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Optimal Government Spending in a Collateral-Constrained Small Open Economy

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Optimal Government Spending in a Collateral-Constrained Small Open Economy*

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Abstract

This paper characterizes the optimal government spending policy in a collateral-constrained small open economy, where inefficiencies in borrowing decisions arise due to pecuniary externalities. In this setting, government spending plays a crucial role in maintaining financial stability. When the borrowing constraint binds, the optimal response involves fiscal stimulus, which mitigates the effects of pecuniary externalities and prevents the amplification of the debt-deflation mechanism. The optimal time-consistent policy helps prevent recessionary shocks from triggering financial crises and sharp reversals in the current account. Additionally, when capital controls are optimally combined with government spending, households are incentivized to accumulate precautionary savings more effectively. The welfare gain from capital controls is smaller when government spending is optimally chosen. We demonstrate that a feasible government spending policy, which maintains a constant ratio to GDP, approximates the optimal policy and achieves a second-best outcome.

Keywords: Small open economy; financial crises; optimal government spending.

JEL classification: F41, F44, E44, G01

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1 Introduction

A number of emerging economies have experienced significant reversals in their current account balances. Extensive literature has explored the root causes of these sudden stops in capital inflows, often attributing them to overborrowing driven by pecuniary externalities. These externalities arise because individual borrowers fail to account for the impact of their borrowing decisions on collateral prices, which are endogenously determined by aggregate demand in the economy. Consequently, borrowing decisions influenced by this pecuniary externality lead to overborrowing, rendering the economy financially vulnerable.[1]

On one hand, capital control policies have been investigated as a way to address pecuniary externalities by Bianchi (2011), Schmitt-Grohé and Uribe (2017), and Bianchi and Mendoza (2018). These studies have shown that capital control taxes can mitigate the problem of overborrowing and internalize the unconsidered effects of households' borrowing decisions on collateral prices, thus reducing the economy's vulnerability. On the other hand, Benigno et al. (2016) have examined collateral price support policies against pecuniary externalities. They show that when implemented without any costs, ex-post collateral support policies can achieve the unconstrained equilibrium.

There is a prevailing view that government spending should function as a stabilization tool in business cycles, particularly when monetary policy is unavailable as is the case when the economy hits the zero lower bound. In small open economies prone to sudden stops, the effectiveness of monetary policy is constrained by the trade-off between stabilizing prices and employment and maintaining financial stability (Ottonello, 2021 and Coulibaly, 2023). Additionally, economies in a currency union, such as the peripheral European small open economies that experienced a sudden stop in capital inflows during the global financial crisis, lack autonomy over monetary policy.[2] These considerations provide a rationale for the use of government spending, especially when monetary policy

[1]In specific instances, underborrowing has also been identified by Benigno et al. (2013), Chi et al. (2021) and Schmitt-Grohé and Uribe (2021).

[2]Gali and Monacelli (2008) highlight the role of government spending as a stabilizing force in small open economies with nominal rigidities that are part of a currency union.

is constrained. While the stabilization role of government spending in the presence of nominal rigidities has been extensively studied in the context of small open economies (e.g., Bianchi et al., 2023), the role of fiscal spending in addressing frictions arising from collateral constraints and pecuniary externalities has not been thoroughly explored. This paper aims to fill that gap.

To address this, we characterize the optimal government spending policy in collateral-constrained small open economies. Our model is similar to Bianchi (2011), with the addition of government spending. In this framework, households' borrowing capacity is constrained by a fraction of their current income, which includes endowment receipts of both tradable and nontradable goods. With tradable goods serving as the numeraire, the key collateral price is the relative price of nontradable goods, which is also the target of government spending. A pecuniary externality arises because households do not account for the impact of their consumption decisions on the relative price of nontradable goods. As a result, they undervalue the marginal utility of wealth compared to the socially optimal level, leading to excessive borrowing. Additionally, during economic downturns, the value of collateral depreciates due to a sudden stop in capital inflows and contractions in domestic absorption, which triggers a debt-deflation spiral.

In this context, fiscal spending plays a stabilizing role in business cycles, particularly in collateral-constrained economies, by promoting financial stability. Ex ante, government spending policy can mitigate the problem of overborrowing. When the collateral constraint is not binding, fiscal austerity, under plausible parameter values, discourages overborrowing driven by pecuniary externalities by shifting the intertemporal allocation of resources toward a more efficient level. Ex post, government spending can help sustain capital inflows. When the collateral constraint binds, an increase in collateral prices allows for more borrowing, as the borrowing limit is determined by the value of the collateral. In our framework, government spending on nontradable goods raises the relative price of nontradables, which serves as the collateral. Thus, when the constraint binds, fiscal stimulus helps maintain capital inflows even as borrowing reaches its limit. The optimal time-consistent government spending policy balances the benefits of maintaining financial stability with the utility costs associated with the crowding out of private consumption.

We investigate how government spending interacts with capital controls. As has been well established, capital controls can be used to address pecuniary externalities. The combination of optimal government spending and capital controls can therefore achieve the first-best benchmark outcome in terms of welfare. Our analysis shows that when a tax on borrowing is available and optimally chosen, it effectively prevents overborrowing ex ante, eliminating the need for government spending to mitigate pecuniary externalities through ex ante intervention. In this case, the capital control policy alone suffices to correct the inefficiency, and there is no additional role for government spending in addressing the externality.

Quantitative analyses suggest that fiscal expansion, when the collateral constraint binds, plays a crucial role in maintaining capital flows. This fiscal expansion supports the value of collateral, helping to sustain capital inflows. The expectation that households will be able to borrow due to the optimal government spending, which boosts collateral values, motivates them to borrow more when the constraint is not binding. This offsets the reduction in borrowing that would result from fiscal austerity. Consequently, households tend to borrow more under the regime of optimal government spending. When a capital control tax is available, it has been shown that households are further incentivized to accumulate precautionary savings, resulting in higher levels of saving compared to scenarios where only optimal government spending is employed.

Our simulation reveals that during a recession, which may trigger the binding of the collateral constraint and a sudden stop in capital inflows, fiscal expansion plays a key role in supporting collateral prices and sustaining capital inflows, thereby preventing abrupt reversals in the current account. This intervention helps the economy escape the vicious cycle of debt-deflation amplification, reducing the severity of recessions. The capital control tax complements fiscal expansion by promoting greater precautionary savings, which in turn lowers the need for aggressive fiscal expansion during crises. Consequently, the crowding out of private consumption is smaller when a capital control tax is in place, as it reduces the extent of fiscal intervention required to stabilize the economy.

In addition to the optimal government spending policy, we examine the consequences of various sub-optimal spending policies: (1) the Samuelson rule, which ignores financial stability but accounts for the crowding-out effect and the direct utility impact of government spending, and (2) a constant spending-to-GDP ratio rule, which is more practical for implementation. Our findings suggest that the optimal government spending policy significantly reduces the volatility of external balances compared to these sub-optimal policies. As a result, it also lowers the countercyclicality of the current account, indicating that consumption smoothing is more effective. This is because fiscal expansion, by maintaining the level of capital inflows, mitigates the distortions in the intertemporal consumption choices. While the capital control tax also contributes to reducing the volatility of current accounts, its impact under the optimal government spending policy is found to be marginal compared to its role under sub-optimal spending policies. Consistently, the welfare gain from having a capital control tax is smaller when the optimal spending policy is in place. These results demonstrate that once implemented, the optimal spending policy can be a highly effective tool for addressing pecuniary externalities.

Our paper contributes to the recent literature on government spending in small open economies. Liu (2022) explores the transmission mechanism of government spending in a collateral-constrained small open economy, showing that during sudden stop crises, the government spending multiplier on private consumption is higher compared to normal times. This is because fiscal expansion appreciates the value of collateral, enabling more borrowing during crises. While our paper shares this transmission mechanism, we extend the analysis by characterizing the optimal government spending policy both with and without capital control measures, a topic not addressed in previous research.

Liu et al. (2024) also examine the transmission mechanism of government spending in a collateral-constrained economy but use a stock collateral constraint, where the price of capital determines the collateral value. In their framework, government spending boosts collateral values and sustains capital inflows by appreciating the future real exchange rate, making fiscal stimulus particularly effective when it is persistent. In contrast, our model relies on a flow collateral constraint, where the current endowment income and current real exchange rate determine the collateral value. We show that in this case, optimal government spending does not need to be persistent to achieve its stabilizing effects.

Bianchi et al. (2023) study optimal fiscal policy during a recession in a small open economy with downward nominal wage rigidity and endogenous sovereign defaults. They quantitatively demonstrate that the benefits of stimulus in reducing unemployment during recessions may be outweighed by the increased risk of debt crises, making fiscal expansion potentially undesirable. In contrast, our paper focuses on optimal spending policies to address pecuniary externalities, rather than nominal rigidities or sovereign default risks.

