilon_{z,t}, \tag{A.16}$$

$$\log(g_{N,t}) = (1-\rho_g)\log(\bar{g}) + \rho_g\log(g_{N,t-1}) + \epsilon_{g,t}. \tag{A.17}$$

B Proof of Propositions

This section provides the proof of propositions in the simplified model.

B.1 Proof of Proposition 1

Proof. **First, we prove that the normal time borrowing multiplier is negative: $\mathcal{M}_N^b < 0$.** Without the financial constraint, the problem can be solved using the bond Euler equation,

$$u_{cT}(t) = \beta R^* u_{cT}(t+1) \quad \text{for} \quad t \geq 1.$$

We solve the model backward. Under assumptions 1 and 2, the tradable consumption is perfectly smoothed since the second period; that is $c_{T,t} = c_{T,t+1}$. Then, the tradable consumption in the second period can be expressed as a function of the beginning-of-period debt balance,

$$c_{T,t} = -\left(1 - \frac{1}{R^*}\right) b_2 + y_T \quad \text{for} \quad t \geq 2. \tag{B.18}$$

Taking it into the Euler equations (8) and (6) yields the expressions of q_t^k and p_t^N for $t \geq 2$ as functions of b_2.

Next, we solve the first-period problem. Without the collateral constraint, the capital price q_1^k is irrelevant to the solution. The model is solved by linearizing bond Euler equation (7) and resource constraints (18)-(19), and the above equation (B.18). We have the following linearized equation system,

$$\left(-1+\frac{1}{\theta}\right)(\hat{c}_2-\hat{c}_1)-\frac{1}{\theta}(\hat{c}_{T,2}-\hat{c}_{T,1})=0, \tag{B.19}$$

$$\hat{c}_{T,1}=\frac{1}{R^*}\frac{b}{c_T}\hat{b}_2, \tag{B.20}$$

$$\hat{c}_{N,1}=-\frac{g_N}{c_N}\hat{g}_{N,1}, \tag{B.21}$$

$$\hat{c}_{T,2}=-\left(1-\frac{1}{R^*}\right)\frac{b}{c_T}\hat{b}_2, \tag{B.22}$$

$$\hat{c}_{N,2}=-\frac{g_N}{c_N}\hat{g}_{N,2}. \tag{B.23}$$

$$\hat{c}_t=\omega^T\hat{c}_{T,t}+\omega^N\hat{c}_{N,t}, \quad t=1,2 \tag{B.24}$$

where $\omega^T=\omega c_T^{\frac{\theta-1}{\theta}}/c^{\frac{\theta-1}{\theta}}$ and $\omega^N=(1-\omega)c_N^{\frac{\theta-1}{\theta}}/c^{\frac{\theta-1}{\theta}}$ are sectoral weights in the steady state. Moreover, the spending process follows $\hat{g}_{N,2}=\rho_g\hat{g}_{N,1}$.

Based on these equations, we can jointly solve $\{\hat{b}_2,\hat{c}_{T,1},\hat{c}_{T,2},\hat{c}_{N,1},\hat{c}_{N,2},\hat{c}_1,\hat{c}_2\}$ as functions of g_1^N. Specifically, the borrowing multiplier in normal time is given by equation (22). Under assumption 3, it is easy to see that $\mathcal{M}_N^b$ is negative.

Second, we prove that the borrowing multiplier in a financial crisis state is positive: $\mathcal{M}_C^b>0$. If the collateral constraint binds, agents' borrowing is restricted by the capital price. Following equation (20), the capital price can be expressed as

$$q_1^k=\frac{\frac{u_{cT}(2)}{u_{cT}(1)}\left[\frac{\beta}{1-\beta}\alpha_K y_N\frac{1-\omega}{\omega}\left(\frac{-(1-\frac{1}{R^*})b_2+y_T}{y_N-g_{N,2}}\right)^{\frac{1}{\theta}}\right]}{(1-\kappa)+\kappa\frac{u_{cT}(2)}{u_{cT}(1)}}. \tag{B.25}$$

Linearizing this equation and the collateral constraint (4), we have the following

$$\hat{b}_2 = \hat{q}_1^k, \tag{B.26}$$

$$\hat{q}_1^k = \left(-1 + \frac{1}{\theta}\right)(1-\kappa)\left(\hat{c}_2 - \hat{c}_1\right) - \frac{1}{\theta}\hat{c}_{N,2} + \kappa\frac{1}{\theta}\hat{c}_{T,2} + \frac{1}{\theta}(1-\kappa)\hat{c}_{T,1}. \tag{B.27}$$

Using equations (B.26)-(B.27) together with equations (B.20)-(B.24), we can solve all the endogenous variables as functions of $\hat{g}_{N,1}$. Ultimately, the borrowing multiplier in a crisis state is given by the expression in equation (23). Under assumptions 3 and 4 and $\omega^N < 1$, it is easy to see that $\mathcal{M}_C^b$ is positive.

