Monetary Policy and Sovereign Risk in Emerging Economies (NK-Default)*

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Abstract

This paper develops a New Keynesian model with sovereign default risk. Inflation is set by forward-looking firms, monetary policy is an interest rate rule, and the fiscal government borrows externally, long-term, with an option to default. In this framework, default risk creates inflation pressures through an expectations channel, and tight monetary policy disincentivizes fiscal overborrowing. The model sheds light on temporary inflation events in emerging-market data: short-lived spikes in inflation, spreads, and domestic policy rates. As spreads rise, firms increase their prices in expectation of higher future inflation and low consumption during default. Monetary policy tightens, which reduces inflation and helps bring spreads down by disciplining government borrowing. These monetary-fiscal interactions imply that delivering the flexible prices allocation may not be optimal for monetary policy.

Keywords: sovereign default, inflation, open economy, New Keynesian theory
JEL classification: F34, F41, E52

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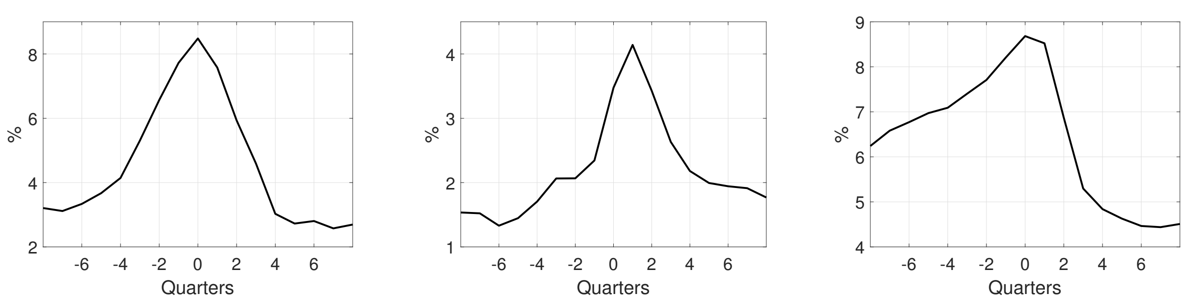
1 Introduction

Since the early 2000s, many central banks in emerging markets have successfully reduced inflation to single-digit levels and achieved policy independence from central governments. As in advanced economies, monetary policy in many emerging markets now largely consists of setting domestic nominal interest rates to target inflation. However, the open economy New Keynesian monetary model, a main toolkit for emerging market central banks, abstracts from sovereign risk, which is a major source of economic fluctuations in these countries. For example, the influential paper by Galí and Monacelli (2005) analyzes monetary policy under perfect financial markets. To bridge this gap, this paper presents a New Keynesian framework that integrates sovereign default and investigates the interplay between monetary policy and sovereign risk. Our findings indicate that sovereign risk affects not only real economic activity but also acts as a critical amplifier of inflation, and that monetary policy can discipline sovereign borrowing.

One motivation for our work is the empirical regularity that in emerging markets inflation comoves positively with sovereign risk. We illustrate this pattern in Figure 1, which shows the time path for inflation, sovereign spreads, and nominal rates during *inflation events*, for eight emerging market inflation targeters over the last two decades.[1] During these events, inflation temporarily rises about 4.5%, sovereign spreads increase by about 2.3%, and central banks increase nominal rates to combat inflation. Notably, the elevated inflation is only temporary, and all variables return to lower levels within approximately a year. We use our model to study these patterns in emerging-market data and perform counterfactual analyses to understand the role of default risk in shaping inflation dynamics and the impact of monetary policy on spreads.



(a) Inflation (b) Spread (c) Nominal Rate

Figure 1: Temporary Inflation Events

We develop a New Keynesian sovereign default framework (NK-Default) for a small open economy.

[1] The events are constructed with data from Brazil, Chile, Colombia, Mexico, Peru, the Philippines, Poland, and South Africa. Spreads are on dollar-denominated government bonds relative to U.S. bonds. Further information on the sample, variables, and construction of these events is in Section 4.1.

Inflation is determined by firms' forward-looking decisions subject to pricing frictions, monetary policy follows an interest rate rule that targets inflation, and the government chooses whether to repay its debt or default and how much to borrow at prices that compensate for default risk. In this framework, default risk creates inflation pressures and depresses consumption through an expectations channel, and tight monetary policy disincentivizes fiscal overborrowing. High default risk increases expected marginal utility and expected inflation because of the credit restrictions encoded in bond prices and because of productivity losses from default. Through such a change in expectations, a rise in default risk immediately produces higher inflation and lower consumption and output. Monetary policy, in turn, affects not only inflation, consumption, and output, but also alters borrowing incentives for the government and therefore default risk. Contractionary monetary policy reduces borrowing incentives because the resulting monetary distortions act as additional costs on government borrowing.

Our integrated *NK-Default* framework rationalizes emerging-market data, including dynamics and comovements of key macro variables and the temporary inflation events, and also sheds light on the drivers of inflation and sovereign spreads. Through counterfactual experiments, we determine that default risk accounts for about half of inflation volatility and show that monetary policy can be designed to reduce spreads substantially. Our framework provides support for the welfare benefits of monetary policy rules in the presence of default risk, across a wide range of robustness exercises.

Our small open economy model consists of households, firms, the monetary authority, and the government. Households value the consumption of foreign and domestic final goods. Consumption is determined through an intertemporal condition which responds to domestic interest rates, set by monetary policy, and to sovereign default risk, which changes expectations of future consumption. Households supply labor to firms which produce varieties of domestic intermediate goods and set their prices under monopolistic competition. The intermediate goods firms are subject to productivity shocks and face frictions in setting their prices, in the tradition of Rotemberg (1982). Final domestic goods firms are competitive and use intermediate goods varieties to produce domestic output, which is consumed by domestic households and exported to the rest of the world. The monetary authority sets a local currency nominal interest rate, using an interest rate rule subject to monetary policy shocks. Our baseline monetary rule responds to inflation deviations from target, but we also consider alternative rules. The government borrows internationally with long-term bonds denominated in foreign currency, decides whether to default, and transfers the proceeds from these credit operations to households. Default leads to a temporary exclusion from international financial markets and a reduction in productivity.[2] The price

[2]Although in our baseline model default leads to a reduction in productivity, we show that our results do not depend on this assumption but it allows for a tighter quantitative fit. In Section 5, we explore alternative costs of default, including cases without productivity losses, and find that our conclusions carry through.

of bonds compensates lenders for default risk, which increases with indebtedness. As in standard New Keynesian models, the interaction of monetary policy and firms' pricing frictions generates monetary distortions, which consist of deviations of inflation from target and inefficient levels of production. In our model, however, default risk also shapes real and nominal variables.

We identify two main monetary-fiscal interactions in our environment. First, default risk amplifies monetary distortions because it triggers expectations of high inflation and low consumption in the future. High expected inflation increases current inflation through the pricing decisions of firms, while low expected consumption lowers current consumption through households' intertemporal consumption-smoothing condition, resulting in depressed production. These endogenous costs highlight the significance of default risk for monetary outcomes, and we refer to this channel as *default amplification*. Second, tight monetary policy can reduce default risk, as monetary distortions tend to disincentivize government borrowing. The government internalizes the costs of default amplification for the economy and can relax the monetary distortions by reducing default risk. We show that monetary frictions induce wedges in the optimal borrowing condition of the sovereign, enforcing *monetary discipline* that results in lower borrowing and default risk in equilibrium. Lowering default risk is useful because, absent monetary frictions, sovereign default models with long-term debt exhibit overborrowing and excessively frequent costly defaults due to debt dilution forces: high levels of legacy debt increase borrowing incentives because the resulting decline in bond prices helps dilute the value of existing obligations.

We establish that monetary policy interacts with sovereign risk both theoretically, in simplified versions of our model, and quantitatively in our general model parameterized to emerging-market data. Our theoretical results isolate the default amplification and monetary discipline mechanisms in a tractable setting with preferences that are separable and quasi-linear in foreign goods consumption. We show that, if expectations of future marginal utility and inflation increase with debt, high default risk tends to increase current inflation and reduce output, which is our default amplification mechanism. We then analyze the consequences of monetary policy on default risk by studying a one-time deviation from a constrained efficient economy. The deviation involves monetary frictions and fiscal overborrowing. Here, we establish our disciplining result: tight monetary policy lowers default risk because the government can counter the increase in the monetary distortion by lowering borrowing and default risk. The disciplining result shows that the standard prescription for monetary policy to neutralize pricing frictions with a strict inflation targeting regime (which induces the flexible price allocation) is not optimal in our environment with default risk. In fact, our third theoretical result is that the constrained efficient outcome can be implemented by a monetary policy rule that targets default risk, as it can neutralize not only the overborrowing but also the pricing frictions.

For our quantitative results, we parameterize the NK-Default model to the data of 8 emerging market inflation targeters. Our model produces patterns for spreads, inflation, nominal domestic rates, output, and consumption that resemble this data. Importantly, the model replicates several untargeted business cycle moments, including the positive comovement of spreads with inflation, nominal rates, and inflation expectations. We also provide empirical evidence of the disciplining mechanism using panel data. By projecting sovereign spreads on monetary policy shocks recovered from estimated monetary policy rules, we find that contractionary monetary shocks lower sovereign spreads, consistent with the model's predictions.[3] We also confront our model with data from the temporary inflation events and find that it can replicate the paths of inflation, output, nominal rates, and spreads with a combination of low productivity shocks and expansionary monetary shocks. The fit of the model over these various dimensions provides support for its mechanisms and credibility for counterfactual analyses.

We perform counterfactual experiments to quantify our amplification and disciplining mechanisms by studying the impact of default risk on inflation outcomes and that of monetary policy on spreads. By comparing with a reference model without default, we find that default risk accounts for about 50% of both the inflation business cycle volatility and its increase during the inflation events. Monetary policy also influences spreads, in addition to other traditional macro outcomes. We find that during the inflation events, a 1% tighter monetary policy could have reduced spreads by about 0.3%. We also consider the effects of monetary policy rules relative to strict inflation targeting. We find that the baseline interest rate rule and one augmented to target default risk reduce mean spreads by 0.5% and 2.2%, respectively, reflecting the disciplining force.