More broadly, our paper relates to the literature on policy interventions in economies prone to sudden stops. Ottonello (2021), Coulibaly (2023) and Matsumoto (2021) investigate the role of monetary and macroprudential policies in mitigating the effects of sudden stops. Davis et al. (2023) examine foreign reserve policies aimed at preventing sudden stop crises, while Chi et al. (2021) analyze the impact of interest rate policies on central bank reserves to avoid household deleveraging from triggering aggregate deleveraging. Korinek and Sandri (2016) distinguish between the roles of capital controls on foreign lending and domestic macroprudential regulation. Benigno et al. (2023) identify a set of policy instruments, including those that can manipulate the price of collateral, which can implement the constrained efficient allocation and restore the allocation without the collateral constraint in the model of Bianchi (2011) and Benigno et al. (2013). Additionally, Durdu and Mendoza (2006) explore the use of asset price guarantees as a policy tool in such contexts.

The remainder of the paper is organized as follows. Section 2 presents our small open economy model. Section 3 discusses the problem of optimal government spending, and Section 4 conducts a quantitative analysis of the model's characteristics and the optimal government spending. Section 5 concludes the paper.

2 The Model

In this section, we present our model environment, building upon the prototypical small open economy model of Bianchi (2011). We incorporate government consumption, which contributes to household utility.[3] The representative households maximize the lifetime expected utility,

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ u\left(c_t\right) + v\left(g_t\right) \right\} \tag{1}$$

where c_t denotes consumption in period t and g_t represents government spending on nontradable goods in period t which we assume provides direct utility. $\beta \in (0,1)$ is the subjective discount factor. We assume $u\left(c_t\right) = \frac{c_t^{1-\sigma}}{1-\sigma}$ and $v\left(g_t\right) = \chi \frac{g_t^{1-\sigma}}{1-\sigma}$ where $\sigma > 0$ is the inverse of the intertemporal elasticity of substitution and $\chi > 0$ is the degree of the direct utility from government spending. As in Bianchi et al. (2023), we assume the same degree of risk aversion for private and public consumption. The consumption basket is a composite of tradable and nontradable goods and is given by a CES aggregator,

$$c_t = \left[a \left(c_t^T\right)^{1-\frac{1}{\xi}} + (1-a)\left(c_t^N\right)^{1-\frac{1}{\xi}} \right]^{\frac{1}{1-\frac{1}{\xi}}} \tag{2}$$

where c_t^T denotes the consumption of tradable goods in period t, and c_t^N denotes the consumption of nontradable goods in period t. The parameter $a \in (0,1)$ governs the weight of tradable goods, while $\xi > 0$ denotes the intratemporal elasticity of substitution between tradable and nontradable consumption. In each period, households receive endowment of tradable and nontradable goods, denoted by y_t^T and y_t^N, respectively. Both endowments are exogenously given. We assume that households have access to a one period, non-state contingent, internationally traded bond denominated in units of tradable goods. Holding this bond from period t to period $t+1$ pays the interest rate r. In addition, households pay a lump-sum tax T_t in nontradable goods, which finances government spending. The

[3] The assumption of direct utility from public spending is common in the literature on optimal government spending in both open and closed economies. See for instance Gali and Monacelli (2008), Nakata (2016), Bilbiie et al. (2019) and Bianchi et al. (2023), among many others.

household's period-by-period budget constraint is given by

$$c_t^T + p_t c_t^N + d_t = y_t^T + p_t y_t^N + \frac{d_{t+1}}{1+r} - p_t T_t \tag{3}$$

where d_{t+1} represents the amount of debt assumed in period t and due in period $t+1$, and p_t is the relative price of nontradable goods in terms of tradable goods. Alongside the sequential budget constraint, households face a collateral constraint of the form

$$d_{t+1} \leq \kappa \left(y_t^T + p_t y_t^N \right) \tag{4}$$

where $\kappa > 0$ is the parameter that determines the fraction of income that can be pledged as collateral. The pecuniary externality arises because each household takes as given the price of collateral, which is the relative price of nontradables, even though their aggregate choices regarding tradable and nontradable consumption determine this price.

Households maximize (1) subject to (2), (3) and (4) by choosing c_t^T, c_t^N, c_t and d_{t+1}. The first order conditions are (2), (3) , (4),

$$c_t^{\frac{1}{\xi}-\sigma} a \left(c_t^T \right)^{-\frac{1}{\xi}} = \lambda_t, \tag{5}$$

$$p_t = \frac{1-a}{a} \left(\frac{c_t^T}{c_t^N} \right)^{\frac{1}{\xi}}, \tag{6}$$

$$\frac{\lambda_t}{1+r} - \mu_t = \beta E_t \lambda_{t+1}, \tag{7}$$

$$\mu_t \left\{ \kappa \left(y_t^T + p_t y_t^N \right) - d_{t+1} \right\} = 0, \tag{8}$$

and

$$\mu_t \geq 0,$$

where λ_t denotes the Lagrange multiplier on the sequential budget constraint and μ_t

is the Lagrange multiplier on the collateral constraint. The Euler equation (7) equates the marginal value of an additional unit of borrowing with its marginal cost. When the collateral constraint is not binding, the marginal value is $\frac{\lambda_t}{1+r}$, while the marginal cost is $\beta E_t \lambda_{t+1}$. When the collateral constraint binds, it introduces a wedge between these two, represented by μ_t, thereby distorting intertemporal choices.

We assume that government spending on nontradable goods is financed through lump-sum taxation, without introducing any distortions. The government's sequential budget constraint is given by

$$g_t = T_t.$$

The nontradable goods market clearing condition is given by

$$c_t^N + g_t = y_t^N. \tag{9}$$

By combining the sequential private and government budget constraints with the nontradable goods market clearing condition, we derive the resource constraint of the economy, which is given by

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r}. \tag{10}$$

An increase in government spending appreciates the relative price of nontradable goods, as can be seen by substituting the nontradable goods market clearing condition (9) into (6).[4] In the current small open economy, when the collateral constraint is binding, the relative price of nontradables determines the amount of borrowing, given exogenous endowments. Therefore, an increase in government spending that appreciates the price of collateral enables households to increase borrowing even under a binding collateral constraint. In contrast, when the collateral constraint is not binding, the relative price does not directly affect the level of borrowing. However, an appreciation in the price of collateral allows for a higher level of indebtedness without triggering the binding of the

[4] The appreciation of the relative price of nontradables implies an appreciation of the real exchange rate. The appreciation of the real exchange rate following the fiscal stimulus is empirically observed in emerging economies. See Miyamoto et al. (2019).

collateral constraint. Thus, an increase in government spending allows higher borrowing while preventing the constraint from binding.

Regardless of the condition of external financing, government spending affects the marginal utility of borrowing unless the intra- and intertemporal elasticities of substitution are equal. When the intratemporal elasticity of substitution is greater than the intertemporal elasticity of substitution ($\xi > \frac{1}{\sigma}$), as shown in our numerical exercise below, the marginal utility of borrowing increases with government spending. In this case, the temporary fiscal stimulus encourages borrowing. Conversely, when the intratemporal elasticity is lower than the intertemporal elasticity ($\xi < \frac{1}{\sigma}$), the marginal utility of borrowing decreases with government spending, implying that the temporary fiscal stimulus discourages borrowing.

The competitive equilibrium is a set of processes $\left\{c_t^T, c_t, d_{t+1}, \lambda_t, \mu_t\right\}$ satisfying

$$c_t = \left[a\left(c_t^T\right)^{1-\frac{1}{\xi}} + (1-a)\left(y_t^N - g_t\right)^{1-\frac{1}{\xi}}\right]^{\frac{1}{1-\frac{1}{\xi}}}, \tag{11}$$

$$c_t^{\frac{1}{\xi}-\sigma} a\left(c_t^T\right)^{-\frac{1}{\xi}} = \lambda_t, \tag{12}$$

$$\frac{\lambda_t}{1+r} - \mu_t = \beta E_t \lambda_{t+1}, \tag{13}$$

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r}, \tag{14}$$

$$d_{t+1} \leq \kappa\left(y_t^T + \frac{1-a}{a}\left(\frac{c_t^T}{y_t^N - g_t}\right)^{\frac{1}{\xi}} y_t^N\right), \tag{15}$$

$$\mu_t\left\{\kappa\left(y_t^T + \frac{1-a}{a}\left(\frac{c_t^T}{y_t^N - g_t}\right)^{\frac{1}{\xi}} y_t^N\right) - d_{t+1}\right\} = 0, \tag{16}$$

and

$$\mu_t \geq 0, \tag{17}$$

given a process $\{g_t\}$ and exogenous processes $\left\{y_t^T, y_t^N\right\}$. As can be seen by substituting (14) into the right-hand side of (15), the value of collateral increases with d_{t+1} and may even increase more than one-for-one with d_{t+1}, depending on parameter values. As discussed by Schmitt-Grohé and Uribe (2021), this feature can lead to the possibility of multiple equilibria. However, in our quantitative analysis, we adopt parameterization under which this possibility does not arise.