Lastly, we prove that the multipliers are higher during a financial crisis than in a normal state. Combining equations (B.20), (B.21), and (B.24), final consumption can be expressed as

$$\hat{c}_1 = \omega^T \frac{1}{R^*}\frac{b}{c_T}\hat{b}_2 - \omega^N \frac{g_N}{c_N}\hat{g}_{N,1}. \tag{B.28}$$

Then, $\mathcal{M}_C^b > \mathcal{M}_N^b$ directly implies the state-contingent consumption multipliers $\mathcal{M}_C^c > \mathcal{M}_N^c$. Moreover, the consumption multiplier in a crisis state is given by

$$\begin{aligned}\mathcal{M}_C^c &= \omega^T \frac{1}{R^*}\frac{b}{c_T}\mathcal{M}_C^b - \omega^N \frac{g_N}{c_N} \\ &= \left[\frac{1}{R^*}\frac{b}{c_T}\omega^T \frac{\rho_g \frac{1}{\theta} + \left(-1+\frac{1}{\theta}\right)(1-\kappa)\omega^N(1-\rho_g)}{1 - \frac{b}{c_T}\left[\frac{1}{\theta}\left(\frac{1}{R^*} - \kappa\right) - \left(-1+\frac{1}{\theta}\right)(1-\kappa)\omega^T\right]} - \omega^N\right]\frac{g_N}{c_N}.\end{aligned} \tag{B.29}$$

Notice that $\mathcal{M}_C^c$ could be either positive or negative depending on the relative size of the two terms. In addition, we have the first-period real exchange rate as

$$\hat{p}_1^N = \frac{1}{\theta}\left(\frac{1}{R^*}\frac{b}{c_T}\hat{b}_2 + \frac{g_N}{c_N}\hat{g}_{N,1}\right). \tag{B.30}$$

Therefore, $\mathcal{M}_C^b > \mathcal{M}_N^b$ also implies the relationship on real exchange rate: $\mathcal{M}_C^{p^N} > \mathcal{M}_N^{p^N}$, which concludes our proof.

□

B.2 Proof of Proposition 2

Proof. In the model without DNWR, the expression of borrowing multiplier comes from equation (23). Assumption 4 means that the denominator is positive. Since $\frac{1}{\theta} > \left(-1 + \frac{1}{\theta}\right)(1-\kappa)\omega^N$, the larger ρ_g always implies the stronger multiplier effect. So, we have $\frac{\partial \mathcal{M}_C^b(\rho_g)}{\partial \rho_g} > 0$. The results on consumption and exchange rate multipliers are due to their expressions in equations (B.29) and (B.30). □

B.3 Proof of Proposition 3

Proof. **First, we prove that in the model with unemployment, the borrowing multiplier during a financial crisis is still positive: $\mathcal{M}^b_{C,DNWR} > 0$.** The procedure is similar to the proof of proposition 2. The only difference is that with the period-1 wage rigidity, $c_{N,1}$ is endogenously linked to agents' borrowing decisions, as in equation (26).

With both the collateral and wage constraints, the first-period equilibrium is solved using equations (B.20), (B.22), (B.23), (B.24), (B.26), (B.27), and (26). All endogenous variables can be derived as functions of $\hat{g}_{N,1}$. Specifically, the borrowing multiplier $\mathcal{M}^b_{C,DNWR}$ is given by equation (27).

Under assumptions 3-5, and also because $\Omega_1, \Omega_2 \in (0, 1)$, we have

$$\mathcal{M}^b_C > \mathcal{M}^b_{C,DNWR} > 0\ .$$

Then, we are ready to prove the state-contingent multiplier effects in the model with DNWR. The above result indicates $\mathcal{M}^b_{C,DNWR} > 0 > \mathcal{M}^b_N$. In a crisis state, the first-period consumption is given by

$$\begin{aligned}\hat{c}_1 &= \omega^T \hat{c}_{T,1} + \omega^N \hat{c}_{N,1} \\ &= \left(\omega^T + \Omega_1 \omega^N\right) \frac{1}{R^*} \frac{b}{c_T} \hat{b}_2 - \Omega_2 \omega^N \frac{g_N}{c_N} \hat{g}_{N,1} \ . \end{aligned} \tag{B.31}$$

where the second equality comes from equation (26). On the contrary, in a normal state without wage rigidity, consumption is

$$\hat{c}_1 = \omega^T \frac{1}{R^*} \frac{b}{c_T} \hat{b}_2 - \omega^N \frac{g_N}{c_N} \hat{g}_{N,1}.$$

Comparing these two cases, we find that during the financial crisis, government spending crowds-in tradable consumption, and at the same time, the crowding-out effect on non-tradable consumption is weaker. Consequently, we have the state-contingent consumption multipliers as follows,

$$\mathcal{M}^c_{C,DNWR} > \mathcal{M}^c_N.$$

The result on the output multiplier is trivial.

In the model with DNWR, the consumption multiplier during a financial crisis can be written as

$$\begin{aligned}\mathcal{M}^c_{C,DNWR} &= \left(\omega^T + \Omega_1 \omega^N\right) \frac{1}{R^*} \frac{b}{c_T} \mathcal{M}^b_{C,DNWR} - \Omega_2 \omega^N \frac{g_N}{c_N} \\ &= \left[\frac{1}{R^*} \frac{b}{c_T} \left(\omega^T + \omega^N \Omega_1\right) \frac{\rho_g \frac{1}{\theta} + \left(-1 + \frac{1}{\theta}\right)(1-\kappa)\omega^N (\Omega_2 - \rho_g)}{1 - \frac{b}{c_T}\left[\frac{1}{\theta}\left(\frac{1}{R^*} - \kappa\right) - \left(-1 + \frac{1}{\theta}\right)(1-\kappa)\left(\omega^T + \frac{1}{R^*}\omega^N \Omega_1\right)\right]} - \omega^N \Omega_2 \right] \frac{g_N}{c_N}. \end{aligned} \tag{B.32}$$