We develop several extensions and show the robustness of our results. We consider the case of local currency sovereign debt and environments with alternative costs of default: one with loose monetary policy during defaults, one where default does not affect productivity, and an economy with domestic financial frictions shaped by nominal rates and sovereign spreads. We find strong monetary-fiscal interactions in all of these environments, default amplifies inflation volatility and tight monetary policy reduces spreads. When default does not affect productivity, high default risk continues to increase expected marginal utility, a key element for default amplification. Nevertheless, we find that productivity costs help with quantitative fit of the model, as is known from the sovereign debt literature.

Our results stress the disciplining properties of monetary policy rules for sovereign debt in environments with monetary commitment, as in the standard New Keynesian models. Using the extension with local currency debt, we also analyze monetary policy under discretion and confirm the disciplining benefits of rules for sovereign debt. With monetary discretion, policy has an inflationary incentive to

[3] In the estimated interest rate rules, policy rates react positively to inflation, in accordance with the statutory mandate of inflation-targeting central banks.

depress the real value of debt and, as expected, average inflation doubles. Importantly, discretion also doubles sovereign spreads.

Finally, we assess quantitatively the welfare implications of different monetary policy rules in the baseline model and in the extension economies. We compare welfare in economies under the baseline interest rule and the rule augmented to respond to default risk, relative to the strict inflation targeting regime. Welfare is higher with our baseline interest rate rule and even higher under the rule that responds to default risk. Under this default risk rule, the level of spreads and the volatility of spreads and inflation plummet, which are the sources of the welfare gains. We find similar rankings of monetary policy regimes across all extension economies. Strict inflation targeting is not the optimal monetary regime in economies with default risk. Monetary rules that are responsive enough to inflation or default risk discipline government borrowing and induce less default and higher welfare.

Related literature. Our project builds on two distinct strands of the literature on the macroeconomics of emerging markets: quantitative models of sovereign default and New Keynesian open economy theory. Our government's problem resembles the standard sovereign default model, in the tradition of Eaton and Gersovitz (1981), as in Aguiar and Gopinath (2006) and Arellano (2008) but with long-term debt, as in Hatchondo and Martinez (2009) and Chatterjee and Eyigungor (2012). We expand this framework to incorporate production, an import–export structure, and pricing frictions. Our domestic monetary environment is close to the workhorse framework of Galí and Monacelli (2005).[4] One methodological difference between our project and standard monetary models is that we use global methods rather than local approximations around the steady state to compute the model.

The literature on sovereign default has recently turned to questions raised by nominal rigidities. Several papers have considered environments with defaultable sovereign debt and downward rigidity of nominal wages. Na, Schmitt-Grohé, Uribe, and Yue (2018) first introduced this friction in a model of sovereign default and emphasized that exchange rate pegs are costly because they prevent devaluations that would adjust real wages to their efficient level. Optimal policy in their environment delivers the joint incidence of devaluations and defaults. Bianchi, Ottonello, and Presno (2023) study the role of downward rigidity of nominal wages for procyclical fiscal policies, which result from a tradeoff between fiscal policy stimulating demand and possibly increasing default risk.[5] Our project shares the emphasis in these papers on the interaction between sovereign risk and nominal rigidities but differs in important

[4] We follow Galí and Monacelli (2005) because they study the small open economy case, in contrast with prior work in a two-country setting, such as Obstfeld and Rogoff (1995) and Benigno and Benigno (2003).

[5] Other papers that have incorporated downward nominal wage rigidity and sovereign default risk include Bianchi and Mondragon (2022) which studies roll-over crises, De Ferra and Romei (2023) on monetary unions, Bianchi and Sosa-Padilla (2023) which considers the stabilizing role of reserves, and Roldán (2025) which emphasizes precautionary private sector behavior.

ways. First, price frictions in our model arise from optimal, forward-looking price-setting by firms, which results in a standard New Keynesian Phillips Curve, where expectations of future inflation matter for current inflation and output. These papers, in contrast, directly impose that nominal wages are downward rigid and abstract from the role of inflation expectations in affecting current inflation and output. Second, our modeling of monetary policy focuses on a positive theory that resembles the practice of central banks in many emerging markets, which set interest rates to target inflation.[6]

A large literature, following Calvo (1988), studies the incentives of governments to reduce the real value of debt denominated in local currency, by engineering higher-than-expected inflation. Aguiar, Amador, Farhi, and Gopinath (2013) analyze the tradeoffs generated by monetary policy credibility in a model of self-fulfilling default crises and show that credibility helps suppress self-fulfilling debt crises but hinders the benefits of state-contingent payments induced by inflation.[7] Hur, Kondo, and Perri (2018), Galli (2020), and Hurtado, Nuño, and Thomas (2023) build models with defaultable local currency debt and a discretionary choice of inflation, whereas Du, Pflueger, and Schreger (2020), Sunder-Plassmann (2020), and Engel and Park (2022) analyze how default and inflation incentives shape the composition of sovereign debt between local and foreign currency. In contrast to these papers, our baseline model focuses on the joint dynamics of endogenous inflation and sovereign risk, with a monetary authority that follows an interest rate rule and a sovereign who issues foreign currency debt, thus abstracting from the incentive to inflate away the debt. We revisit the case of local currency debt in one of the extensions of our framework and connect our mechanisms to the more familiar one of inflation diluting the value of the nominal debt. More recently, Maeng (2025) studies the currency composition of defaultable sovereign debt in a setting based on our NK-Default framework. Also related, Espino, Kozlowski, Martin, and Sanchez (2024) study monetary policy as arising from the classic incentive to finance fiscal deficits with seigniorage and its interactions with sovereign default risk also with foreign currency debt. We view this work as complementary to ours and important, especially for emerging markets that have not been able to achieve central bank independence.

An important result of our paper is that monetary policy can discipline the overborrowing incentive of the fiscal government. Aguiar, Amador, Hopenhayn, and Werning (2019) sharply illustrate that sovereign default models with long-term debt feature overborrowing, because of the debt dilution suffered by legacy lenders, and that the exclusive use of short-term debt can support the constrained efficient outcome. In this context, Hatchondo, Martinez, and Sosa-Padilla (2016) show that adding no-

[6]For the countries in our sample, the statutory objectives assigned by the legislature to central banks center on controlling inflation and are stated in their legal mandates and public statements of goals.

[7]Concerning the multiplicity of equilibria and the role inflation can play in selecting among them, Corsetti and Dedola (2016) focus on unconventional monetary policy, whereas Bacchetta, Perazzi, and Van Wincoop (2018) analyze how interest rate rules can be used to prevent the self-fulfilling crises in the environment of Lorenzoni and Werning (2019).

dilution covenants to long-term contracts can substantially improve outcomes. In our work, we show that monetary policy can provide an alternative avenue for disciplining. We find that, under certain conditions, it is possible to design a monetary policy rule that targets default risk so as to achieve the constrained efficient outcome.

The idea that monetary policy faces a tension between addressing pricing distortions and frictions in international financial markets, a thread running through our paper, is present in several classic New Keynesian open-economy studies. Corsetti, Dedola, and Leduc (2010), in the Handbook chapter, summarize that the lack of perfect international risk sharing has spillovers on domestic inflation and leads monetary policy to deviate from strict inflation targeting. With incomplete markets, firms' pricing decisions are shaped by inefficient consumption levels, even absent pricing frictions, and the monetary authority may choose to set policy to improve consumption even at the cost of inflation.[8]

Aoki, Benigno, and Kiyotaki (2021) study financial frictions in the banking sector and find an active role for both monetary policy and macroprudential policies. Related, Basu, Boz, Gopinath, Roch, Unsal, and Unsal (2023) consider the use of capital controls and foreign exchange interventions, and find that these are superior to interest rate policies, in response to shocks to external inflows. Itskhoki and Mukhin (2022) study the role of optimal monetary policy in fostering international risk sharing and find instead that, under certain conditions, a policy that pegs the exchange rate can address both frictions. In our work, we focus on financial frictions arising from sovereign default risk, which shape demand patterns as in previous work, but also impact expectations of inflation. In our context, an interest rate rule that targets default risk may address both the monetary frictions and overborrowing incentives.

Finally, our model's implications for exchange rates and international capital flows raise a natural comparison with the work on capital controls, exchange rates, and financial frictions in small open economies, such as Farhi and Werning (2016), Fanelli (2017), Devereux, Young, and Yu (2019), Itskhoki and Mukhin (2021), Ottonello (2021), and the handbook treatment in Bianchi and Lorenzoni (2022).

2 Model

We consider a small open economy consisting of households, final goods producers, intermediate goods producers, a monetary authority, and a government conducting fiscal policy. There are three types of goods: final domestic goods, domestic intermediate goods varieties, and foreign imported goods. The final good is produced using all varieties of differentiated intermediate goods, and it is consumed by both domestic and foreign households. Intermediate goods firms produce using labor and set prices in

[8] The analysis in the Handbook chapter draws on several primary sources, including Obstfeld and Rogoff (1995), Clarida, Galı, and Gertler (2002), Corsetti and Pesenti (2001, 2005), Benigno and Benigno (2003, 2006), and Devereux and Engel (2003).

local currency subject to price-setting frictions.[9]

Foreign demand for domestic goods (export demand) is given by

$$X_t = \left(\frac{P_t^d}{\varepsilon_t P_t^*}\right)^{-\rho} \xi,$$

where P_t^d is the price of domestic goods in local currency, P_t^* the price of foreign goods in foreign currency, ξ is the level of overall foreign demand, ρ is the export elasticity, and ε_t is the nominal exchange rate, domestic currency units per foreign currency unit. An increase in ε_t represents a depreciation of the home currency. We assume that the law of one price holds, so we can write the price of the foreign good in local currency as $P_t^f = \varepsilon_t P_t^*$. The terms of trade e_t equal

$$e_t = \frac{P_t^f}{P_t^d} = \frac{\varepsilon_t P_t^*}{P_t^d}. \tag{1}$$

Hence, the foreign demand for domestic goods is a constant elasticity function of the terms of trade and the level of overall foreign demand ξ:

$$X_t = e_t^{\rho} \xi. \tag{2}$$

We normalize the foreign price level P_t^* to one in all periods, thus abstracting from inflation dynamics abroad.

2.1 Households

Identical households consume domestic goods C_t, foreign goods C_t^f, and supply labor N_t. Their preferences are given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(C_t, C_t^f, N_t),$$

where $u(C_t, C_t^f, N_t)$ is the per-period utility function and β is the discount factor of households.