3 Optimal Government Spending

In this section, we characterize time-consistent optimal government spending. The government maximizes households' utility using government spending as its sole policy instrument, subject to competitive equilibrium conditions. We assume the government lacks a commitment device and look for a Markov-perfect equilibrium, as in Bianchi and Mendoza (2018), Devereux et al. (2019), and Coulibaly (2023). The current government takes future governments' decisions as given but considers the effects of its borrowing choice, which serves as the state variable for the next period, on those future policies. Let $G\left(d, y^T, y^N\right)$ represent the future government's spending choice, which the current government takes as given, and let $C^T\left(d, y^T, y^N\right)$ denote the associated function that gives the value of tradable goods consumption under that policy. Given these functions, the government's problem is described as

$$V\left(d, y^T, y^N\right) = \max_{c^T, d', \mu, g} u\left[c\left(c^T, y^N - g\right)\right] + v\left(g\right) + \beta E_{y^{T\prime}, y^{N\prime} | y^T, y^N} V\left(d', y^{T\prime}, y^{N\prime}\right) \quad (18)$$

subject to

$$c = \left[a\left(c^T\right)^{1-\frac{1}{\xi}} + (1-a)\left(y^N - g\right)^{1-\frac{1}{\xi}}\right]^{\frac{1}{1-\frac{1}{\xi}}}, \quad (19)$$

$$c^T + d = y^T + \frac{d'}{1+r}, \quad (20)$$

$$\frac{u_T\left(c^T, y^N - g\right)}{1+r} - \mu = \beta E_{y^{T\prime}, y^{N\prime} | y^T, y^N}\left[u_T\left(C^T\left(d', y^{T\prime}, y^{N\prime}\right), y^{N\prime} - G\left(d', y^{T\prime}, y^{N\prime}\right)\right)\right], \quad (21)$$

$$\kappa\left[y^T+\frac{1-a}{a}\left(\frac{c^T}{y^N-g}\right)^{\frac{1}{\xi}}y^N\right]\geq d', \tag{22}$$

$$\mu\left[\kappa\left(y^T+\frac{1-a}{a}\left(\frac{c^T}{y^N-g}\right)^{\frac{1}{\xi}}y^N\right)-d'\right]=0, \tag{23}$$

and

$$\mu\geq 0, \tag{24}$$

where $u_T\equiv\frac{\partial u\left(c^T,y^N-g\right)}{\partial c^T}$ is the marginal utility of tradable consumption, and a prime superscript denotes the variable in the next period.

We examine the first-order condition with respect to government spending in the government's problem. It is given by

$$\frac{\partial u\left(c^T,y^N-g\right)}{\partial g}+\frac{\partial v\left(g\right)}{\partial g}+\left(\lambda^3+\lambda^4\mu\right)\kappa\frac{\partial p}{\partial g}y^N+\frac{\lambda^2}{1+r}\frac{\partial u_T\left(c^T,y^N-g\right)}{\partial g}=0, \tag{25}$$

where λ^2, λ^3 and λ^4 are the multipliers associated with the private Euler equation (21), the collateral constraint (22) and the slackness condition (23). The first two terms of (25) represent the marginal decline in the utility due to crowded-out nontradable consumption and the marginal increase in the direct utility from government spending, respectively. The Samuelson rule (Samuelson, 1954) is satisfied when the level of spending is determined so that these terms are equated. Facing the collateral constraint, the government may find it optimal to deviate from the Samuelson rule to maintain financial stability, as expressed by third and fourth terms of (25). Noting that the relative price of nontradables is increasing in government spending, fiscal stimulus yields benefits because it allows to continue to borrow even when the collateral constraint binds. The third term of (25) represents this benefit. The marginal increase in government spending increases the value of collateral by the magnitude of $\kappa\frac{\partial p}{\partial g}y^N$. Noting that $\lambda^3+\lambda^4\mu$ is the government's effective shadow value of relaxing the collateral constraint which is positive when the constraint binds, the ex post fiscal stimulus has the utility benefits of $\left(\lambda^3+\lambda^4\mu\right)\kappa\frac{\partial p}{\partial g}y^N$.

In contrast, the fourth term of (25) captures the utility benefit of ex-ante intervention. This term appears when the collateral constraint does not bind and government spending affects the marginal utility of tradable consumption.[5] As discussed by Bianchi (2011) and others, the current economy experiences an overborrowing problem due to a pecuniary externality. Households take the relative price of nontradables as given and fail to internalize the relaxation effects of an additional unit of tradable consumption on the collateral constraint. Specifically, the households' shadow value of tradable consumption is represented by the marginal utility of tradable consumption, $u_T(t)$. If the pecuniary externality were internalized, the shadow value would be $u_T(t) + \mu_t \kappa \frac{\partial p_t}{\partial c_t^T} y_t^N$, where $\mu_t \kappa \frac{\partial p_t}{\partial c_t^T} y_t^N \geq 0$ represents the value of relaxing the collateral constraint through an additional unit of tradable consumption. When the constraint is not binding, the marginal benefit of borrowing, $u_T(t)$ is equated to the marginal cost of borrowing, given by $\beta(1+r) E_t u_T(t+1)$, while it would be equated to $\beta(1+r) E_t \left[u_T(t+1) + \mu_{t+1} \kappa \frac{\partial p_{t+1}}{\partial c_{t+1}^T} y_{t+1}^N \right]$ if the pecuniary externality were internalized. Consequently, households facing a pecuniary externality accumulate an inefficiently high level of borrowing when the collateral constraint is not binding. The government recognizes this ex-ante inefficiency and mitigates overborrowing by altering the marginal utility of borrowing when the collateral constraint is slack. As mentioned above, when the intratemporal elasticity of substitution is greater (less) than the intertemporal elasticity of substitution, the marginal utility of borrowing increases (decreases) with government spending. Therefore, current fiscal austerity (expansion) reduces overborrowing.

3.1 Optimal Government Spending with a Capital Control Tax

We now examine how the optimal government spending policy coordinates with capital controls. We assume that the government can impose a tax on external borrowing. We continue to assume that a lump-sum tax is available. With the capital control tax, the budget constraint of households is modified as

[5] The multiplier on the private Euler equation is zero ($\lambda^2 = 0$) when the collateral constraint binds. See Appendix A.

$$c_t^T + p_t c_t^N + d_t = y_t^T + p_t y_t^N + (1 - \tau_t) \frac{d_{t+1}}{1+r} - p_t T_t$$

where $\tau_t > 0$ represents a capital control tax (subsidy when $\tau_t < 0$) in period t. The Euler equation of households under the capital control tax is given by

$$(1 - \tau_t) \frac{\lambda_t}{1+r} - \mu_t = \beta E_t \lambda_{t+1}. \tag{26}$$

The budget constraint of the government is modified as

$$\tau_t \frac{d_{t+1}}{1+r} + p_t T_t = p_t g_t. \tag{27}$$

Other equilibrium conditions remain unchanged. The government maximizes household utility by choosing government spending and the capital control tax, subject to competitive equilibrium conditions. The constraint set for the government consists of (19), (20), (22), (23), (24), (26) and (27). However, (26) and (27) are not binding, because, given quantity, τ_t is picked up so that (26) holds and T_t is then chosen so that (27) holds.[6] Thus, the relaxed problem for the government is solving (18) subject to (19), (20), (22), (23) and (24).

The first order condition with respect to government spending is

$$\frac{\partial u \left(c^T, y^N - g\right)}{\partial g} + \frac{\partial v (g)}{\partial g} + \left(\lambda^3 + \lambda^4 \mu\right) \kappa \frac{\partial p}{\partial g} y^N = 0 \tag{28}$$

where λ^3 and λ^4 are the multiplier on (22) and (23), respectively. When the collateral constraint binds, the optimal government spending is characterized in a similar manner to when the capital control tax is not available, as (25) and (28) coincide in this case. Government spending is expansionary to support the price of collateral and the level of borrowing, while its benefits, including the direct utility from spending, are balanced against the cost of crowding out of private consumption. However, when the capital control tax is available, government spending is not used ex-ante to curb capital inflows.

[6] Appendix B provides a detailed proof.