Lastly, we prove that in this environment, a larger shock persistence implies a stronger multipliers effect on consumption, output, borrowing, and the real exchange rate. Since $\frac{1}{\theta} > \left(-1 + \frac{1}{\theta}\right)(1-\kappa)\omega^N$, it follows that a higher ρ_g implies a stronger multiplier effect on borrowing as in equation (27); that is $\frac{\partial \mathcal{M}^{b}_{C,DNWR}(\rho_g)}{\partial \rho_g} > 0$. From equation (B.32), we also notice that the larger shock persistence implies a stronger multiplier effect on consumption. The real exchange rate and output are given by

$$\hat{p}^N_1 = \frac{1}{\theta}\Omega_2 \left(\frac{b}{c_T}\frac{1}{R^*}\mathcal{M}^{b}_{C,DNWR} + \frac{g_N}{c_N} \right) \hat{g}_{N,1}, \tag{B.33}$$

$$\hat{y}_{N,1} = \frac{\alpha}{1-\alpha}\hat{p}^N_1. \tag{B.34}$$

So, a larger ρ_g indicates a stronger impact of government spending on output and exchange rate: $\frac{\partial \mathcal{M}^{y_N}_{C,DNWR}(\rho_g)}{\partial \rho_g} > 0$, $\frac{\partial \mathcal{M}^{p^N}_{C,DNWR}(\rho_g)}{\partial \rho_g} > 0$, which completes the proof. □

C Computational Method

The model is solved using the global solution method with time iteration and linear interpolation. The high-dimensional expectations are evaluated using monomial quadrature. In the baseline model, the state vector is

$$\mathcal{S}_t = [b_t, w_{t-1}; y_{T,t}, z_t, g_t].$$

Firstly, we discretize the state space and approximate a set of policy functions ($\mathbb{C}_t$) on the state space $\mathcal{S}_t$. Taking these functions as the initial guess, we back out other model variables in time t and derive the next-period endogenous state in $t+1$: $\mathcal{S}_{t+1}$. Then, we evaluate the policies at time $t+1$ ($\mathbb{C}_{t+1}$) using the guessed policy functions and linear interpolation. The conditional expectations are calculated. At each state point, a system of simultaneous equations is solved using a Newton-type solver, and the policy functions are updated accordingly. In the next iteration, we use the updated policy functions to evaluate the variables at $t+1$. We iterate on these policies until the distance between successive iterations is small enough. The algorithm proceeds as follows,

1. Use the piecewise linear functions to approximate a set of decision rules on the state space $\mathbb{C}^0 = \{c^0_{T,t}, h^0_t, q^0_t, \eta^{w,0}_t, \tilde{\mu}^0_t\}$ and take them as initial guess. $\eta^{w,0}_t$ and $\tilde{\mu}^0_t$ are an auxiliary variables for dealing with the DNWR and collateral constraint.

2. For each point in state, use $\mathbb{C}^0$ and equilibrium conditions to back out other endogenous variables in the current period: $c_{N,t}, b_{t+1}, y_{N,t}, w_t, p^N_t, \mu_t, h^s_t$, where we assume $\mu_t = \max(\tilde{\mu}_t, 0)^3 \times 1000$ and $h^s_t = h_t + \max(\eta^w_t, 0)^3 \times 1000$. Notice that b_{t+1} and w_t are the beginning-of-period state in the next period.

3. Apply the law of motion for the exogenous processes $(y_{T,t}, z_t, g_t)$ and iterate the state variables forward. At each quadrature point, the state vector for the next-period problem is $\mathcal{S}_{t+1} = [b_{t+1}, w_t; y_{T,t+1}, z_{t+1}, g_{t+1}]$. Then, we use linear interpolation to evaluate the guessed decisions in $t+1$, which gives $\{c_{T,t+1}, h_{t+1}, q_{t+1}, \eta^w_{t+1}, \tilde{\mu}_{t+1}\}$. And we out other variables in time $t+1$: $\{p^N_{t+1}, c_{N,t+1}, y_{N,t+1}, h^s_{t+1}\}$.

4. At each state point, we jointly solve a system of equations (A.2), (A.3), (A.4), (A.6), (A.7) by root-finding method and update the decision rules of $\mathbb{C}^1 = \{c^1_{T,t}, h^1_t, q^1_t, \eta^{w,1}_t, \tilde{\mu}^1_t\}$.

5. Compute the distance between the new policy functions and the original ones. Stop if

$$\max|\mathbb{C}^0 - \mathbb{C}^1| < 1e - 7.$$

   Otherwise, take the new policy functions as the guess and start from the second step.

The two occasionally-binding constraints are treated using the "auxiliary variable method." For the wage constraint, suppose the variable η^w_t is positive if and only if the wage constraint is binding when there exists involuntary unemployment. In this case, η^w_t is defined as

$$h^s_t - h_t = \max(\eta^w_t, 0)^3 \times 1000 \ .$$

If the wage constraint is not binding, η_t^w is negative and its absolute value is defined as the difference between the full-employment wage and the wage state inherited from the last period, that is,

$$w_t - \frac{\gamma w_{t-1}}{\epsilon_t} = \max(-\eta_t^w, 0)^3 \times 1000 \ .$$

The method allows us to transform the two inequality constraints into equality constraints, to which the Newton-type solver can be applied.