Households choose consumption, labor supply, and holdings of domestic bonds B_t^d, taking prices and policies as given. Domestic bonds are denominated in local currency and can only be traded by domestic households. Households own all domestic firms and receive their profits Ψ_t. They also earn labor income $W_t N_t$ and receive government transfers T_t. Their budget constraint is given by

$$P_t^d C_t + (1+\tau_f) P_t^f C_t^f + q_t^d B_{t+1}^d \leq W_t N_t + B_t^d + \Psi_t + T_t$$

where q_t^d is the nominal price of domestic discount bonds and τ_f is a constant tax on imports. We can

[9] Our sticky prices setup is a case of producer currency pricing (PCP), following Galí and Monacelli (2005).

characterize households' choices with the following optimality conditions:

$$-\frac{u_{N,t}}{u_{C,t}} = w_t, \tag{3}$$

$$\frac{u_{C^f,t}}{u_{C,t}} = (1+\tau_f)e_t, \tag{4}$$

$$u_{C,t} = i_t \beta \mathbb{E}_t \left[\frac{u_{C,t+1}}{\pi_{t+1}}\right]. \tag{5}$$

The real wage is $w_t = W_t/P_t^d$, the gross domestic goods inflation, hereafter *inflation*, is $\pi_t = P_t^d/P_{t-1}^d$, and the gross, nominal domestic interest rate is the yield of the discount bond price $i_t \equiv 1/q_t^d$.

2.2 Final Goods Producers

The final good Y_t is produced using a unit measure of differentiated intermediate goods y_{jt}, $j \in [0,1]$, under perfect competition, with $Y_t = \left[\int_0^1 y_{jt}^{\frac{\eta-1}{\eta}} dj\right]^{\frac{\eta}{\eta-1}}$, where η is the elasticity of substitution between intermediate goods. The problem of the final goods producers yields the standard demand schedule

$$y_{jt} = \left(\frac{p_{jt}}{P_t^d}\right)^{-\eta} Y_t, \tag{6}$$

where p_{jt} is the price of intermediate good j at time t. The price of domestic goods P_t^d is the price index $P_t^d = \left[\int_0^1 p_{jt}^{1-\eta} dj\right]^{\frac{1}{1-\eta}}$.

2.3 Intermediate Goods Producers

Each differentiated intermediate good is produced with labor n_{jt}, using a constant return to scale production function, given productivity z_t:

$$y_{jt} = z_t n_{jt} \tag{7}$$

Productivity depends on an aggregate shock, $\tilde{z}_t$, and the credit standing of the government in international markets, Θ_t, such that $z_t = z(\tilde{z}_t, \Theta_t)$. As discussed shortly, when credit standing is good, productivity is equal to the shock; when credit standing is bad, productivity is lower.[10]

Intermediate goods firms are monopolistically competitive and set the prices of their products, taking as given the demand schedule (6). These firms face price-setting frictions in that they have to pay a quadratic adjustment cost when they do not increase their prices at the inflation rate $\overline{\pi}$, as in Rotemberg

[10] This assumption is motivated by the evidence that sovereign defaults result in reductions in output and productivity, as documented in Bai and Zhang (2012), Mendoza and Yue (2012), Hébert and Schreger (2017), and Arellano, Bai, and Bocola (2020). We explore alternative costs of default in Section 5.2, including a case without productivity costs and one where costs arise endogenously from domestic financial frictions.

(1982). Taking as given the nominal wage W_t and the final good price P^d_t, an intermediate firm j chooses labor and its price to maximize the present discounted value of profits,

$$\max_{\{n_{jt}, p_{jt}\}} \mathbb{E}_0 \sum_t Q_{t,0} \left\{ p_{jt} y_{jt} - (1-\tau) W_t n_{jt} - \frac{\varphi}{2} \left(\frac{p_{jt}}{p_{jt-1}} - \overline{\pi} \right)^2 P^d_t Y_t \right\},$$

subject to the production function (7). Firms discount profits using the stochastic discount factor of households, $Q_{t,0} = \beta^t \frac{u_{C,t} P^d_0}{u_{C,0} P^d_t}$, and receive a labor subsidy τ. The first-order condition for each firm, after imposing symmetry across all firms ($p_{jt} = P^d_t$), results in

$$(1-\tau) \frac{w_t}{z_t} = \frac{\eta - 1}{\eta} + \frac{1}{\eta} \left\{ \varphi \left(\pi_t - \overline{\pi} \right) \pi_t - \mathbb{E}_t \left[\beta \frac{Y_{t+1}}{Y_t} \frac{u_{C,t+1}}{u_{C,t}} \varphi \left(\pi_{t+1} - \overline{\pi} \right) \pi_{t+1} \right] \right\}. \tag{8}$$

This equation is a standard New Keynesian Phillips Curve (NKPC) that relates inflation to a measure of contemporaneous unit cost, $(1-\tau) w_t / z_t$, and expected inflation valued by marginal utility next period.

2.4 Government and External Debt

The government borrows internationally by issuing long-term bonds denominated in foreign currency, with an option to default. To keep long-term debt tractable, we employ the maturity structure used by Hatchondo and Martinez (2009) and Chatterjee and Eyigungor (2012). The bond is a perpetuity that specifies a price q_t and a quantity ℓ_t such that the government receives $q_t \ell_t$ units of foreign currency in period t. In the following period, a fraction δ of the debt matures, and the government's debt is the sum of legacy debt that has not matured $(1-\delta) B_t$ and the new issuance ℓ_t such that $B_{t+1} = (1-\delta) B_t + \ell_t$. Each unit of outstanding bonds calls for a payment every period of $r + \delta$.[11]

The government can default on its debt and, depending on its default history, it is in good or bad credit standing, which is recorded by Θ_t. When the government services its debt, $D_t = 0$, credit standing is good $\Theta_t = 0$, and the government can borrow and decide on the level of debt next period B_{t+1}. When the government instead chooses to default, $D_t = 1$, it avoids the debt payments but suffers a direct utility cost ν_t and a temporary bad credit standing, $\Theta_t = 1$. The utility costs ν_t are i.i.d. enforcement shocks. While in bad credit standing, the government loses access to financial markets and the productivity of domestic intermediate goods producers is depressed $z(\tilde{z}_t, \Theta_t = 1) \leq \tilde{z}_t$. Good credit standing is regained with probability ι, at which point the government reenters financial markets with no outstanding debt.

The government transfers to households the proceeds resulting from its trades in international financial markets, T_t. Conditional on having a good credit standing and repaying the debt, the government's

[11] Note that with this structure, the default-free bond price is equal to 1.

budget constraint in local currency is

$$T_t + \tau W_t N_t = \varepsilon_t \left[q_t (B_{t+1} - (1-\delta)B_t) - (r+\delta)B_t \right] + \tau_f P_t^f C_t^f, \tag{9}$$

where the net capital inflow from debt operations is multiplied by the nominal exchange rate ε_t to convert it to domestic currency. When the government is in bad credit standing, its budget constraint has $B_t = B_{t+1} = 0$. The constant tax rates for labor and foreign goods consumption, τ and τ_f, are set as in standard New Keynesian models to correct the markup in goods markets (Rotemberg and Woodford, 1999) and allow for a static optimal tariff on imports in steady state, such that $1 - \tau = \frac{\eta - 1}{\eta}$ and $1 + \tau_f = \frac{\rho}{\rho - 1}$. Using the definition of the terms of trade (1), the government budget constraint in units of domestic goods is

$$t_t + \tau w_t N_t = e_t[q_t(B_{t+1} - (1-\delta)B_t) - (r+\delta)B_t] + \tau_f e_t C_t^f.$$

The government's objective is to maximize the present discounted value of the flow utility derived from consumption and labor by households, $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta_g^t u(C_t, C_t^f, N_t)$. The government's discount factor β_g can differ, in general, from that of households, β. The government borrows from competitive, risk-neutral international lenders discounting the future at a foreign currency rate r. The bond price is such that they break even in expectation, thus receiving compensation for any expected losses from default:

$$q_t = \frac{1}{1+r} \mathbb{E}_t \left[(1 - D_{t+1})(r + \delta + (1-\delta) q_{t+1}) \right].$$

In states where the government does not default $D_{t+1} = 0$, each unit of the bond pays $r + \delta$ and the $1 - \delta$ fraction, that does not mature and remains outstanding next period, has market value $(1-\delta)q_{t+1}$. In states in which the government defaults, the associated payoff for lenders is zero. We define the government spread as the difference between the yield-to-maturity of the bond and the international rate r, such that

$$\text{spread}_t = (r+\delta)\left(\frac{1}{q_t} - 1\right).$$

We let $\Phi_t = \mathbb{E}_t D_{t+1}$ denote the one-period-ahead probability of default.

2.5 The Monetary Authority

The monetary authority sets policy according to an interest rate rule. In our baseline inflation targeting regime, the nominal interest rate rule targets domestic goods inflation. The nominal domestic rate i_t depends on a long-run value $\bar{i}$, responds to the deviation of inflation from target, π_t relative to $\overline{\pi}$, and is subject to monetary shocks m_t

$$i_t = \bar{i} \left(\frac{\pi_t}{\overline{\pi}}\right)^{\alpha_P} m_t, \tag{10}$$

with $\alpha_P > 1$.

In the analysis that follows, we will also consider a strict inflation targeting regime, under which the monetary authority sets the nominal rate to keep inflation on target at all times, $\pi_t = \overline{\pi}$, a default risk targeting regime, under which monetary policy employs a rule which reacts to the default risk Φ_t directly, and a case of discretionary monetary policy.

2.6 Equilibrium

We consider a Markov Perfect Equilibrium, where the government takes into account how its default and borrowing policies affect the allocation of the domestic private economy and the monetary authority's response, now and in the future. The exogenous states are the productivity and monetary shocks, $s = \{\tilde{z}, m\}$, and the enforcement shock, ν. The endogenous states for the private and monetary equilibrium are the level of debt B, the credit standing Θ, and borrowing B'. Recall that the government chooses borrowing B' only when it has good credit.