When the collateral constraint is not binding, the third term of (28) vanishes, and the level of government spending is set so that its direct utility matches the disutility from reduced consumption. It appears that the capital control tax is preferred over government spending as an intervention to address the inefficiently high level of borrowing caused by pecuniary externalities.

4 Numerical Exercises

In this section, we examine the quantitative properties of the model. We numerically solve the government's problem both with and without capital control tax.[7] Additionally, we solve for the competitive equilibrium where government spending is governed by sub-optimal policies, specifically the Samuelson rule and the constant spending-to-GDP ratio rule.

4.1 Calibration

We set the parameter values by following previous literature and matching business cycle moments. The inverse of the intertemporal elasticity of substitution, the intratemporal elasticity of substitution between tradable and nontradable consumption, and the real interest rate are set to $\sigma = 2$, $\xi = 0.83$, and $r = 0.04$, as in Bianchi (2011) and Coulibaly (2023). The discount factor β, the weight of tradable goods a, the fraction of income that can be pledged as collateral κ, and the degree of direct utility from government spending χ, are set so that long-run moments under the Samuelson rule match targeted values. We target four moments: a debt-to-GDP ratio of 29 percent, the share of tradable production in total production at 32 percent, the probability of sudden stop crises at 5.5 percent, and a government spending-to-GDP ratio of 18 percent. The first three targeted moments align with the values in Bianchi (2011) and Coulibaly (2023), while the spending-to-GDP ratio reflects the average observed in Argentina from 1965 to 2019.[8] Following the literature, we define sudden stop crises in our model as events where the collateral constraint binds

[7] The solution method is described in Appendix C.

[8] The average spending-to-GDP ratio is calculated using data from PWT 10.01 (Feenstra et al. (2015)).

Table 1: Calibration

	Parameter	Value	Source
σ	Inverse of intertemporal elasticity of substitution	2	
ξ	Intratemporal elasticity of substitution	0.83	Bianchi (2011)
r	Real interest rate	0.04	
β	Discount factor	0.9053	Debt-to-GDP ratio, $\frac{d}{y^T+py^N}=0.29$
a	Weight of tradable consumption	0.3898	Tradable share, $\frac{y^T}{y^T+py^N}=0.32$
κ	Collateral constraint	0.3188	Frequency of sudden stops, 0.055
χ	Degree of utility from public spending	0.0712	Spending-to-GDP ratio, $\frac{pg}{y^T+py^N}=0.18$

Note: The calibration is on an annual basis.

and the current account is at least one standard deviation above its mean. The resulting parameter values are $\beta = 0.9053$, $a = 0.3898$, $\kappa = 0.3188$, and $\chi = 0.0712$.[9] Table 1 summarizes these parameter values.

The natural logarithms of tradable and nontradable endowments follow a bivariate AR(1) process, with parameters set according to Bianchi (2011). The process is given by $\begin{bmatrix} \ln y_t^T \\ \ln y_t^N \end{bmatrix} = \begin{bmatrix} 0.901 & -0.453 \\ 0.495 & 0.225 \end{bmatrix} \begin{bmatrix} \ln y_{t-1}^T \\ \ln y_{t-1}^N \end{bmatrix} + \varepsilon_t$, where $\varepsilon_t \sim N(\emptyset, \Sigma)$ and $\Sigma = \begin{bmatrix} 0.00219 & 0.00162 \\ 0.00162 & 0.00167 \end{bmatrix}$. As in Bianchi (2011), we discretize this process into a Markov process with 16 pairs of $\ln y^T$ and $\ln y^N$ using the procedure of Tauchen and Hussey (1991). The endogenous state variable d_t is discretized into 100 evenly spaced points within the range of 0.2 and 1.15.

4.2 Policy Functions

Figure 1 plots the policy functions for borrowing, government spending, and the relative price of nontradables as functions of current indebtedness. The policy functions are conditional on a state where both tradable and nontradable endowments are hit by negative one standard deviation shocks. We examine policy functions under four alternative specifications of government spending policy: optimal government spending without a

[9] The predicted moments under the Samuelson rule are as follows: a debt-to-GDP ratio of 0.2901, a tradable share of total production of 0.3174, a probability of sudden stop crises of 0.0554, and a government spending-to-GDP ratio of 0.1792.

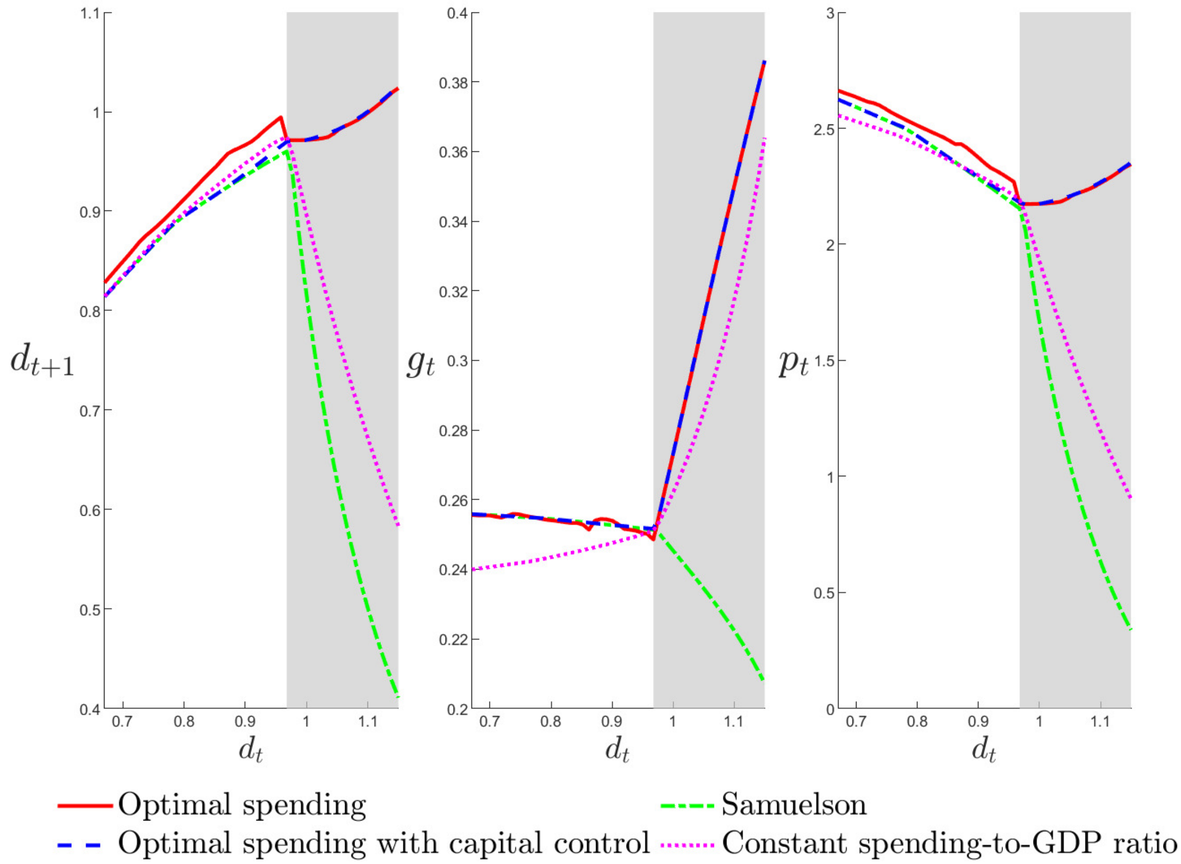
capital control tax, optimal government spending with an optimal capital control tax, the Samuelson rule, and a constant government spending-to-GDP ratio rule. Under the Samuelson rule, government spending is determined such that the marginal utility gain from government spending equals the marginal utility cost of crowded out private nontradable consumption, expressed as $\frac{\partial u\left(c^T, y^N - g\right)}{\partial g} + \frac{\partial v(g)}{\partial g} = 0$.[10] This policy ignores the financial stability. We consider this policy to emphasize the role of government spending in maintaining financial stability. By comparing the outcomes under optimal policies with those under the Samuelson rule, we demonstrate the importance of mitigating the overborrowing problem ex ante and supporting the price of collateral ex post. We also propose a constant spending-to-GDP ratio rule as an implementable second-best policy that approximates the optimal policy. The government spending-to-GDP ratio is set to a targeted value of 18 percent. Since the government must increase spending to maintain this ratio when the relative price declines, this policy acts as a fiscal stimulus when the collateral constraint binds and relative price falls.[11]

Under the Samuelson rule (dash-dotted green), the policy function for borrowing exhibits a kink due to the presence of the collateral constraint. In the region where the collateral constraint is not binding with relatively low indebtedness, current borrowing increases with the level of borrowing in the previous period. In contrast, in the region where the constraint is binding (shaded region), current borrowing decreases as borrowing in the previous period increases. Higher borrowing in the previous period results in lower tradable consumption for any given level of current borrowing, ensuring the resource constraint is satisfied. Lower tradable consumption leads to a lower relative price of nontradables, which, in turn, reduces the value of collateral. When the collateral constraint holds with equality, this reduction in collateral value translates to a lower level of borrowing. At the same time, because the marginal utility of nontradable consumption decreases with tradable consumption when $\frac{1}{\xi} - \sigma < 0$, a decline in tradable consumption increases

[10] Using the fact that $\frac{\partial u\left(c^T, y^N - g\right)}{\partial g} = -\frac{\partial u\left(c^T, c^N\right)}{\partial c^N}$, the condition for the Samuelson rule can be written as $\frac{\partial u\left(c^T, c^N\right)}{\partial c^N} = \frac{\partial v(g)}{\partial g}$.