Similarly, to deal with the collateral constraint, we define an auxiliary variable $\tilde{\mu}_t$, which is positive only when the constraint is binding: $\mu_t = \max(\tilde{\mu}_t, 0)^3 \times 1000 > 0$. When the collateral constraint is slack, we assume

$$\kappa q_t^k - \frac{1}{R^*} b_{t+1} = \max(-\tilde{\mu}, 0)^3 \times 1000 \geq 0 \ .$$

D Details in the Model with Optimal Policy

D.1 The Competitive Equilibrium

We first consider an environment without capital control and optimal spending policies. In periods 0, 1, and 2, the resource constraints of the economy are given by

$$c_{T,0} + b_0 = \frac{1}{R} b_1 + y_T, \tag{D.1}$$

$$c_{T,1} + b_1 = \frac{1}{R} b_2 + y_{T,2}, \tag{D.2}$$

$$c_{T,2} + \left(1 - \frac{1}{R}\right) b_2 = y_T, \tag{D.3}$$

$$c_{N,1} + g_{N,1} = 1, \tag{D.4}$$

$$c_{N,2} + g_{N,2} = 1. \tag{D.5}$$

Since the period 1, the equilibrium is described by the following Euler equations,

$$u_{cT}(1) - \mu_1 = u_{cT}(2), \tag{D.6}$$

$$u_{cN}(1) = v'(g_{N,1}), \tag{D.7}$$

$$u_{cN}(2) = v'(g_{N,2}), \tag{D.8}$$

$$\frac{1}{R}b_2 \leq \kappa q_1^k, \tag{D.9}$$

$$q_1^k = \frac{\beta}{1-\beta}\alpha_K y_N \frac{u_{cT}(2)p_2^N}{u_{cT}(1) - \kappa\mu_1}. \tag{D.10}$$

In period 0, the borrowing decisions under the private equilibrium and the policymaker's problem are different. The private agents fail to internalize the cost of borrowing in reducing the aggregate consumption and capital price when the collateral constraint binds, thus amplifying the financial cycle (overborrowing externality). Their borrowing conditions are characterized by the following Euler equation,

$$u_{cT}(0) = \beta R \mathbb{E} u_{cT}(1). \tag{D.11}$$

where the marginal cost of borrowing equals the marginal utility: $u_{cT}(1)$. On the other hand, for the policymaker, the bond Euler equation is

$$u_{cT}(0) = \beta R \mathbb{E}\lambda_{T,1}^{sp} = \beta R \mathbb{E}\left[u_{cT}(1) - \frac{\kappa\mu_1^{sp}}{u_{cT}(1) - \kappa\mu_1} q_1^k (1-\kappa)\frac{\partial u_{cT}(1)}{\partial c_{T,1}}\right]. \tag{D.12}$$

We notice that at the same level of borrowing, the marginal social value of wealth is bigger than the private one $\lambda_{T,1}^{sp} \geq u_{cT}(1)$. So, the policymaker has an incentive to constrain agents' debt issuance in period 0 to mitigate the pecuniary externality from the collateral constraint.

The optimal macroprudential tax in period 0 has the following formula:

$$\tau_0 = -\frac{1}{u_{cT}(0)}\mathbb{E}\left[\beta R \frac{\kappa \mu_1^{sp}}{u_{cT}(1) - \kappa \mu_1} q_1^k (1-\kappa) \frac{\partial u_{cT}(1)}{\partial c_{T,1}}\right]. \tag{D.13}$$

D.2 The Discretionary Optimal Policy

Starting in period 1, the optimal policies under discretion can be characterized by the following Euler equations,

$$\lambda_{T,1}^{sp} = u_{cT}(1) - \frac{\kappa \mu_1^{sp}}{u_{cT}(1) - \kappa \mu_1} q_1^k (1-\kappa) \frac{\partial u_{cT}(1)}{\partial c_{T,1}}, \tag{D.14}$$

$$\lambda_{N,1}^{sp} = u_{cN}(1) - \frac{\kappa \mu_1^{sp}}{u_{cN}(1) - \kappa \mu_1} q_1^k (1-\kappa) \frac{\partial u_{cT}(1)}{\partial c_{N,1}}, \tag{D.15}$$

$$\frac{1}{R}\left[\lambda_{T,1}^{sp} - \mu_1^{sp}\right] = \beta u_{cT}(2) - \frac{\kappa \mu_1^{sp}}{u_{cT}(1) - \kappa \mu_1} \frac{\partial \left[\alpha_K y_N \frac{\beta}{1-\beta} u_{cT}(2) p_2^N\right]}{\partial b_2}, \tag{D.16}$$

$$\lambda_{N,1}^{sp} = v'(g_{N,1}), \tag{D.17}$$

$$u_{cN}(2) = v'(g_{N,2}), \tag{D.18}$$

together with equations (D.9)-(D.10). The period-0 solution follows equation (D.12).