When the government enters the period with good credit standing $\Theta_{-1} = 0$ and debt B, it chooses whether to default or repay the debt. The default decision determines the end-of-the-period credit standing Θ. If it enters the period with bad credit $\Theta_{-1} = 1$, the government draws a random variable Λ following a Bernoulli distribution. With probability ι, $\Lambda = 1$ and the government regains good credit $\Theta = 0$ if it chooses not to immediately default again. The evolution of credit standing is given by

$$H_\Theta(s, \nu, B, \Theta_{-1}) = \begin{cases} 0 & \text{if } (\Theta_{-1} = 0 \text{ and } D = 0) \text{ or} \\ & \quad (\Theta_{-1} = 1 \text{ and } \Lambda = 1 \text{ and } D = 0) \\ 1 & \text{otherwise} . \end{cases} \tag{11}$$

The private and monetary equilibrium, which we label $\Xi(S)$, depends on the shocks, the debt B, the credit standing Θ, and the government's borrowing choice B', because these variables affect government transfers and productivity in the current period. Let $S = \{s, B, \Theta, B'\}$ be the end-of-period state. The private and monetary equilibrium also depends on the government's equilibrium policy functions for default $D' = H_D(s', \nu', B')$, borrowing $B'' = H_B(s', B')$, and the corresponding credit standing $\Theta' = H_\Theta(s', \nu', B', \Theta)$, because of the forward-looking nature of the equilibrium.

Definition 1 (Private and Monetary Equilibrium)**.** *Given state S, the government policy functions for default $H_D(s', \nu', B')$, borrowing $H_B(s', B')$, credit standing $H_\Theta(s', \nu', B', \Theta)$, and the transfer function $t(S)$ consistent* *with the government budget constraint, the symmetric private and monetary equilibrium $\Xi(S)$ consists of*

- *Households' policies for domestic goods consumption $C(S)$, foreign goods consumption $C^f(S)$, labor $N(S)$, and domestic debt $B^d(S)$,*
- *Intermediate and final goods firms' policies for employment $n(S)$, inflation $\pi(S)$, final domestic goods output $Y(S)$, and exports $X(S)$,*
- *The wage $w(S)$, nominal domestic rate $i(S)$, and the terms of trade $e(S)$*

such that: (i) *the policies for households satisfy their budget constraint and optimality conditions (3), (4), (5);* (ii) *the policies of intermediate and final goods firms satisfy their optimization problem (6), (7), and (8);* (iii) *export demand (2) is satisfied;* (iv) *the nominal domestic rate satisfies the monetary authority's interest rate rule (10); and* (v) *labor, domestic goods, and domestic bond markets clear, and the balance of payments condition is satisfied.*

The labor market clears, with firms' labor demand equal to the labor supplied by households $n = N$. Domestic bonds are in zero net supply in the economy, reflected in the market clearing condition $B^d = 0$. The resource constraint for domestic goods requires that domestic final goods output equals domestic consumption plus exports and the pricing adjustment costs,

$$C(S) + X(S) + \frac{\varphi}{2}(\pi - \overline{\pi})^2 Y(S) = Y(S) \tag{12}$$

where aggregate output is given by $Y(S) = z(\tilde{z}, \Theta)\, N(S)$.

The Balance of Payments condition requires that net imports equal net capital inflows, which here equal the government transfer plus the labor subsidy,

$$e(S)C^f(S)(1+\tau_f) - X(S) = t(S) + \tau w(S)N(S). \tag{13}$$

The presence of price rigidities leads to inefficient use of labor, as monopolistic firms set time-varying markups. We use a *monetary wedge* to measure these distortions in production, defined as

$$1 + \text{monetary wedge} \equiv \frac{z(\tilde{z},\Theta)}{w(S)} = -\frac{z(\tilde{z},\Theta)u_C(S)}{u_N(S)}. \tag{14}$$

This wedge captures deviations from production efficiency and depends on the dynamics of current and future inflation, as seen in the NKPC equation (8). Production efficiency requires the marginal product of labor, z, to be equalized to households' marginal rate of substitution between labor and consumption, $\frac{-u_N}{u_C}$.

2.7 Government Recursive Formulation

We employ the following recursive formulation for the government's problem. The bond price $q(s, B')$ compensates lenders for default risk. It depends on the shocks s and the borrowing level B', because these affect future default probabilities. The bond price schedule which satisfies the break-even condition for lenders depends on the policy functions of the government for default, $H_D(s', \nu', B')$, and borrowing, $H_B(s', B')$, as follows

$$q(s, B') = \frac{1}{1+r}\mathbb{E}\left[(1 - H_D(s', \nu', B'))(r + \delta + (1 - \delta)q(s', H_B(s', B'))\right]. \tag{15}$$

Let $V(s, \nu, B)$ be the value to the government, including the option to default, such that

$$V(s, \nu, B) = \max_{D \in \{0,1\}} \left\{(1 - D)W(s, B) + D\left[W^d(s) - \nu\right]\right\}, \tag{16}$$

where $W(s, B)$ is the value under debt repayment and $W^d(s) - \nu$ is the value from defaulting, inclusive of the enforcement shock ν. The value of repaying is

$$W(s, B) = \max_{B'} \left\{u(C, C^f, N) + \beta_g \mathbb{E} V(s', \nu', B')\right\}$$

subject to the private and monetary equilibrium $\Xi(S)$ with $S = \{s, B, \Theta = 0, B'\}$ and the bond price schedule (15). The defaulting value W^d net of the enforcement cost is given by

$$W^d(s) = u(C, C^f, N) + \beta_g \mathbb{E}\left[\iota V(s', \nu', B' = 0) + (1 - \iota)W^d(s')\right]$$

subject to the private and monetary equilibrium $\Xi(S)$ with $S = \{s, B = 0, \Theta = 1, B' = 0\}$. Once in default, the government regains access to the international financial markets with probability ι, without outstanding debt. The conditions for the private and monetary equilibrium are collected in Appendix A.1.

It is helpful to express the default decision of the government as a cutoff rule based on the enforcement shock ν. Given the i.i.d. nature of the enforcement shock, the default decision $D(s, \nu, B)$ can be characterized by a cutoff level $\hat{\nu}(s, B)$, at which the repayment value is equal to the default payoff, such that

$$\hat{\nu}(s, B) = W^d(s) - W(s, B),$$

and the sovereign is indifferent between the two options. Then $D(s, \nu, B) = 1$ whenever $\nu \leq \hat{\nu}(s, B)$ and zero otherwise. Let F_ν be the cumulative distribution function of ν, so that the default probability equals

$\Phi(s, B') = \mathbb{E}_{s'|s} F_\nu(\hat{v}(s', B'))$.

We can now define the recursive equilibrium of the economy.

Definition 2 (Equilibrium)**.** *Given the aggregate state $\{s, \nu, B\}$, a recursive equilibrium consists of government policies for default $D(s, \nu, B)$ and borrowing $B'(s, B)$, and government value functions $V(s, \nu, B)$, $W(s, B)$, and $W^d(s)$, such that*

- *Taking as given future policy and value functions, $H_D(s', \nu', B')$, $H_B(s', B')$, $V(s', \nu', B')$, $W(s', B')$, and $W^d(s')$, government policies for default and borrowing and value functions solve its optimization problem.*
- *Government policies and values are consistent with future policies and values.*

2.8 Government Borrowing

We illustrate the forces shaping debt accumulation, by deriving the government's optimality condition for borrowing, assuming that all functions in the government problem are differentiable.[12] Optimal borrowing satisfies the following Euler equation

$$u_{Cf}\left[q + \frac{dq}{dB'}\left(B' - (1-\delta)B\right)\right](1 - \tau_m^X) - \tau_m^C = \beta_g \mathbb{E}(1 - D')u'_{Cf}\left[r + \delta + (1-\delta)q'\right]\left(1 - \tau_m^{X\prime}\right), \qquad (17)$$

which relates the marginal utility of foreign goods consumption across periods to the bond price schedule $q(s, B')$, future default and borrowing decisions D' and B'', future bond prices q', and the borrowing wedges τ_m^X and τ_m^C. Appendix A.2 contains a detailed derivation of this equation.

The borrowing wedges τ_m^X and τ_m^C arise exclusively due to monetary frictions and reflect the Lagrange multipliers associated with the NKPC and domestic Euler equations in the government's problem. Without pricing frictions, these wedges are zero. These wedges depend on B' and are present in this Euler equation because the government internalizes the consequences of its borrowing and default decisions on monetary frictions.

Equation (17) reflects three major forces. The first is the incentive to smooth and tilt the time path of foreign goods consumption. This force is present in standard models without default risk, like Galí and Monacelli (2005), which exhibit the following undistorted international Euler equation

$$q\, u_{Cf} = \beta_g \mathbb{E}\, u'_{Cf}\left[r + \delta + (1-\delta)q'\right]. \qquad (18)$$

Absent financial frictions, borrowing only smooths the marginal utility of foreign goods consumption against shocks and achieves the right tilting of consumption over time, given q and β_g.

[12] We do not require this assumption for the computation of the model, nor do we employ the Euler equation derived in this section for the numerical implementation.

The second force affecting borrowing in our model is the endogenous bond price schedule q and the presence of legacy long-term debt $(1-\delta)B$, as emphasized by Aguiar et al. (2019). Bond prices decrease with borrowing due to the increased risk of default, $\frac{\partial q}{\partial B'} \leq 0$, and a higher legacy debt $(1-\delta)B$ incentivizes borrowing because lower prices dilute this debt, $-\frac{\partial q}{\partial B'}(1-\delta)B \geq 0$. Moreover, with long-term debt the government rolls over only a fraction of debt and therefore has less incentives to reduce debt to secure a higher price for the new issuance. Such debt dilution leads to *overborrowing*, as established by Hatchondo et al. (2016). A lower discount for the government, $\beta_g < \beta$, also leads to overborrowing, as discussed by Aguiar, Amador, and Fourakis (2020).[13]

The third force works through the borrowing wedges τ_m^X and τ_m^C and it is unique to our model with sovereign risk and monetary frictions. Positive borrowing wedges lower incentives to borrow. These wedges tend to be positive when the expected marginal utility and the valuation of expected inflation are high, because, as shown in the Appendix, the wedges increase with the multipliers on the domestic Euler equation and the NKPC. Government borrowing tends to increase expected marginal utility because servicing higher debt under the credit restrictions implied by the bond price schedule depresses consumption. Through the Euler equation, this leads to a decrease in current consumption, increasing the monetary wedge. Higher borrowing also increases the valuation of expected inflation because the high inflation occurs in low productivity states and becomes more heavily weighed with higher marginal utility, given especially unfavorable bond prices in such states. Higher borrowing increases expected inflation also because of a higher probability of a default, which comes with low productivity and higher inflation. In response, the NKPC calls for increases in current inflation. These extra costs from borrowing in the form of worse monetary frictions are reflected in the borrowing wedges. Importantly, borrowing wedges may nevertheless improve allocations in our model because of overborrowing from dilution and lower discount factors. In the next section, we provide a sharper characterization of these interactions between monetary frictions and default risk in a simplified environment.