[11] The government spending-to-GDP ratio, $\frac{p_t g_t}{y_t^T + p_t y_t^N}$, increases with both the relative price and government spending.

Figure 1: Policy functions



Note: The figure displays the policy functions for borrowing, government spending, and the relative price of nontradables under different government spending policies as a function of current indebtedness. The solid red line represents the policy functions under the optimal government spending without capital controls, the dashed blue line represents the policy functions under optimal spending with the optimal capital control tax, the dash-dotted green line corresponds to the policy functions under the Samuelson rule, and the dotted magenta line represents the policy functions under the constant spending-to-GDP ratio rule. The shaded region indicates where the collateral constraint binds under the Samuelson rule.

the marginal utility of nontradables, necessitating a reduction in government spending under the Samuelson rule.[12] Consequently, the negative slope of policy function of the government spending is steeper in the constrained region.[13] The negative slope of the

[12]The fall in the government spending increases the direct marginal utility from the government spending, $\frac{\partial v(g)}{\partial g}$, and decreases the marginal utility of nontradable consumption with higher nontradable consumption, $\frac{\partial u\left(c^T,c^N\right)}{\partial c^N}$.

[13]Under the Samuelson rule, government spending decreases with current indebtedness in the unconstrained region because tradable consumption declines as current indebtedness increases. In the constrained region, tradable consumption decreases more sharply with current indebtedness due to the binding collateral constraint, causing government spending to decrease more sharply as well.

relative price of nontradables is also more pronounced in the constrained region, as both tradable consumption and government spending decrease more sharply with higher past borrowing. It appears that the government spending under the Samuelson rule deflates the price of collateral in the constrained region.

The optimal government spending (solid red) alters the downward-sloping pattern of the policy function of borrowing. In the highly indebted region where the collateral constraint would bind under the Samuelson rule, borrowing increases with past borrowing under the optimal government spending policy. In this constrained region, optimal government spending increases with past borrowing, supporting the relative price of nontradables, which no longer shows a downward-sloping pattern in this region. Because the price of collateral is maintained, the economy can sustain borrowing even at high levels of indebtedness where the collateral constraint holds with equality. Furthermore, when the capital control tax is not available, optimal government spending leads to a higher level of borrowing compared to other spending policies in regions of relatively low indebtedness (left of the shaded region). Because households anticipate that government spending will enable to maintain the borrowing even when the collateral constraint holds with equality, they accumulates more debt. The reduction in borrowing due to fiscal austerity when the constraint is not binding is outweighed by the increase in borrowing driven by expectations of expansion when the constraint binds. When the capital control tax is available and optimally chosen (dashed blue), the level of borrowing in the region where the collateral constraint does not bind is consistently lower, even though households still expect fiscal expansion when the constraint binds. The capital control tax appears to be a more effective tool for reducing borrowing in the unconstrained region.[14] Government spending that maintains a constant ratio to GDP mimics the upward-sloping pattern of the optimal policy in the constrained region (dotted magenta). This supports the value of collateral and enables a higher level of borrowing compared to the Samuelson rule.

[14]When government spending ensures that the collateral constraint never binds, there is no need for ex ante intervention, as noted by Benigno et al. (2016). However, completely removing the collateral constraint through fiscal expansion is not optimal in our environment.

4.3 Financial Crises

We examine the effectiveness of each government spending policy around financial crises. First, we simulate the model under each government spending policy for 1.1 million periods, discarding the first $100,000$ periods as burn-in, using the same sequence of exogenous endowments and the same initial level of borrowing. We define a financial crisis period as one where the collateral constraint binds and the current account is one standard deviation above its simulated average. Under this criteria, the probability of financial crises is 0.79 percent, 0.01 percent, 5.54 percent and 2.73 percent under the optimal government spending policy without and with an optimal capital control tax, the Samuelson rule, and the constant spending-to-GDP ratio rule, respectively. The optimal government spending drastically reduces the probability of financial crises, and an optimal capital control tax further reduces the probability of crises. The constant spending-to-GDP ratio rule also lowers the probability of crises compared to the Samuelson rule.

To understand how each policy functions around financial crises, we investigate the dynamics under each policy during these periods. We identify 7-year windows of simulated series centered around periods when a crisis occurs under the Samuelson rule. We then extract the simulated series under other government spending policies within these identified windows of financial crises.[15] Figure 2 illustrates the average dynamics under each government spending policy across all identified windows. The period in which a financial crisis occurs under the Samuelson rule is normalized to period zero. On average, under the Samuelson rule, a financial crisis takes place when tradable and nontradable endowments decline by approximately 10 percent and 8 percent, respectively, from their means.

Regardless of the availability of the capital control tax, optimal fiscal expansion during financial crises supports the price of collateral and helps sustain capital inflows. This fiscal expansion prevents a sharp improvement in the current account to GDP ratio and results in a more moderate decline in output (8.35 percent and 7.77 percent from simulated

[15] We examine the dynamics under each government spending policy for the same realizations of endowments that trigger financial crises under the Samuelson rule.

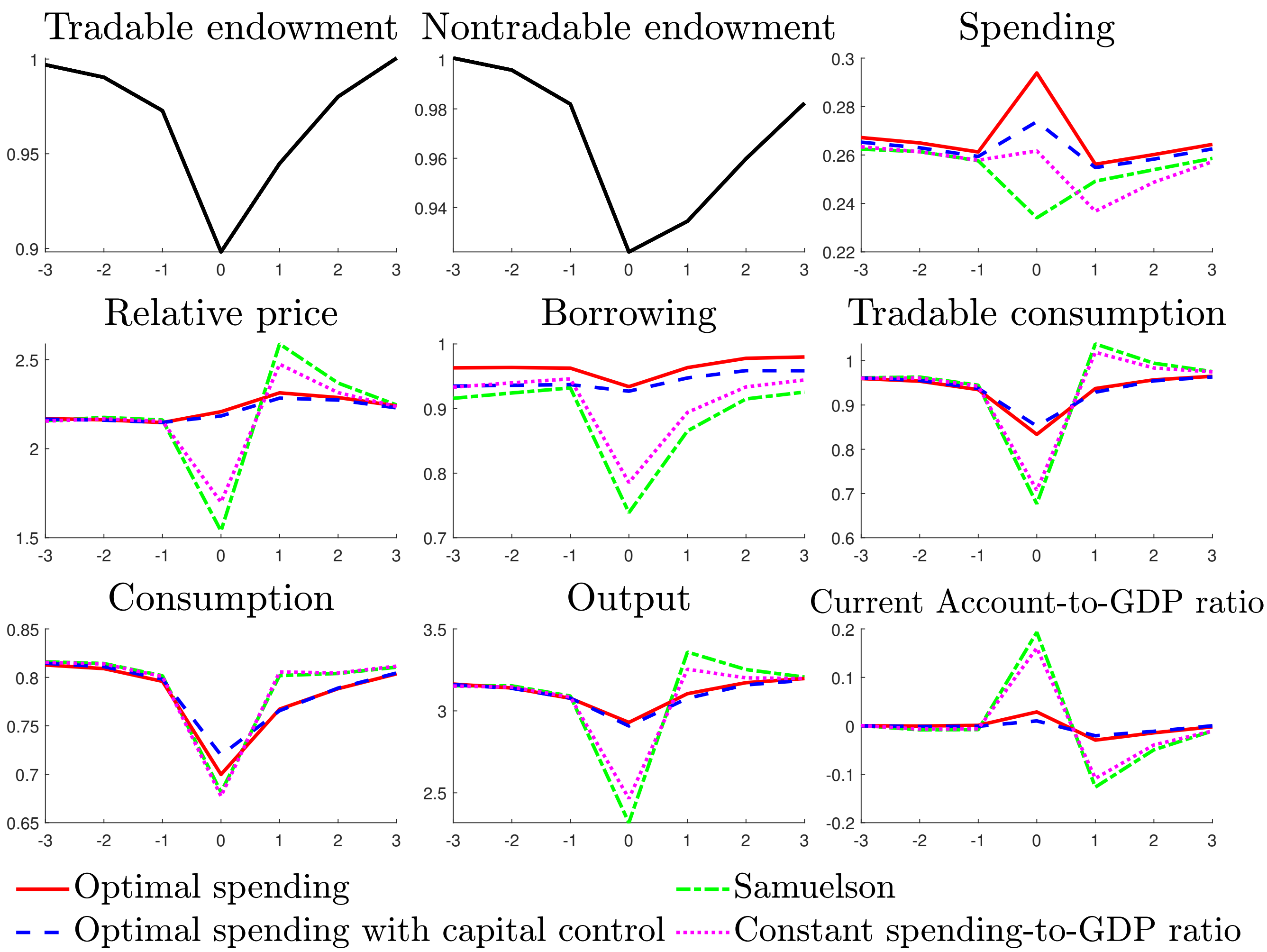
average, with and without the capital control tax, respectively). When the capital control tax is available and optimally chosen, the level of borrowing before crises is lower than in the case without capital control. This lower ex-ante borrowing leads to higher tradable consumption and higher relative price of nontradables during crises. As a result, the government does not need to spend as much as it would without capital control to prop up the value of collateral. Because the crowding out of nontradable consumption is smaller, private consumption falls less during crises when the capital control tax is available (11.70 percent, compared to 13.97 percent without capital control).