D.3 The Optimal Policy under Commitment

If the period-1 government is able to commit to future spending policies, the optimal policy under commitment is described by the following Euler equations,

$$\lambda_{T,1}^{sp} = u_{cT}(1) - \frac{\kappa\mu_1^{sp}}{u_{cT}(1) - \kappa\mu_1} q_1^k (1-\kappa) \frac{\partial u_{cT}(1)}{\partial c_{T,1}}, \tag{D.19}$$

$$\lambda_{N,1}^{sp} = u_{cN}(1) - \frac{\kappa\mu_1^{sp}}{u_{cN}(1) - \kappa\mu_1} q_1^k (1-\kappa) \frac{\partial u_{cT}(1)}{\partial c_{N,1}}, \tag{D.20}$$

$$\lambda_{T,2}^{sp} = u_{cT}(2) + \frac{\kappa\mu_1^{sp}}{u_{cT}(1) - \kappa\mu_1} q_1^k \alpha_K y_N \frac{\partial \left[u_{cT}(2) p_2^N\right]}{\partial c_{T,2}}, \tag{D.21}$$

$$\lambda_{N,2}^{sp} = u_{cN}(2) + \frac{\kappa\mu_1^{sp}}{u_{cN}(1) - \kappa\mu_1} q_1^k \alpha_K y_N \frac{\partial \left[u_{cT}(2) p_2^N\right]}{\partial c_{N,2}}, \tag{D.22}$$

$$\frac{1}{R}\left[\lambda_{T,1}^{sp} - \mu_1^{sp}\right] = \beta\lambda_{T,2}^{sp}, \tag{D.23}$$

$$\lambda_{N,1}^{sp} = v'(g_{N,1}), \tag{D.24}$$

$$\lambda_{N,2}^{sp} = v'(g_{N,2}), \tag{D.25}$$

together with equations (D.9)-(D.10). Similarly, the period-0 solution follows equation (D.12).

E Additional Tables

Table E.1: Parameter Values

Parameters	Description	Method
From the literature or simple moment match:		
$\sigma = 1$	The relative risk aversion	Standard
$\nu = 1$	Frisch elasticity	Standard
$\chi = 1.35$	Labor disutility	Normalize steady-state labor to 1
$\theta = 0.45$	Elasticity of sub. b/w T and NT	Mendoza (2005)
$\omega = 0.46$	Weight on T sector	$\frac{c_T}{p^N c_N} = 64.2\%$
$\alpha_K = 0.05$	Production function	Mendoza & Bianchi (2011)
$\alpha_H = 0.64$	Production function	Mendoza & Bianchi (2011)
$\gamma = 0.99^{1/4}$	Downward wage rigidity	Schmitt-Grohé & Uribe (2016a)
$R^* = 1.02$	External int. rate	U.S. bond rate
$G/GDP = 0.117$	Steady state level of G	Mexican public consumption
Calibrated to fit targets:		
$\beta = 0.963$	Subjective discount factor	Debt service-to-GDP ratio
$\kappa = 0.285$	Maximum leverage	Equity premium or crisis probability
$\sigma_z = 0.016$	Std. of productivity shock	Standard deviation of GDP
$\rho_z = 0.75$	Persistence of productivity shock	Autocorrelation of GDP
$\sigma_{y_T} = 0.023$	Std. of endowment shock	Standard deviation of RER
$\rho_{y_T} = 0.81$	persistence of endowment shock	Autocorrelation of RER

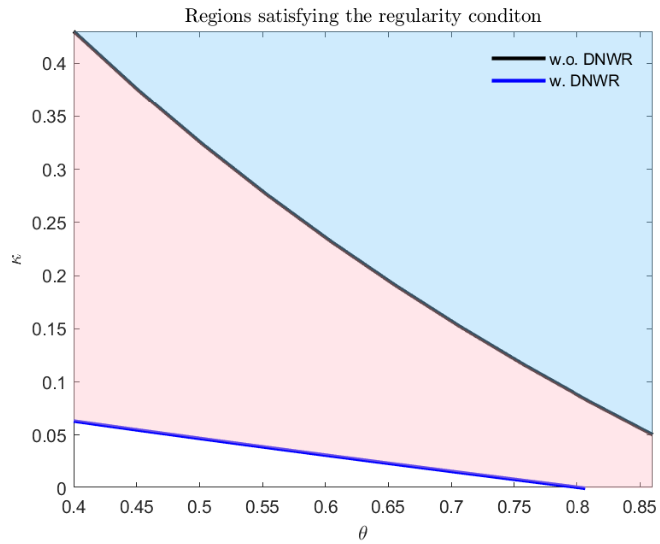
Table E.2: Model Fit

	Mexico 1993Q1-2015Q4	Baseline Model Floating	Pegged
Targeted Moments:			
$\sigma(y)$	2.34	2.27	3.12
$\rho(y, y_{-1})$	0.77	0.79	0.70
$\sigma(RER) \times 50\%$	3.93	4.12	2.53
$\rho(RER, RER_{-1})$	0.70	0.69	0.82
Debt service-to-GDP (%)	5.19%	5.16%	5.25%
Average Spread (%)	6.04%	5.73%	5.65%
Prob. of Crisis (%)	3%-5%	4.1%	3.2%
Other Statistics:			
$\sigma(c)/\sigma(y)$	1.18	1.13	1.18
$\sigma(tb)/\sigma(y)$	0.53	0.19	0.14
$\rho(c, y)$	0.82	0.95	0.97
$\rho(\frac{tb}{y}, y)$	-0.51	-0.23	-0.39
$\rho(RER, y)$	0.58	0.44	0.31
$\rho(spread, y)$	-0.22	-0.55	-0.72

Note: In the data, the logarithms of GDP, private consumption, and government consumption are detrended using the HP-filter. The numbers are based on their deviations from the trend. The spread (risk premium) is in annual rate and reflects the difference between the domestic lending rate and saving rate. A sudden stop in the model is defined as the episode when GDP falls one standard deviation below its mean and the annual current account reversal is greater than two standard deviations.