3 Theoretical Characterizations

This section characterizes the interactions between monetary frictions and default risk in a tractable version of our framework and presents our two main mechanisms, default amplification and monetary discipline. We show that default risk worsens monetary distortions by increasing inflation and monetary wedges. This occurs through an expectation channel, as high default risk increases the expectations of future inflation and depressed consumption, which feed into current outcomes through the Euler

[13] Cuadra and Sapriza (2008) and Hatchondo, Martinez, and Sapriza (2009) motivate such discounting as arising from political turnover.

equation and the NKPC. Tight monetary policy, in turn, can discipline the government's borrowing and lower default risk by affecting monetary frictions. We relegate all proofs to Appendix B.

3.1 Default Amplification

To show why high default risk tends to increase inflation and induce inefficiently low production, we revisit the key equilibrium NKPC pricing condition

$$(\pi - \overline{\pi})\,\pi = \frac{\eta - 1}{\varphi}\left(-\frac{u_N}{z u_C} - 1\right) + \frac{\beta}{Y u_C}\,\mathbb{E}\left(Y'\,u'_C\left(\pi' - \overline{\pi}\right)\pi'\right), \tag{19}$$

where primes ($'$) mark future variables. Inflation increases whenever future expected inflation π' or the marginal utility of consumption u'_C are high, or when the monetary wedge is low (i.e., $-u_N/zu_C$ is high).[14] Default risk impacts inflation by affecting these three main terms. Recall that, during a default event, productivity is reduced, which implies that inflation is high and consumption is low. Hence, if the risk of a default next period is high, expectations for future inflation and the marginal utility of consumption are high, which increase the expectation term on the right-hand side of the NKPC. Such an *expectation channel* from default risk gives firms incentives to increase their prices now, raising current inflation.

In response to these inflationary pressures, the monetary policy rule calls for higher interest rates and tight monetary policy. These high nominal domestic rates, however, depress consumption through the domestic Euler equation

$$u_C = i\beta\,\mathbb{E}\frac{u'_C}{\pi'}. \tag{20}$$

In turn, low domestic consumption tends to reduce production and increase the monetary wedge. All in all, high default risk can result in high inflation and monetary wedges, and tight monetary policy. We call this effect *default amplification*.[15]

To characterize formally the default amplification mechanism, we simplify the model by assuming that preferences are quasi-linear in foreign goods consumption and are given by

$$u(C, C^f, N) = \log C + C^f - \frac{N^{1+1/\zeta}}{1+1/\zeta}. \tag{21}$$

Under these preferences, the consumption of foreign goods fully adjusts to accommodate net capital inflows from debt operations. We evaluate the responses of the model to an increase in default risk

[14] We find that u'_C and Y' tend to move in opposite directions but that the net effect is dominated by the marginal utility term. Also, the covariance between $Y'u'_C$ and π' tends to be positive.

[15] We thank Luigi Bocola for his insightful discussion which led to much of this analysis.

$\mathbb{E}_{s'|s}F_\nu(\hat{\nu}(s',B'))$ from higher government borrowing B'. Higher borrowing affects the rest of the private and monetary equilibrium only through its impact on default risk and the expectation channels: high default risk is reflected in the expectation terms in the NKPC (19) and the domestic Euler equation (20). Let functions $F(s,B',\Theta)$ and $M(s,B',\Theta)$ encode these expectations, with

$$F(s,B',\Theta) = \mathbb{E}\left[z(\tilde{z},'\Theta')N(S')u_C(S')\left(\pi(S')-\overline{\pi}\right)\pi(S')\right], \tag{22}$$

$$M(s,B',\Theta) = \mathbb{E}\frac{u_C(S')}{\pi(S')}, \tag{23}$$

where the future state $S' = (s',B',H_\Theta(s',\nu',B',\Theta),H_B(s',B'))$ depends on the future government policies and the evolution of credit standing. We assume that the functions $F(s,B',\Theta)$ and $M(s,B',\Theta)$, which the government takes as given, are differentiable and increase with borrowing, and then analyze how changes in borrowing affect the equilibrium using a first-order Taylor expansion.

Assumption 1 (Expectation Terms)**.** *$\partial F(s,B',\Theta)/\partial B' \geq 0$ and $\partial M(s,B',\Theta)/\partial B' \geq 0$, and the parameters satisfy the restriction $a_0 \geq (\partial M(s,B',\Theta)/\partial B')/(\partial F(s,B',\Theta)/\partial B')$, with $a_0 = \varphi/\left[(\eta-1)(1+(\alpha_c+\rho(1-\alpha_c))/\zeta)\beta\bar{i}\overline{\pi}\right]$, where α_c is the share of domestic consumption in output at the approximating point for the Taylor expansion.*

These assumptions ensure that expected inflation and the marginal utility of consumption rise with default risk as B' increases. These properties, which also hold in our full quantitative model, feed through the equilibrium and affect current allocations and prices. The following proposition characterizes, up to first-order, the effects on default risk, inflation, the nominal domestic rate, and the monetary wedge from increased borrowing under Assumption 1, preferences given by (21), and when inflation is close to target.

Proposition 1 (Amplification)**.** *Higher borrowing increases default risk, inflation, the nominal domestic rate, and the monetary wedge.*

Borrowing more increases default risk, which in turn affects current inflation and the monetary wedge. High default risk increases expectations of future inflation and marginal utility. Given the stance of monetary policy, the NKPC calls for an increase in current inflation and the domestic Euler equation calls for a decline in current consumption, which increases the monetary wedge. The interest rate rule, in turn, increases the nominal domestic rate, and this monetary policy response dampens the increase in inflation but amplifies the increase in the monetary wedge.

This amplification effect of government borrowing on inflation and the monetary wedge in Proposition 1 depends crucially on the presence of default risk. In our simplified setup here, with quasi-linear preferences, if there were no default risk higher borrowing would have no effect on inflation, the nominal domestic rate, domestic consumption, or output. In the general model, however, with concave and non-separable preferences over domestic and imported consumption, government borrowing directly affects future consumption, even conditional on repayment. Default risk generates endogenous borrowing limits and an elastic bond price schedule that further restricts future borrowing capacity. Higher current borrowing therefore reduces future consumption due to these tighter borrowing constraints, causing the expected marginal utility to rise, which makes functions M and F increase in B'. We examine next how monetary policy interacts with the government's borrowing incentives before presenting these results quantitatively.

3.2 Monetary Discipline

In our framework, not only does default risk amplify monetary frictions, but monetary frictions in turn affect government borrowing and default choices. In particular, tight monetary policy reduces the government's borrowing incentives and lowers default risk. We call this mechanism *monetary discipline*. We further simplify the model, to characterize this mechanism precisely. We alter our environment such that our main frictions—namely pricing frictions and overborrowing incentives—are only present in period 0, while from period 1 onward the economy's equilibrium is constrained efficient. We analyze the effects of different monetary policies in period 0 on monetary wedges and default risk, show that strict inflation targeting will not be optimal, and provide an alternative monetary policy rule that can approach arbitrarily close the constrained efficient outcome.

To set up the constrained efficient economy for periods $t \geq 1$, we restrict attention to the case of short-term debt $\delta = 1$ and a government as patient as households, $\beta_g = \beta$. The monetary authority eliminates any pricing frictions by setting nominal rates to deliver stable inflation at $\overline{\pi}$ for periods $t \geq 1$. In contrast, in period 0 we assume that $\beta_g < \beta$, which induces overborrowing, and monetary policy is given by a set nominal rate i. We abstract from productivity shocks, $z_t = \overline{z}$ for any t, although default continues to reduce productivity, $z_d \leq \overline{z}$, and, for tractability, we assume the exclusion from international financial markets caused by default is permanent. Default involves an enforcement shock ν with a cumulative distribution function F_ν and hazard function $h(\nu)$, which we assume is strictly increasing. These assumptions allow us to analyze the effects of a *one-time deviation* from a constraint-efficient environment. The following assumption summarizes the settings for this case:

Assumption 2 (One-time Deviation)**.** *For $t \geq 1$, the fiscal government is as patient as the household $\beta_g = \beta$ and the monetary authority implements strict inflation targeting, $\pi_t = \overline{\pi}$. In period 0, the government is less patient than households $\beta_g < \beta$ and the monetary authority sets the domestic nominal rate to a level i. Absent* *default, productivity is constant $z_t = \bar{z}$. Debt is short-term $\delta = 1$, financial market exclusion is permanent $\iota = 0$, the hazard function of the enforcement shock $h(\nu)$ is increasing in ν, and preferences are given by (21).*

Before analyzing policy options during the one-time deviation, we characterize the problem from $t \geq 1$ onward. In this reference model, pricing frictions are neutralized, and the government borrows and defaults in a constrained efficient manner. For this analysis, we rely on Aguiar et al. (2019), which characterizes constrained efficient borrowing in a sovereign default model and shows that it can be implemented with standard, defaultable short-term bonds. We therefore label this reference economy *constrained efficient*.

The constrained efficient economy. In this economy, the consumption-labor choices are undistorted, and monetary wedges are zero in all states. This implies that inflation is always at target and pricing frictions are neutralized. Furthermore, debt, borrowing, and default do not affect the optimal allocations for domestic consumption, labor, and terms of trade, $C^\star$, $N^\star$, and $e^\star$, which satisfy the following three equations,

$$\begin{aligned} C^\star + e^{\star\rho} &= \bar{z}N^\star \\ C^\star &= \frac{\rho}{\rho-1}e^\star \\ N^{\star 1/\zeta}C^\star &= \bar{z}. \end{aligned}$$

We can substitute these into the utility function and define $u^\star \equiv \log C^\star - \frac{(N^\star)^{1+1/\zeta}}{1+1/\zeta} + (e^\star)^{\rho-1}$. The government's problem for the constrained efficient economy reduces to

$$W(B) = \max_{B'} \; u^\star - (1+r)B + q(B')B' + \beta\left\{\left[1 - F_\nu(\hat{\nu}(B'))\right] W(B') + \int^{\hat{\nu}(B')} (W^d - \nu)dF_\nu(\nu)\right\} \tag{24}$$

subject to the bond price function $q(B') = 1 - F_\nu(\hat{\nu}(B'))$, and where the default cutoff $\hat{\nu}(B')$ satisfies $\hat{\nu}(B) = W^d - W(B)$.

The default value W^d is the present value of permanent financial autarky $W^d = u(C_d, C_d^f, N_d)/(1-\beta)$ subject to the resource constraint $C_d + e_d^\rho = z_d N_d$ and the balanced trade condition $e_d^\rho = e_d C_d^f$.