When government spending does not care about financial stability (the Samuelson rule), the government reduces spending during crises. This austerity deflates the relative price of nontradables and diminishes the borrowing capacity of households, leading to drastic current account reversals and significant declines in output measured in tradable units (26.80 percent fall in output). Comparing the outcomes under optimal government spending and the Samuelson rule, countercyclical fiscal spending, which is often absent in emerging economies (Kaminsky et al. (2005)), appears to maintain financial stability and stabilize the macroeconomy. Fiscal expansion during crises under the constant spending-to-GDP ratio rule also mitigates current account improvements and declines in output (22.08 percent fall in output).

4.4 Business Cycle Moments

Table 2 presents the second moments computed from the simulations under each government spending policy, both with and without an optimal capital control tax. First, optimal government spending reduces the volatility of the current account-to-GDP ratio and the trade balance-to-GDP ratio compared to other sub-optimal spending policies. A comparison of the standard deviation of the current account-to-GDP ratio under optimal government spending without a capital control tax and under the Samuelson rule without a capital control tax highlights the significant role of optimal government spending in maintaining financial stability. The lower countercyclicality of the current account-to-GDP ratio under optimal government spending implies that the consumption

Figure 2: Financial Crisis Dynamics



Note: The figure illustrates the dynamics of each variable during an average financial crisis. The solid red line represents the dynamics under optimal government spending without capital controls, the dashed blue line shows the dynamics under the optimal spending with the optimal capital control tax, the dash-dotted green line corresponds to the dynamics under the Samuelson rule, and the dotted magenta line represents the dynamics under the constant spending-to-GDP ratio rule. The dynamics are expressed in levels.

smoothing works better in response to endowment income shocks. Consistently, tradable consumption is better smoothed under optimal government spending.[16] The constant spending-to-GDP ratio policy contributes to stabilizing capital flows as well.

Second, regardless of the government spending policy, the optimal capital control tax contributes to maintaining financial and economic stability, consistent with the findings of

[16] Aggregate consumption is more volatile under optimal government spending because the government adjusts its spending in response to shocks, thereby impacting private nontradable consumption.

Table 2: Second moments

	Optimal spending		Samuelson rule		Constant ratio rule	
	No CC	With CC	No CC	With CC	No CC	With CC
Standard deviation						
Consumption	5.04	4.57	4.92	4.30	4.97	4.30
Tradable consumption	6.03	5.27	8.76	5.56	8.11	5.68
Current account-to-GDP	0.91	0.70	2.73	0.66	2.15	0.74
Trade balance-to-GDP	0.91	0.69	2.76	0.66	2.17	0.74
Correlation with GDP						
Consumption	0.78	0.79	0.85	0.86	0.91	0.90
Current account-to-GDP	−0.29	0.02	−0.76	−0.12	−0.67	−0.15
Trade balance-to-GDP	−0.34	−0.06	−0.77	−0.22	−0.68	−0.23

Bianchi (2011) and Coulibaly (2023), among others. However, when government spending is chosen optimally, the contribution of capital control is reduced compared to cases without optimal spending, in terms of stabilizing the economy. This is because optimal government spending sustains borrowing levels when the collateral constraint binds and reduces the impact of the binding constraint. Consequently, the role of capital control, which lowers the probability of the binding of the constraint, is diminished.

4.5 Welfare Analysis

We examine the welfare implication of each government spending policy. Our measure of welfare for each policy is the required percentage change in private and public consumption in an economy with each government spending policy to achieve the same level of welfare as in the economy under optimal government spending without a capital control tax.[17] The state-dependent welfare implication of each policy, denoted by $\gamma^a\left(d, y^T, y^N\right)$, solves

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left[c_t^a\left(1+\gamma^a\left(d, y^T, y^N\right)\right)\right]^{1-\sigma}}{1-\sigma} + \chi \frac{\left[g_t^a\left(1+\gamma^a\left(d, y^T, y^N\right)\right)\right]^{1-\sigma}}{1-\sigma} \right] = V^{OP}\left(d, y^T, y^N\right)$$

[17] We measure the welfare in terms of total consumption as in Bianchi et al. (2023). This approach is natural because the government spending entails direct utility.

where c_t^a and g_t^a denote private and public consumption under alternative government spending policies, and V^{OP} is the expected lifetime utility associated with optimal government spending without a capital control tax. Figure 3 plots these welfare implications as a function of current indebtedness. In the high indebtedness region where the collateral constraint binds under the Samuelson rule (shaded area), optimal government spending without a capital control tax results in larger welfare gains compared to the Samuelson rule and the constant spending-to-GDP ratio policy. This is because optimal fiscal expansion when the collateral constraint binds allows to continue borrowing and mitigates the effects of the binding of the constraint. The expectation that households can continue to borrow due to fiscal expansion encourages more borrowing, thus the optimal government spending provides welfare gains over sub-optimal policies even in the low-indebtedness region where the collateral constraint does not bind. On average, 0.15 percent and 0.10 percent of permanent total consumption would need to be added under the Samuelson rule and the constant spending-to-GDP ratio rule, respectively, to achieve the same level of welfare as under the optimal policy without a capital control tax.

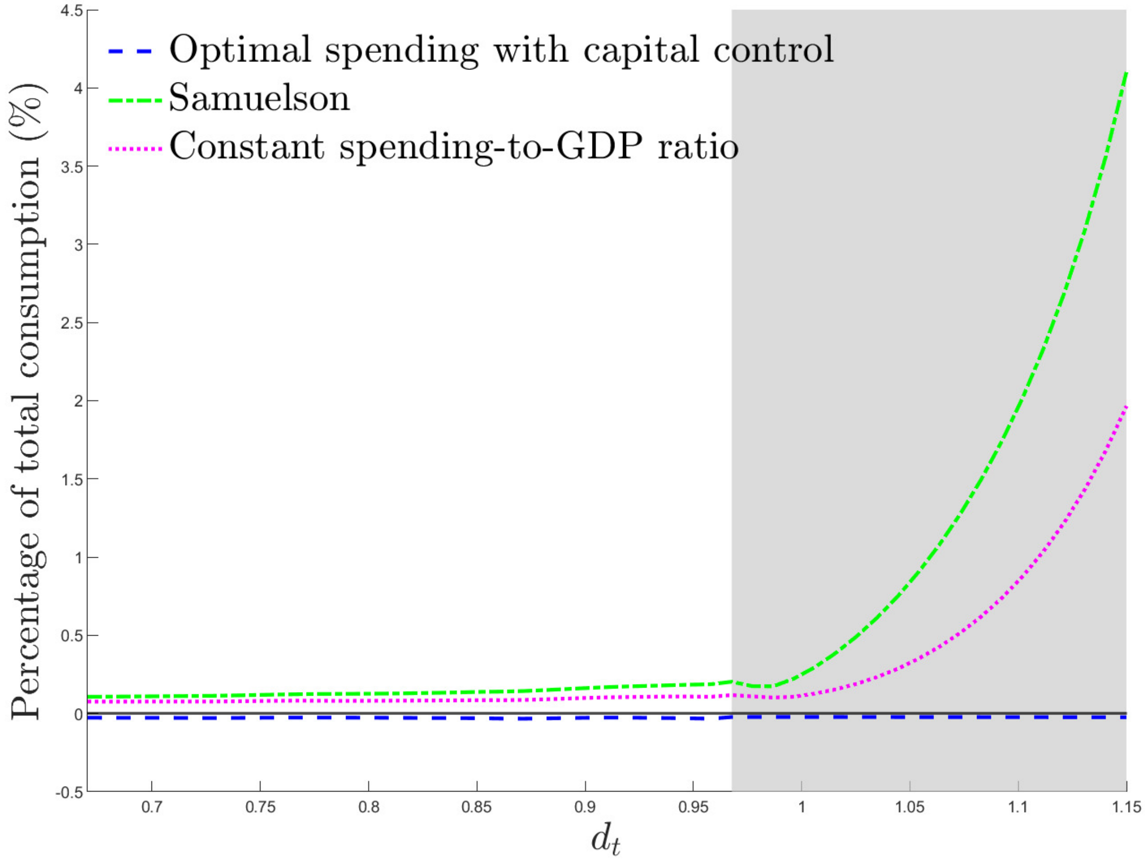
Adding the capital control tax to the government's set of policy tools, alongside optimal government spending, delivers welfare gains. On average, implementing an optimal capital control tax together with optimal government spending provides a welfare gain of 0.03 percent of permanent total consumption. However, the welfare gain from the capital control tax is smaller under optimal government spending, compared to the 0.11 percent welfare gain of the optimal capital control with the Samuelson rule.[18] This is because optimal government spending reduces the effects of the binding of the collateral constraint, thereby mitigating the pecuniary externality. Since government spending can alleviate the impacts of the binding constraint, the role of the capital control tax becomes