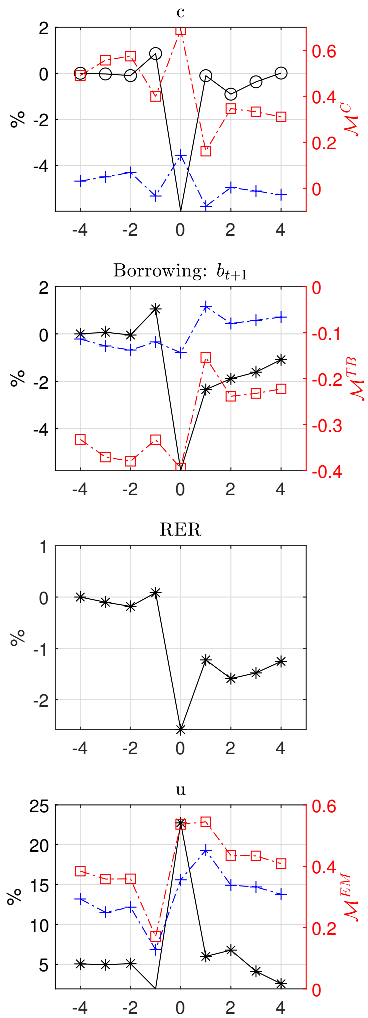
F Additional Figures

Figure F.1: Parameter values that exclude multiple equilibria



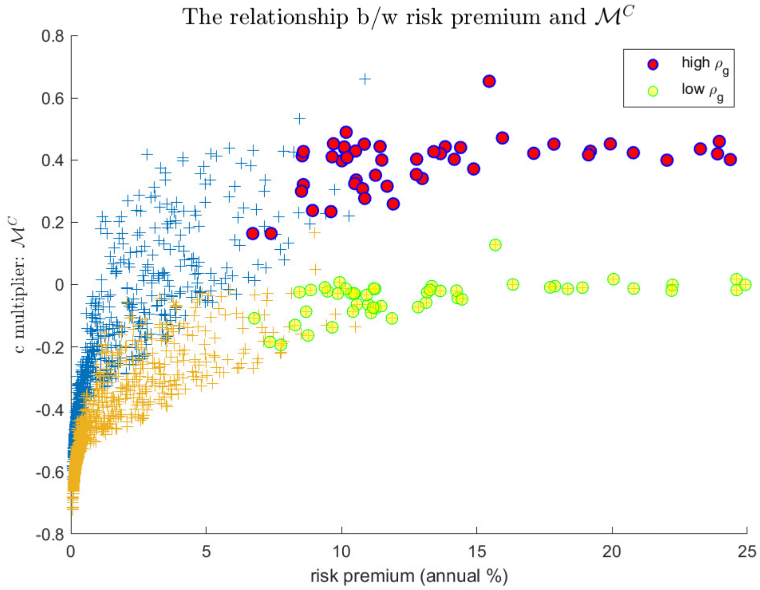
NOTE: This figure displays the combinations of κ and θ that ensure a unique equilibrium in our financial crisis model with the collateral constraint. The blue area is the case for the model without DNWR, while the blue and pink areas combined are the case for the model with DNWR.

Figure F.2: Event path of crisis and time-varying multipliers: pegged regime



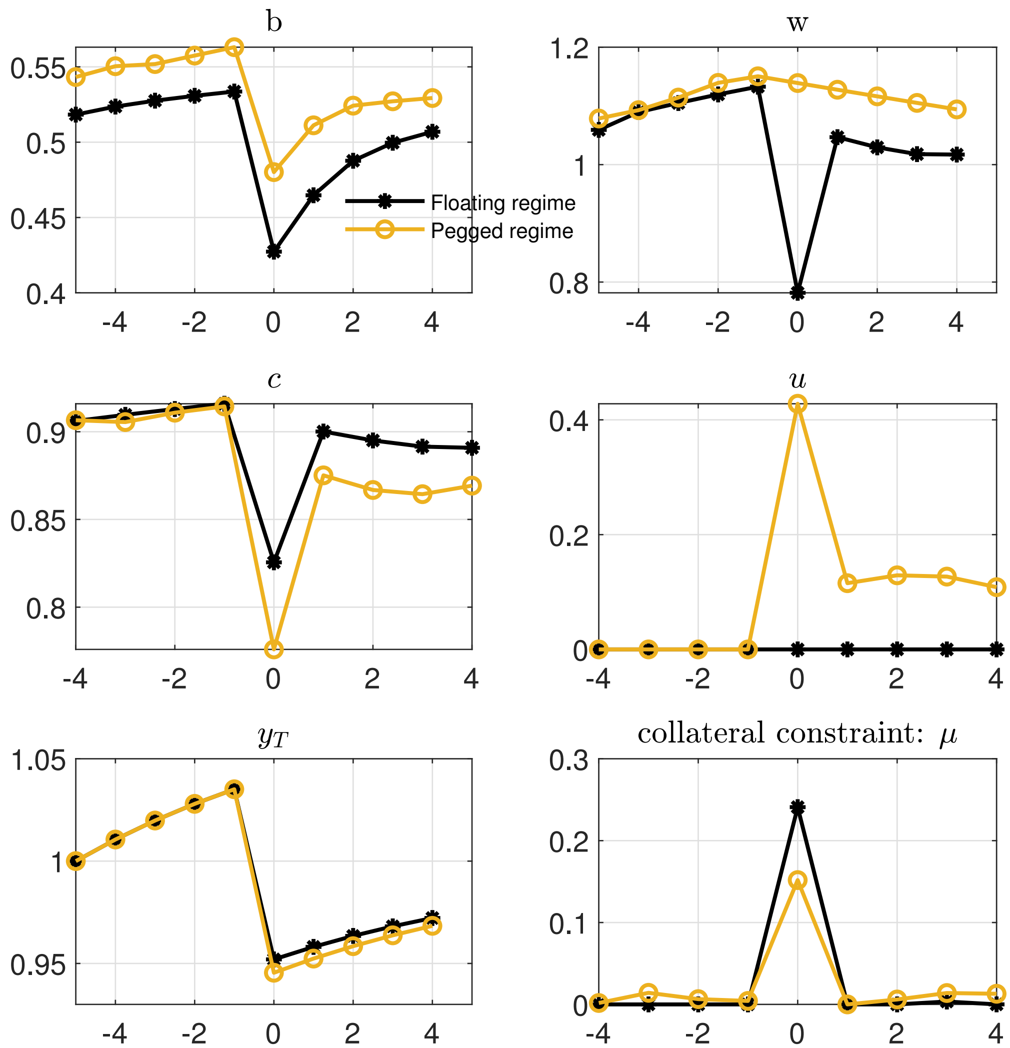
Note: The black lines show the average paths of endogenous variables around the identified sudden stop episodes. The red lines show the time-varying fiscal multipliers (consumption, output, trade balance, employment) around an event window in an economy with high spending persistence: $\rho_g = 0.95$. The blue lines are fiscal multipliers in an economy with low spending persistence: $\rho_g = 0.75$. Both economies are under the pegged regime. The multiplier on employment is defined as $\mathcal{M}^{EM} = \frac{\Delta EM}{\Delta g/\bar{g}}$, where $EM = 1 - u$.