The optimal borrowing in the constrained efficient economy satisfies the following Euler equation

$$1 - h(\hat{\nu}(B^\star))B^\star = \beta(1+r). \tag{25}$$

and borrowing is at the constrained efficient level $B^\star$. Let $\Phi^\star \equiv F_\nu(\hat{\nu}(B^\star))$ be the equilibrium default risk in the constrained efficient economy.

To implement the inflation target $\overline{\pi}$, the nominal rate in the constrained efficient economy, $i^\star$, satisfies the domestic Euler equation,

$$\frac{1}{C^\star} = \beta \frac{i^\star}{\overline{\pi}} \left[\frac{1-\Phi^\star}{C^\star} + \frac{\Phi^\star}{C_d} \right].$$

These constrained efficient outcomes prevail for all $t \geq 1$.[16] These allocations matter for the economy in period 0 because of the expectation terms in the NKPC, the Euler equation, the bond price function, as well as the continuation utility.

A one-time deviation. We now study a one-time deviation from constrained efficiency. Recall that in period 0 monetary policy is given by the interest rate i and the government has a lower discount factor $\beta_g < \beta$. Inflation may deviate from the target, as called for the NKPC condition. In period 0, conditional on not defaulting, the government solves the following problem:

$$\max_{B',C,C^f,N} \; u(C, C^f, N) + \beta_g \left\{ \left[1 - F_\nu(\hat{\nu}(B'))\right] W(B') + \int^{\hat{\nu}(B')} (W^d - \nu) dF_\nu(\nu) \right\} \tag{26}$$

subject to the private equilibrium conditions, the bond price function, and monetary policy i which are summarized by:

$$\begin{aligned}
C + e^\rho &= \left[1 - \frac{\varphi}{2}\left(\pi - \overline{\pi}\right)^2\right] zN && \text{(resource constraint)} \\
e^\rho &= e\left[C^f + (1+r)B - q(B')B'\right] && \text{(balance payments)} \\
C &= \frac{\rho}{\rho - 1} e && \text{(intra } C - C^f\text{)} \\
-\frac{u_N}{z u_C} &= 1 + \frac{1}{\eta - 1}\varphi\left(\pi - \overline{\pi}\right)\pi && \text{(NKPC)} \\
\frac{1}{C} &= \frac{\beta i}{\overline{\pi}} \mathbb{E} u_{C'}(B') = \frac{\beta i}{\overline{\pi}} \left[\frac{1 - F_\nu(\hat{\nu}(B'))}{C^\star} + \frac{F_\nu(\hat{\nu}(B'))}{C_d} \right] && \text{(domestic Euler)} \\
q(B') &= 1 - F_\nu(\hat{\nu}(B')). && \text{(bond price)}
\end{aligned}$$

The expectation terms of this problem are those arising from the constrained efficient problem. The NKPC condition above reflects the fact that in period $t = 1$ and onward $\pi = \overline{\pi}$; the expected marginal utility $\mathbb{E} u_{C'}(B')$ is the weighted average of marginal utility of future consumption without default $C^\star$ and in default C_d; the bond price function and the expected marginal utility use the cutoff function $\hat{\nu}$ for an arbitrary state B'; and the continuation value function is also that of the constrained efficient problem for an arbitrary state.[17] Unlike the case of the constrained efficient economy, the private equilibrium now

[16] See Appendix B.2 for a detailed characterization of the constrained efficient allocations.

[17] With some abuse of notation, in equations (resource constraint) through (bond price), we highlight the Markov aspect of the problem. The future functions are written for arbitrary B' and are viewed as functions for the government. Of course, all

depends on borrowing and default risk, through the expectations of terms that enter into the domestic Euler equation and bond price function.

We are now ready to characterize the way in which monetary policy, the nominal rate i, impacts the equilibrium in the one-time deviation economy. Consider a candidate nominal rate such that the solution to the government problem, program (26), delivers strict inflation targeting $\overline{\pi}$ in period 0. Denote such nominal rate in period 0 by i^{ST}. With strict inflation targeting, the monetary wedge is zero and domestic consumption and labor are efficient, $(C^{ST} = C^{\star}, N^{ST} = N^{\star})$. Optimal borrowing, however, B^{ST}, is different from the constrained efficient borrowing since the government has an overborrowing incentive and satisfies

$$1 - h(\hat{v}(B^{ST}))B^{ST} = \beta_g(1+r). \tag{27}$$

The government discounts the future more heavily, at $\beta_g < \beta$ and such impatience leads to overborrowing by the government, $B^{ST} > B^{\star}$. Overborrowing is costly for households and lowers their welfare level, W^{ST}. These results are summarized in the next lemma.

Lemma 1. *Under Assumption 2, the monetary authority can deliver strict inflation targeting, $\pi = \overline{\pi}$, in period 0. If it does so, default risk is higher, and households' welfare is lower than in the constrained efficient outcome, $\Phi^{ST} > \Phi^{\star}$, $W^{ST} \leq W^{\star}$.*

The lemma shows that it is possible for the monetary authority to eliminate domestic pricing frictions in period 0 through strict inflation targeting, but that the resulting welfare level is lower than the constrained efficient case, since the government borrows and defaults too much. The monetary authority, however, can set nominal rates at different levels and affect the economy's outcomes including borrowing and default risk.

Before we explore these effects, it is useful to analyze the effects of default risk on the private economy and, in particular, on pricing frictions. The next lemma shows that, given a monetary policy i, higher default risk increases the monetary wedge.

Lemma 2. *Under Assumption 2, higher default risk Φ increases the monetary wedge $-zu_C/u_N$, when the monetary wedge is positive.*

This result is similar to the amplification result in Proposition 1, but derived for the one-time deviation economy under assumptions on the environment summarized in Assumption 2. Higher default risk increases the future marginal utility of consumption since the expectation in (domestic Euler) places more weight on default states, in which consumption is lower, $C_d \leq C^{\star}$. In response to this low expected future consumption, current consumption, C, declines. Low C also leads to a real appreciation,

the contemporaneous variables will also be functions of the optimal borrowing choice B', but they are chosen as part of the maximization program.

e decreases, which in turn reduces exports. Labor is lower because of lower demand for both domestic consumption and exports. As a result, the monetary wedge increases and domestic production is more distorted.

We now characterize equilibrium default risk and monetary wedges for alternative monetary policies in period 0. We find that tighter monetary policy disciplines the fiscal government to borrow less. The following proposition summarizes our disciplining result

Proposition 2 (Discipline)**.** *Under Assumption 2, if $i > i^{ST}$, the monetary wedge is positive, and default risk is lower than under strict inflation targeting.*

The higher policy rate, $i > i^{ST}$, depresses the domestic economy and generates a positive monetary wedge through standard channels in open economy New Keynesian models. It decreases the consumption demand for domestic goods through the domestic Euler and the demand for exports through the resulting exchange rate appreciation, both of which reduce output. The government internalizes the effects of its borrowing on default risk $\Phi = F_v(\hat{v}(B'))$, expected marginal utility $\mathbb{E}u_{C'}$, domestic consumption C, and the multiplier on (domestic Euler) κ. Its Euler equation for optimal international borrowing reflects such effects, and in this case is

$$1 - h(\hat{v}(B'))B' - \kappa \frac{1}{1 - F_v(\hat{v}(B'))} \left(\frac{\partial \mathbb{E}u_{C'}(B')}{\partial B'} \frac{u_C}{\mathbb{E}u_{C'}(B')} \right) = \beta_g(1 + r). \tag{28}$$

The government faces an additional cost of borrowing, relative to the case of strict inflation targeting, as $\kappa \left(\frac{\partial \mathbb{E}u_{C'}(B')}{\partial B'} \frac{u_C}{\mathbb{E}u_{C'}(B')} \right) > 0$ from Lemma 2 because increasing B' increases default risk and the monetary wedge. The additional cost lowers incentives to borrow and, therefore reduces default risk.

Proposition 2 illustrates a trade-off for monetary policy. Strict inflation targeting eliminates pricing frictions, but at the cost of inefficiently high borrowing by the government. Alternatively, a higher policy rate, $i > i^{ST}$, induces lower default risk, closer to its efficient level, but at the cost of distorting domestic production. A natural question is whether alternative monetary policy rules could deliver a better outcome or eliminate the trade-off.

Next, we propose an alternative interest rate rule that does indeed deliver better outcomes. The rule targets default risk and dictates increasing nominal rates when default risk rises. We will show with this rule, which we label the *default risk monetary rule*, monetary policy can achieve both efficient default risk and a near-zero monetary wedge. Because of the disciplining effects of high domestic interest rates, this rule discourages excessive borrowing and default risk. We show below that the default risk monetary rule can be designed to deliver both efficient default risk and efficient production.

Proposition 3 (Default Risk Monetary Rule)**.** *A monetary policy rule of the form $i = \bar{i}\ \Phi^{\ \alpha_D}$ can achieve the constrained efficient default risk $\Phi^\star$ and an arbitrarily small monetary wedge of size $\varepsilon > 0$, with a positive coefficient α^D.*

Here is the sketch of the proof. Under the default risk monetary rule, monetary policy responds to the equilibrium default probability $\Phi = F(\hat{v}(B'))$, which depends on the fiscal borrowing choices. The government internalizes these effects, giving rise to the following international Euler equation

$$1 - h(\hat{v}(B'))B' - \kappa \frac{1}{1 - F_v(\hat{v}(B'))} \left[\frac{\partial \mathbb{E} u_{C'}(B')}{\partial B'} \frac{u_C}{\mathbb{E} u_{C'}(B')} + \alpha_D u_C \frac{f_v(\hat{v}(B'))}{F_v(\hat{v}(B'))} \right] = \beta_g(1+r).$$

The optimal borrowing condition is modified relative to condition (28) with an additional term, $\alpha_D u_C f_v(\hat{v}(B'))/F_v(\hat{v}(B'))$. This additional term reflects the increased costs of borrowing from tighter monetary policy, which matters through its effects on the multiplier on the domestic Euler equation κ.