[18]We measure the state-dependent welfare implication of having an optimal capital control tax under the Samuelson rule with $\gamma^{cc}\left(d, y^T, y^N\right)$ which solves

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left[c_t^{cc}\left(1+\gamma^{cc}\left(d, y^T, y^N\right)\right)\right]^{1-\sigma}}{1-\sigma} + \chi \frac{\left[g_t^{cc}\left(1+\gamma^{cc}\left(d, y^T, y^N\right)\right)\right]^{1-\sigma}}{1-\sigma} \right] = V\left(d, y^T, y^N\right)$$

where c_t^{cc} and g_t^{cc} represent private and public consumption under the Samuelson rule with an optimal capital control tax, and V is the expected lifetime utility associated with the Samuelson rule without a capital control tax.

Figure 3: Welfare



Note: The figure shows the percentage of permanent total consumption in economies under alternative government spending policies required to achieve the same level of welfare as in the economy under optimal government spending without a capital control tax. The dashed blue line represents the welfare implication for optimal government spending with an optimal capital control tax, the dash-dotted green line shows the welfare implication for the Samuelson rule, and the dotted magenta line indicates the welfare implication for the constant spending-to-GDP ratio rule.

less significant. Nevertheless, correcting the pecuniary externality by imposing a capital control tax yields welfare gains unless the ex-post fiscal stimulus completely removes the effects of the binding of the collateral constraint, as discussed in Benigno et al. (2016).

5 Conclusion

This paper characterizes optimal government spending in a small open economy with collateral constraints. Government spending plays a crucial role in maintaining financial stability, thereby stabilizing business cycles. By boosting demand in the nontradable sector and appreciating the price of collateral, optimal fiscal expansion sustains capital inflows during economic downturns. Optimal fiscal austerity discourages borrowing when the collateral constraint is not binding, mitigating the overborrowing. When a capital control tax is available and optimally implemented, it substitutes for ex-ante intervention. Numerical analyses show that optimal government spending significantly stabilizes capital flows and the macroeconomy. The introduction of optimal capital control reduces the magnitude of fiscal expansion required to maintain capital inflows during adverse shocks by encouraging households to accumulate more precautionary savings, and thus reduces the crowding out of private consumption. Fiscal expansion during periods when the collateral constraint binds is the primary source of welfare gains. While the capital control tax delivers welfare gains, these are smaller when government spending is optimally chosen compared to when the government spending follows sub-optimal rules. A policy of maintaining a constant government spending-to-GDP ratio approximates optimal government spending in our setting.

This paper highlights the stabilizing role of government spending in business cycles, advocating for the optimality of countercyclical fiscal policies during financial crises. This complements the Keynesian perspective on the benefits of countercyclical fiscal spending, which is often not observed in emerging economies (Kaminsky et al., 2005). Incorporating sovereign risk, as explored by Bianchi et al. (2023), would be a meaningful direction for future research.

References

Benigno, G., H. Chen, C. Otrok, A. Rebucci, and E. R. Young (2013): "Financial crises and macro-prudential policies," *Journal of International Economics*, 89, 453–470.

——— (2016): "Optimal capital controls and real exchange rate policies: A pecuniary externality perspective," *Journal of Monetary Economics*, 84, 147–165.

——— (2023): "Optimal Policy for Macrofinancial Stability," *American Economic Journal: Macroeconomics*, 15, 401–428.

Bianchi, J. (2011): "Overborrowing and Systemic Externalities in the Business Cycle," *American Economic Review*, 101, 3400–3426.

Bianchi, J. and E. G. Mendoza (2018): "Optimal Time-Consistent Macroprudential Policy," *Journal of Political Economy*, 126, 588–634.

Bianchi, J., P. Ottonello, and I. Presno (2023): "Fiscal Stimulus under Sovereign Risk," *Journal of Political Economy*, 131, 2328–2369.

Bilbiie, F. O., T. Monacelli, and R. Perotti (2019): "Is Government Spending at the Zero Lower Bound Desirable?" *American Economic Journal: Macroeconomics*, 11, 147–173.

Chi, C.-C., S. Schmitt-Grohé, and M. Uribe (2021): "Optimal Bank Reserve Remuneration and Capital Control Policy," NBER Working Papers 29473, National Bureau of Economic Research, Inc.

Coulibaly, L. (2023): "Monetary Policy in Sudden Stop-Prone Economies," *American Economic Journal: Macroeconomics*, 15, 141–76.

Davis, J. S., M. B. Devereux, and C. Yu (2023): "Sudden stops and optimal foreign exchange intervention," *Journal of International Economics*, 141.

Devereux, M. B., E. R. Young, and C. Yu (2019): "Capital controls and monetary policy in sudden-stop economies," *Journal of Monetary Economics*, 103, 52–74.

Durdu, C. B. and E. G. Mendoza (2006): "Are asset price guarantees useful for preventing Sudden Stops?: A quantitative investigation of the globalization hazard-moral hazard tradeoff," *Journal of International Economics*, 69, 84–119.

Feenstra, R. C., R. Inklaar, and M. P. Timmer (2015): "The Next Generation of the Penn World Table," *American Economic Review*, 105, 3150–3182.

Gali, J. and T. Monacelli (2008): "Optimal monetary and fiscal policy in a currency union," *Journal of International Economics*, 76, 116–132.

Kaminsky, G. L., C. M. Reinhart, and C. A. Végh (2005): "When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies," in *NBER Macroeconomics Annual 2004, Volume 19*, National Bureau of Economic Research, Inc, NBER Chapters, 11–82.

Korinek, A. and D. Sandri (2016): "Capital controls or macroprudential regulation?" *Journal of International Economics*, 99, 27–42.

Liu, S. (2022): "Government spending during sudden stop crises," *Journal of International Economics*, 135.

Liu, S., H. Shen, and W. Wang (2024): "Persistent Fiscal Expansions in Sudden-Stop Crises: Expectation Channel," *Available at SSRN: https://ssrn.com/abstract=4802446*.

Matsumoto, H. (2021): "Monetary and Macroprudential Policies under Dollar-Denominated Foreign Debt," IMES Discussion Paper Series 21-E-04, Institute for Monetary and Economic Studies, Bank of Japan.

Miyamoto, W., T. L. Nguyen, and V. Sheremirov (2019): "The effects of government spending on real exchange rates: Evidence from military spending panel data," *Journal of International Economics*, 116, 144–157.

Nakata, T. (2016): "Optimal fiscal and monetary policy with occasionally binding zero bound constraints," *Journal of Economic Dynamics and Control*, 73, 220–240.

Ottonello, P. (2021): "Optimal exchange-rate policy under collateral constraints and wage rigidity," *Journal of International Economics*, 131.

Samuelson, P. A. (1954): "The Pure Theory of Public Expenditure," *The Review of Economics and Statistics*, 36, 387–389.

Schmitt-Grohé, S. and M. Uribe (2017): "Is Optimal Capital Control Policy Countercyclical in Open Economy Models with Collateral Constraints?" *IMF Economic Review*, 65, 498–527.