Figure F.3: Risk premium and time-varying multipliers



NOTE: The figure shows the scatter plot of the consumption multiplier against the risk premium on capital in the simulated data. The risk premium on capital is defined as in equation (11).

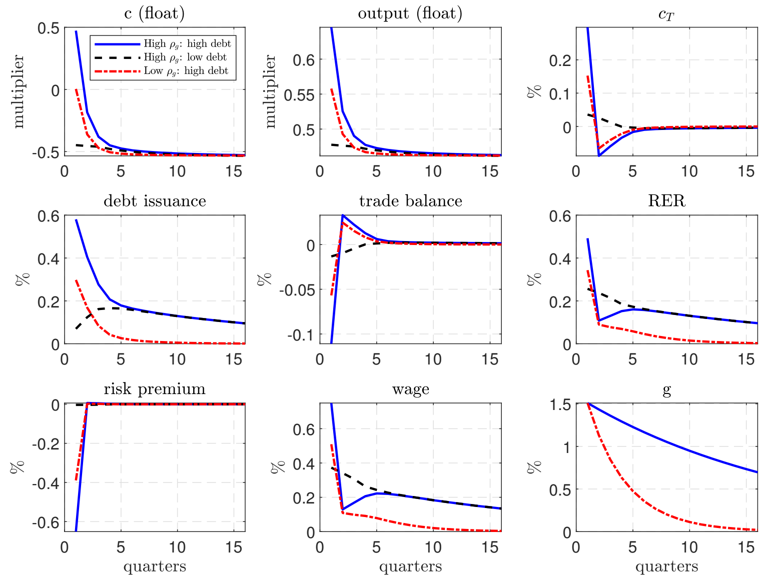
Figure F.4: Artificial boom-bust cycles



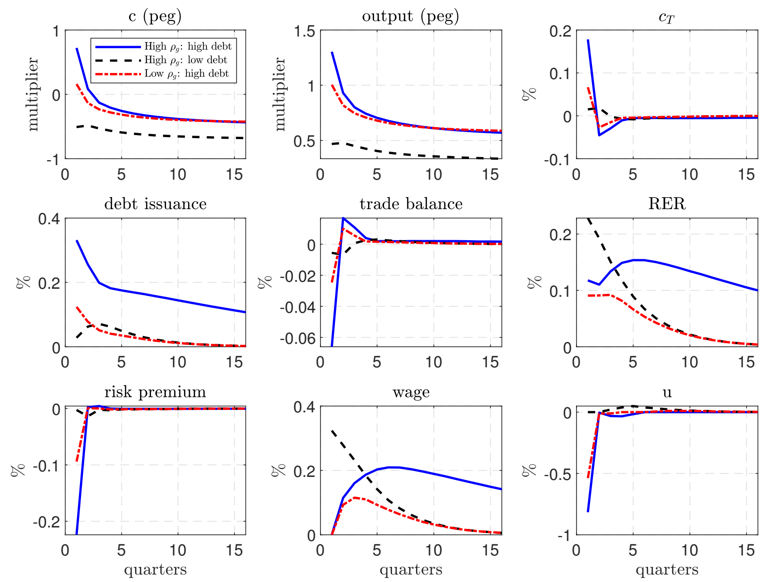
NOTE: The graph shows the paths of endogenous variables in a simulated boom-bust cycle. We start the economy from the ergodic steady-state (t=-5) and hit it with a sequence of four positive y_T shocks of 0.5 standard deviations (t=-4, -3, -2, -1). The period t=-1 is defined as the "boom." We derive the "bust" state (t=0) by imposing a sudden stop shock on the leveraged economy, which is extracted from the model's long-run simulations. The black lines represent simulation under the floating regime, and the yellow lines represent the pegged regime.