Our approach for implementing the constrained efficient borrowing is to set α_D such that the optimal borrowing condition for the government is the constrained efficient one, condition (25). This implementation requires setting α_D to satisfy the following condition

$$\frac{\kappa}{1 - \Phi^\star} \left[\frac{\partial \mathbb{E} u_{C'}}{\partial B'} \frac{u_C}{\mathbb{E} u_{C'}(B^\star)} + \alpha_D u_C \frac{f_v{}^\star}{\Phi^\star} \right] = \left(\beta - \beta_g\right)(1+r).$$

The multiplier κ and the marginal utility u_C in this equation are pinned down by the monetary wedge of size ε. The default risk monetary rule can implement a monetary wedge ε by the appropriate choice of $\bar{i}$ because of its effects through the domestic Euler equation. By setting $\bar{i} \to i^\star / \Phi^{\star \alpha_D}$ the rule can deliver a monetary wedge of $\varepsilon \to 0$. Inflation, as determined by the NKPC condition, is close to target when $\varepsilon \to 0$. Hence, by targeting only default risk, the optimal monetary rule is able to eliminate two frictions, by achieving both a near-efficient domestic production and constrained efficient external borrowing.[18]

We conclude this section with a summary of our findings thus far. We have shown that, in a simplified version of our model, high default risk can induce high inflation and positive monetary wedges because it affects expectations of future inflation and consumption. Tight monetary policy, in turn, can discipline the government's overborrowing incentives and curb default risk. We also showed that a monetary rule that targets default risk can alleviate the tradeoff for monetary policy. In deriving these results, we focused on an economy where default risk affects inflation and monetary wedges only through the expectation channel and abstracted from shocks and preferences that are concave in imported consumption. In the next section, we analyze our general model and show numerically that our key theoretical

[18] We have also analyzed rules that target nominal devaluation rates, and found that such a policy will not affect borrowing incentives and therefore cannot be designed to achieve constrained efficient outcomes.

results are present and shape much of the quantitative outcomes.

4 Quantitative and Data Analysis

We proceed to the quantitative analysis of our model and its mapping to the data. We start by describing key patterns in emerging-market data. We document comovements of inflation, nominal domestic rates, and spreads, discuss properties of temporary inflation events, and provide evidence of the key disciplining mechanism in the model. We then describe the parameterization of the model, analyze decision rules and impulse response functions, and compare the model's predictions to the data. We show that our model can fit the data across several untargeted dimensions, including key comovements, time paths, and the elasticities of spread to monetary shocks and that of inflation expectations to default risk. In drawing our lessons, we also compare our baseline NK-Default model to a reference model without default risk and consider alternative monetary policy regimes.

4.1 Emerging Market Inflation Targeters Data

Several emerging markets successfully adopted inflation targeting as their monetary policy regime in the early 2000s.[19] We analyze data from these countries and document stylized facts about the volatility and comovements of inflation, spreads, and domestic nominal rates. We also compile an event analysis around periods of elevated inflation and provide some evidence for our disciplining and amplification mechanisms.

Stylized facts. We collect data on inflation, spreads, nominal domestic rates, and output for eight emerging markets that are inflation targeters. The sample of countries consists of those included in the JP-Morgan Emerging Market Bond Index (EMBI+) that have also successfully adopted inflation targeting. The data start in 2004, by which point all countries considered had adopted the monetary policy regime, and run through 2019.

Table 1 reports key statistics on the joint behavior of these series using quarterly data. Inflation is measured by the Consumer Price Index (CPI) and computed as the log difference in the index relative to four quarters prior. Spreads are measured as the difference in yields between foreign currency government bonds of these emerging markets, as captured by the EMBI index, and a U.S. government bond of comparable duration. Domestic nominal rates are the nominal policy rates of Central Banks, and

[19] See Roger (2009) and Ha, Kose, and Ohnsorge (2019) for more details on the implementation and performance of inflation targeting in emerging markets.

	Mean		Std. Dev. Rel. Output		Correlation with Spread		
	Inflation	Spread	Inflation	Spread	Inflation	Domestic Rate	Output
Brazil	5.6	2.8	0.6	0.3	0.5	0.6	−0.3
Chile	3.2	1.4	0.8	0.2	0.4	0.2	−0.6
Colombia	4.3	2.3	0.9	0.5	0.6	0.4	−0.3
Mexico	4.1	2.2	0.4	0.3	0.2	0.1	−0.5
Peru	2.9	2.0	0.5	0.3	0.5	0.1	0.0
Philippines	3.9	2.1	1.4	0.8	0.6	0.6	−0.5
Poland	2.1	1.1	0.9	0.4	0.4	0.2	−0.4
South Africa	5.0	2.2	1.2	0.5	0.5	0.1	−0.7
Mean	3.9	2.0	0.8	0.4	0.5	0.3	−0.5

Table 1: Emerging Market Inflation Targeters, Key Statistics

Note: Quarterly data, 2004Q1–2019Q4. "Inflation" is CPI four-quarter log difference. "Spread" is the JP Morgan EMBI+ Spread. "Output" is four-quarter log difference of real GDP. See Appendix C.1 for the construction of our sample.

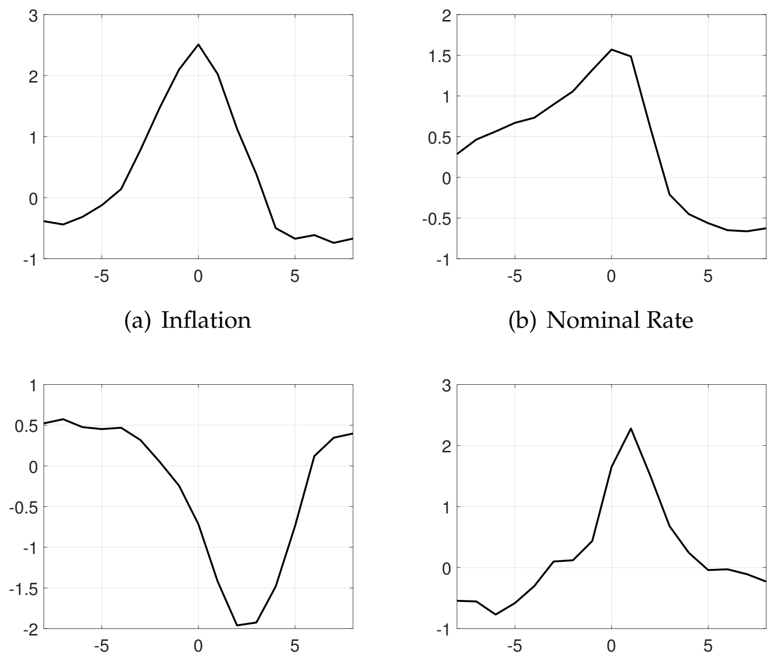
output is the four-quarter difference in log real Gross Domestic Product. Appendix C.1 reports detailed definitions and sources for the data.

We highlight several findings. Inflation is low on average and relatively stable. Mean inflation across these countries ranges between 2.1% and 5.6%, with an overall average of 3.9%. The standard deviation of inflation relative to that of output ranges from 0.4 to 1.4, with an average across countries of 0.8. This stable inflation contrasts sharply with the historical experience of these countries, with episodes of very high and volatile inflation. Emerging markets bond spreads are on average 2% and with a mean standard deviation of 0.9%, which is 0.4 relative to that of output.

We also report correlations of spreads with inflation, nominal domestic rates, and output. Spreads are negatively correlated with output, with an average correlation of -0.5 in this sample. Correlations of spreads with nominal rates and inflation are positive, on average 0.3 and 0.5, respectively. Note that domestic nominal rates are denominated in local currency whereas government spreads are in foreign currency, so that the correlation is not driven by a common domestic inflation or exchange rate factor but instead likely reflects the relationship between inflation and default risk.[20]

Temporary inflation events. Although the emerging markets in our sample have successfully kept average inflation low, these countries have experienced several events, over the last 20 years, during which inflation rose temporarily by a few percentage points. Importantly, these *temporary inflation events* have been relatively subdued, and inflation returned to lower levels shortly after the monetary authority

[20]For a similar time period, we found a wide range of correlations between inflation and spreads for non-inflation targeting emerging countries: the correlation is -3% for Argentina, -4% for Bulgaria, and 51% for Ecuador. Therefore, we conclude that the positive correlation between inflation and spreads may not be unique to inflation targeting emerging countries.



(a) Inflation (b) Nominal Rate

(c) Output (d) Spread

Figure 2: Temporary Inflation Events

Note: Average paths around spikes in inflation, in excess of two standard deviations, based on the nine events in our emerging markets sample. All series are quarterly and standardized country-by-country so that units on the vertical axes are standard deviations, and zero is the sample average. Appendix C.1 describes our sample.

tightened policy. We illustrate the dynamics of key variables during these events and rely on these findings for the quantitative analysis of our model.

We classify a country as experiencing an inflation event if inflation is unusually high, defined as two standard deviations or more above its mean. We center the events around the peak in inflation, where the standard deviation is calculated country by country, and analyze the dynamics 8 quarters before and after this peak. Figure 2 plots average paths across the 9 events we found in our dataset for inflation dynamics, domestic nominal rates, spreads, and output.[21] The underlying series are standardized country by country; therefore the units in the figure are standard deviations, and a value of zero means the series is at its average. The top left panel illustrates the tent-like shape of inflation during the event. Inflation starts slightly below its average level and increases close to 2.5 standard deviations at its peak, before returning to low levels. The 2.5 standard deviation increase corresponds to an average of 4.5 percentage points. The top right panel plots the domestic nominal rate, which increases by about 1.2 standard deviations and then falls at the end of the event. At its peak, the domestic nominal rate increase corresponds to 2.9 percentage points above its mean. Output, in the bottom left panel, starts above its average and falls about 2.5 standard deviations, corresponding to a 5.7 percentage points recession, before recovering towards the end of the event. The bottom right panel plots spread dynamics. Spreads also feature a tent-like shape, increasing about 2.5 standard deviations from start to peak, corresponding to about 2.3 percentage points, and falling back to their long-run average by the end of the event.[22]

These dynamics illustrate how emerging market inflation targeters have been successful at managing shocks that lead to temporarily high inflation. The resolution of these inflation episodes is impressive, as inflation decreased and returned to target in about a year with monetary tightening. We also find it noteworthy that spreads are high during these elevated inflation events. The standard, open economy New Keynesian model of Galí and Monacelli (2005) is silent about sovereign spreads, yet this empirical regularity in emerging markets is consistent with one of the main mechanisms in our NK-Default framework, that default risk can be an amplifying force for elevated inflation, a mechanism we explored theoretically in Section 3. In Appendix C.3, we also document that, consistent with our amplifying mechanism, increases in spreads are associated with elevated survey-based inflation expectations for our sample of emerging market inflation targeters.