——— (2021): "Multiple Equilibria in Open Economies with Collateral Constraints," *Review of Economic Studies*, 88, 969–1001.

Tauchen, G. and R. Hussey (1991): "Quadrature-Based Methods for Obtaining Approximate Solutions to Nonlinear Asset Pricing Models," *Econometrica*, 59, 371–396.

Appendix

A Optimal Government Spending without a Capital Control Tax under Discretion

We denote the multiplier on (20), (21), (22), (23) and (24) by λ^1, λ^2, λ^3, λ^4, and λ^5. The government's optimality conditions are as follows:

$$
\begin{aligned}
c^T &: u_T\left(c^T, y^N - g\right) - \lambda^1 + \left(\lambda^3 + \lambda^4 \mu\right)\kappa \frac{\partial p}{\partial c^T} y^N + \frac{\lambda^2}{1+r}\frac{\partial u_T\left(c^T, y^N - g\right)}{\partial c^T} = 0 \\
d' &: \frac{\lambda^1}{1+r} = \beta E_{y^{T\prime}, y^{N\prime} | y^T, y^N} \lambda^{1\prime} + \lambda^3 + \lambda^4 \mu \\
&\quad + \beta \lambda^2 E_{y^{T\prime}, y^{N\prime} | y^T, y^N} \frac{\partial u_T\left(\boldsymbol{C^T}\left(d', y^{T\prime}, y^{N\prime}\right), y^{N\prime} - \boldsymbol{G}\left(d', y^{T\prime}, y^{N\prime}\right)\right)}{\partial d'} \\
g &: \frac{\partial u\left(c^T, y^N - g\right)}{\partial g} + \frac{\partial v\left(g\right)}{\partial g} + \left(\lambda^3 + \lambda^4 \mu\right)\kappa \frac{\partial p}{\partial g} y^N + \frac{\lambda^2}{1+r}\frac{\partial u_T\left(c^T, y^N - g\right)}{\partial g} = 0 \\
\mu &: -\lambda^2 + \lambda^4 \left[\kappa\left(y^T + \frac{1-a}{a}\left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} y^N\right) - d'\right] + \lambda^5 = 0
\end{aligned} \tag{29}
$$

$$
\begin{aligned}
&\text{KT: } \lambda^3 \left[\kappa\left(y^T + \frac{1-a}{a}\left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} y^N\right) - d'\right] = 0 \\
&\text{KT: } \lambda^5 \mu = 0
\end{aligned} \tag{30}
$$

The multiplier on the private Euler equation is zero ($\lambda^2 = 0$) when the collateral constraint binds. Suppose $\mu > 0$. Then, $\kappa\left(y^T + \frac{1-a}{a}\left(\frac{c^T}{y^N-g}\right)^{\frac{1}{\xi}} y^N\right) - d' = 0$. The Kuhn-Tucker condition (30) implies $\lambda^5 = 0$. The optimality condition with respect to μ (29) imply $\lambda^2 = 0$.

B Optimal Government Spending with a Capital Control Tax

When the capital control tax is available, the problem of the government is

$$V\left(d, y^T, y^N\right) = \max_{c^T, d', \mu, g, T, \tau} u\left[c\left(c^T, y^N - g\right)\right] + v\left(g\right) + \beta E_{y^{T\prime}, y^{N\prime}|y^T, y^N} V\left(d', y^{T\prime}, y^{N\prime}\right)$$

subject to

$$\lambda^1 : c^T + d = y^T + \frac{d'}{1+r},$$

$$\lambda^2 :\ (1-\tau)\frac{u_T\left(c^T, y^N - g\right)}{1+r} - \mu = \beta E_{y^{T\prime}, y^{N\prime}|y^T, y^N}\left[u_T\left(C^T\left(d', y^{T\prime}, y^{N\prime}\right), y^{N\prime} - G\left(d', y^{T\prime}, y^{N\prime}\right)\right)\right], \tag{31}$$

$$\lambda^3 : \kappa\left[y^T + \frac{1-a}{a}\left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} y^N\right] \geq d',$$

$$\lambda^4 : \mu\left[\kappa\left(y^T + \frac{1-a}{a}\left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} y^N\right) - d'\right] = 0,$$

$$\lambda^5 : \mu \geq 0,$$

$$\lambda^6 : \tau\frac{d'}{1+r} + \frac{1-a}{a}\left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} T = \frac{1-a}{a}\left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} g. \tag{32}$$

Note that the lump-sum tax appears only in (32), and the first order condition with respect to T requires $\lambda^6 = 0$, implying that the government budget constraint (32) is not binding and can be dropped from the constraint set of the government's problem. Furthermore, the capital control tax appears only in (31) after dropping (32), and the first order condition with respect to τ implies $\lambda^2 = 0$. Thus, (31) is not binding. The optimality conditions associated with the less constrained problem are as follows:

$$
\begin{aligned}
c^T &: u_T\left(c^T, y^N - g\right) - \lambda^1 + \left(\lambda^3 + \lambda^4 \mu\right) \kappa \frac{\partial p}{\partial c^T} y^N = 0 \\
d' &: \frac{\lambda^1}{1+r} = \beta E_{y^{T\prime}, y^{N\prime} | y^T, y^N} \lambda^{1\prime} + \lambda^3 + \lambda^4 \mu \\
g &: \frac{\partial u\left(c^T, y^N - g\right)}{\partial g} + \frac{\partial v\left(g\right)}{\partial g} + \left(\lambda^3 + \lambda^4 \mu\right) \kappa \frac{\partial p}{\partial g} y^N = 0 \\
\mu &: \lambda^4 \left[\kappa \left(y^T + \frac{1-a}{a} \left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} y^N\right) - d'\right] + \lambda^5 = 0 \\
\text{KT} &: \lambda^3 \left[\kappa \left(y^T + \frac{1-a}{a} \left(\frac{c^T}{y^N - g}\right)^{\frac{1}{\xi}} y^N\right) - d'\right] = 0 \\
\text{KT} &: \lambda^5 \mu = 0
\end{aligned}
$$

Given quantity, the capital control tax is backed out from (31) as

$$
\tau = 1 - (1+r) \frac{\mu + \beta E_{y^{T\prime}, y^{N\prime} | y^T, y^N} \left[\left(c'\right)^{\frac{1}{\xi} - \sigma} a \left(c^{T\prime}\right)^{-\frac{1}{\xi}}\right]}{c^{\frac{1}{\xi} - \sigma} a \left(c^T\right)^{-\frac{1}{\xi}}}.
$$

When the collateral constraint binds, the capital control tax τ and the households' shadow value of the collateral constraint μ are indeterminate, as documented by Schmitt-Grohé and Uribe (2017). We set $\tau = 0$ when the constraint binds, as in Bianchi (2011).

C Numerical Solution Method

We solve for the time-consistent optimal government spending policy without a capital control tax using a nested fixed-point algorithm described in Bianchi and Mendoza (2018) and Coulibaly (2023). The solution method consists of two loops. In the inner loop, value function iteration provides the value function and policy functions given future policies. Given these solutions, future policies are updated in the outer loop.

1. We generate a 100 equally-spaced discrete grid for the borrowing. We employ spline interpolation to evaluate functions outside the grid. We initialize the policy func-

tions $c^T\left(d, y^T, y^N\right)$ and $g\left(d, y^T, y^N\right)$, as well as the value function $V\left(d, y^T, y^N\right)$, with those obtained under the Samuelson rule with an optimal capital control tax. The same initial guess is used for future policies $C^T\left(d, y^T, y^N\right)$ and $G\left(d, y^T, y^N\right)$.

2. For each grid point we solve the government problem assuming that the collateral constraint is not binding. With $\mu = 0$, the problem is to solve the Bellman equation (18) subject to (19), (20) and (21), given future policies $C^T\left(d, y^T, y^N\right)$ and $G\left(d, y^T, y^N\right)$. We check whether (22) holds. If not, we solve the problem assuming the collateral constraint is binding. The problem is to solve the Bellman equation (18) subject to (19), (20), (21), (24) and (22) holding with equality, given future policies. We check the convergence of the value function. If the current and guessed value functions are not sufficiently close, we update the value function.

3. We compare the solutions from the inner loop, $c^T\left(d, y^T, y^N\right)$ and $g\left(d, y^T, y^N\right)$, with the guessed future policies, $C^T\left(d, y^T, y^N\right)$ and $G\left(d, y^T, y^N\right)$. If they are not sufficiently close, we update future policies and return to to the inner loop.

We solve for the equilibrium under each government spending policy with an optimal capital control tax using a standard value function iteration algorithm. To solve for the equilibrium under sub-optimal government spending policies without a capital control tax, we employ an Euler equation iteration algorithm.