Figure F.5: Generalized impulse response functions conditional on the high- and low-debt states

Panel A: Floating Regime



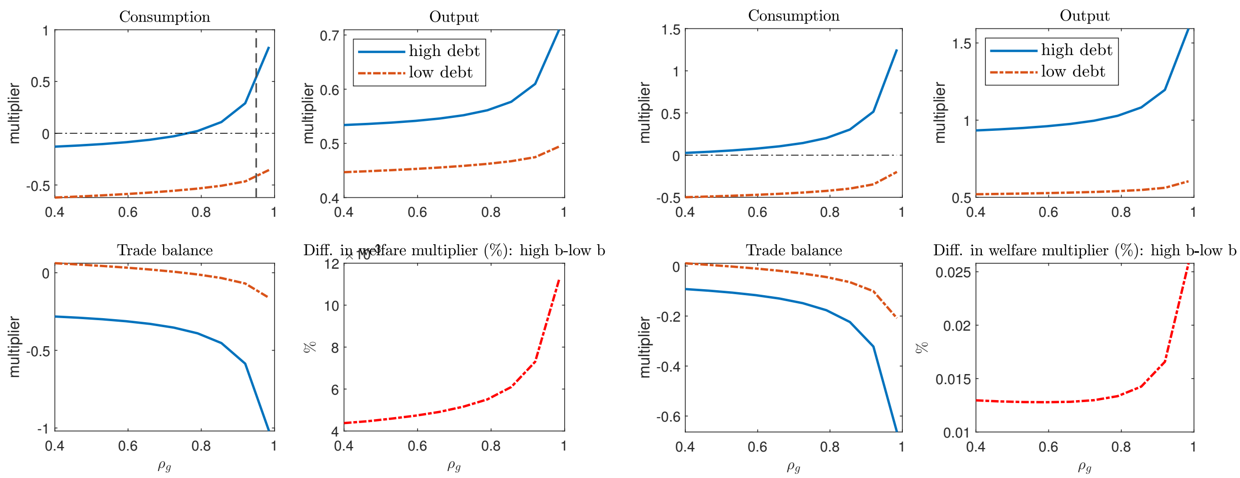
Panel B: Pegged Regime



Note: The figure shows the impulse response functions to a positive government spending shock conditional high- and low-debt states. High and low-debt states are defined as one standard deviation above or below the ergodic steady state. See notes under figure 5 for description.

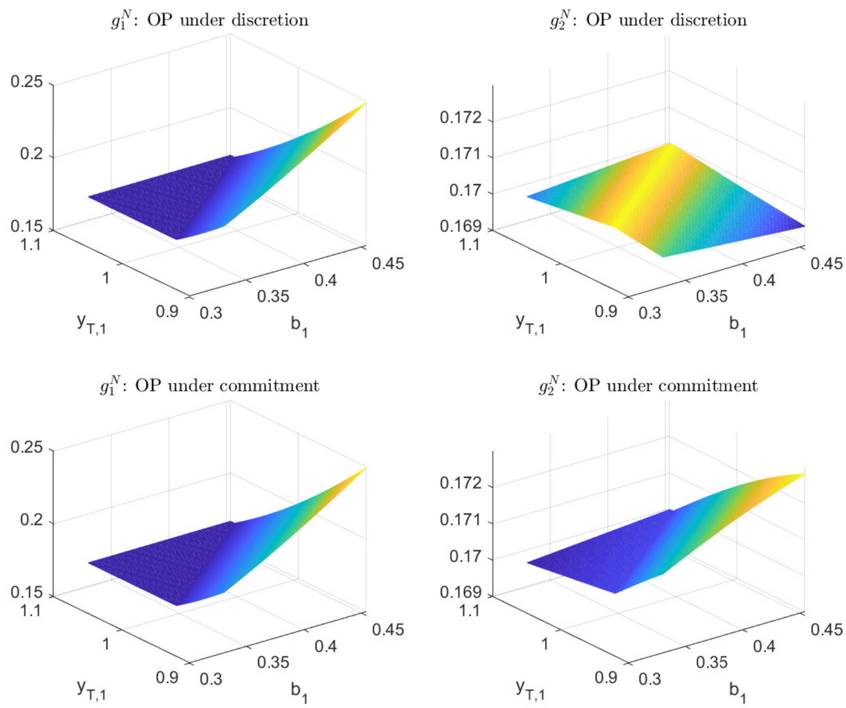
Figure F.6: Fiscal multipliers at different level of shock persistence: high-debt vs. low-debt states

Panel A: Floating Regime	**Panel B:** Pegged Regime



Note: The graph shows the impact multipliers for different values of shock persistence (ρ_g) at the simulated high-debt and low-debt states. Panel A is under the floating exchange rate regime, while panel B is under the Pegged regime. We also report the difference in welfare multipliers between the high-debt state and the low-debt state; that is $\mathcal{M}^V_{\text{high-b}} - \mathcal{M}^V_{\text{low-b}}$.

Figure F.7: Optimal government spending policies in period 1: under discretion and commitment



NOTE: The figure shows the *ex-post* optimal spending policies. The upper panel shows the optimal discretionary policies. The lower panel shows the optimal policies in the environment with commitment.