[21] The events have the following peak dates: Brazil 2015Q4, Chile 2008Q3, Colombia 2008Q4 and 2015Q2, Mexico 2008Q4 and 2017Q4, Peru 2008Q4, Philippines 2008Q4, South Africa 2008Q3.

[22] Emerging markets experienced an inflation episode starting in 2021, which featured dynamics similar to those documented here. Inflation increased substantially in all of our 8 countries and central banks responded by tightening aggressively, after which inflation fell and broadly returned to target by early 2024. Spreads spiked together with inflation and have since reverted. Appendix C.4 contains more details.

Disciplining effect in the data. Employing our data sample, we can provide empirical evidence of the disciplining mechanism in our model that tight monetary policy reduces government spreads. As we illustrated above, unconditionally, nominal rates tend to rise with sovereign spreads, as seen by the overall positive correlation and during inflation events. This unconditional positive correlation is of course silent on the direct effect of monetary policy on spreads, which is the object of interest for the disciplining effect.[23] To tease out the direct effect of monetary policy on spreads, we follow the monetary literature and first recover monetary shocks. We then project government spread on these estimated monetary shocks.

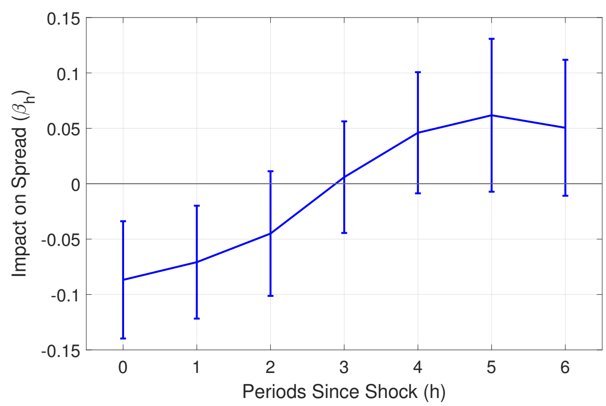


Figure 3: Projections of Spreads on Monetary Policy Shocks

Note: The figure plots the point estimates and 95% confidence intervals for the β_h coefficients in equation (29). The coefficients are the projection estimates of sovereign spreads on monetary policy shocks.

For the first step, we recover monetary policy shocks by estimating the reaction function of the monetary authority's policy rates to inflation. In particular, for each country c, we recover the monetary shock $m_{c,t}$ by projecting policy rates on inflation and lagged policy rates, such that $i_{c,t} = \alpha_c^0 + \alpha_c^1 i_{c,t-1} + \alpha_c^2 \pi_{c,t} + m_{c,t}$, where we allow the residuals to be autocorrelated. In estimating these regressions, we follow the literature and estimate them with monthly data. The coefficients α_c^2 are positive for all our countries and statistically significant for 6 of them. The finding that policy rates tend to react positively to inflation is consistent with the statutory inflation targeting regime of the countries in our sample.

We then estimate the effects of monetary shocks on spreads with a panel regression, where we project spreads on the estimated monetary policy shocks. For our baseline panel regression, we standardize all series at the country level. We project spreads for country c at time t on a vector of monetary shocks with

[23]The unconditional positive correlation of nominal rates and spreads can reflect a third factor affecting both. If, for example, low productivity is associated with increases in default risk and inflation, then a productivity-driven business cycle can rationalize the unconditional correlation.

L lags and additional controls $Z_{c,t}$,

$$\text{spr}_{c,t} = \sum_{h=0}^{L} \beta_h m_{c,t-h} + Z_{c,t}\Gamma + \nu_{c,t}. \tag{29}$$

The coefficients of interest are the β_hs. We include in the controls $Z_{c,t}$ contemporaneous values for output growth and inflation, as well as nine lags for these variables. We set $L = 6$ for our baseline specification. The identifying assumption is that with these control variables, the coefficients β_h isolate the effects of monetary shocks on fluctuations in spreads. We also cluster standard errors across time and country.

Figure 3 plots the estimated coefficients β_h together with their 95% confidence band. Contractionary monetary policy shocks tend to decrease spreads. On impact, a positive monetary policy shock of one standard deviation decreases spreads by about 0.09 standard deviations. The effects are also persistent, as the point estimate is negative for three periods, but the significance decreases. Given these estimates and that the mean standard deviation of monetary shocks is 0.23 and that for spreads is 0.9, the mean estimate for the first 3 months of -0.07 implies an elasticity of spreads to monetary shocks of -0.3, with confidence bands reaching -0.6 in the first month. In Appendix C.2, we provide more details on our exercise and document the robustness of these results.

4.2 Functional Forms and Parameterization

We assume preferences are separable between a composite consumption good H and labor N. The per-period utility function is given by

$$u(C_t, C_t^f, N_t) = \log\left[H(C_t, C_t^f)\right] - \frac{N_t^{1+1/\zeta}}{1+1/\zeta},$$

where $H(C_t, C_t^f)$ is a CES composite of domestic goods C and imported goods C^f,

$$H(C_t, C_t^f) = \left(\theta C_t^{\frac{\omega-1}{\omega}} + (1-\theta)(C_t^f)^{\frac{\omega-1}{\omega}}\right)^{\frac{\omega}{\omega-1}}.$$

We can derive the Consumer Price Index (CPI) as the price of the bundle of domestic and foreign goods consumption, $P^{\text{CPI}} = P^d\left[\theta^\omega + (1-\theta)^\omega e^{1-\omega}\right]^{\frac{1}{1-\omega}}$, and the resulting CPI inflation, $\pi^{\text{CPI}} = \frac{P^{\text{CPI}}}{P^{\text{CPI}}_{-1}}$, where the subscript $_{-1}$ denotes the previous period's value. The rate of depreciation of the nominal exchange rate is given by

$$\frac{\varepsilon}{\varepsilon_{-1}} = \frac{e}{e_{-1}}\frac{P^d}{P^d_{-1}} = \frac{e}{e_{-1}}\pi, \tag{30}$$

which reflects inflation and the depreciation of the terms of trade.

The model features productivity, monetary, and enforcement shocks. We assume that the productivity and monetary shocks follow independent AR(1) processes, $\log \tilde{z}_t = \rho_z \log \tilde{z}_{t-1} + \sigma_z \varepsilon_{z,t}$ and $\log m_t = \rho_m \log m_{t-1} + \sigma_m \varepsilon_{m,t}$, with innovations $[\varepsilon_{z,t},\ \varepsilon_{m,t}] \sim \mathcal{N}(0, I_2)$. The productivity costs from default follow Chatterjee and Eyigungor (2012) such that $z(\tilde{z}, \Theta) = \tilde{z} - \max\left\{0, \lambda_0 \tilde{z} + \lambda_1 \tilde{z}^2\right\}$ if $\Theta = 1$, and $z(\tilde{z}, \Theta) = \tilde{z}$ if $\Theta = 0$. The enforcement shocks ν are i.i.d. and perturb the value of default. We integrate these shocks into our computational technique following Dvorkin, Sánchez, Sapriza, and Yurdagul (2021) and Mihalache (2020) such that ν follows a logistic distribution, where the parameter ϱ_D controls the relative importance of the shocks.[24]

Assigned Parameters		*Parameters from Moment Matching*	
Preferences	$\omega = 0.85, \theta = 0.73, \zeta = 0.33$	Discount factor	$\beta = 0.9947$
Varieties elasticity	$\eta = 6$	Interest rate rule	$\alpha_P = 1.575$
Export demand elasticity	$\rho = 5$	Inflation target	$\overline{\pi} = 1.010$
Price adjustment cost	$\varphi = 58$	Government discount factor	$\beta_g = 0.9775$
Productivity persistence	$\rho_z = 0.9$	Productivity volatility	$\sigma_z = 1.3\%$
Monetary shock	$\rho_m = 0.3, \sigma_m = 0.06\%$	Default costs	$\lambda_0 = -0.45, \lambda_1 = 0.5$
International rate	$r = 0.5\%$	Enforcement shock	$\varrho_D = 1.8e^{-4}$
Reentry probability	$\iota = 4.17\%$		
Debt duration	$\delta = 0.037$		

Table 2: Parameter Values

	Data	NK-Default
Means		
CPI inflation	3.9	3.9
Nominal domestic rate	5.7	5.7
Spread	2.0	2.0
Debt to output	16	17
Standard Deviations		
Output	2.3	2.2
CPI inflation	1.8	1.8
Spread	0.9	0.9
Consumption aggregate	2.4	2.6
Correlation		
(Output, Spread)	−42	−53

Table 3: Targeted Moments

We consider a quarterly model and set some parameters externally, based on prior studies, while others are determined internally as part of a moment-matching exercise. We first describe the parameters set based on direct measurement or previous work. In terms of preferences parameters, we set the elasticity of substitution between foreign and domestic goods in consumption ω to 0.85 following Corsetti,

[24] This computational technique consists of augmenting the model with taste shocks in the discrete choice tradition. Appendix G contains more details on the computational algorithm and simulation of the model.

Dedola, and Leduc (2008), the weight of domestic goods in consumption θ set to induce an imports' share in the balanced-trade steady state of 29% based on our emerging-market data, and the elasticity of labor supply ζ to 1/3 as in Galí and Monacelli (2005). In terms of technology parameters, we set the domestic varieties' elasticity η to 6, which corresponds to a 20% markup, in line with the estimates in Edmond, Midrigan, and Xu (2023) and Díez, Fan, and Villegas-Sánchez (2021), the Rotemberg adjustment cost φ such that the frequency of price changes is roughly once per year, using the well-known equivalence between Calvo and Rotemberg pricing,[25] and the persistence of the productivity shock to 0.9 based on international business cycle studies. Other parameters we set are the export demand elasticity ρ to 5 based on Bajzik, Havranek, Irsova, and Schwarz (2020), the international interest rate r to 0.5 implying a 2% annual rate, consistent with U.S. Treasury yields, the probability of return to financial markets after default ι such the average length of market exclusion is 6 years, based on Cruces and Trebesch (2013), the debt decay parameters δ such that the duration of debt is 6 years, consistent with emerging markets data, the persistence and standard deviation of monetary shocks to 0.3 and 0.23%, respectively, based on our estimates of monetary shocks, and the intercept of the interest rate rule to satisfy the steady-state condition $\bar{i} = \overline{\pi}/\beta$. Finally, we normalize the level of export demand ξ to 1.

The second set of parameters is pinned down by a moment-matching exercise, such that our model replicates salient features of emerging market inflation targeters' data. These eight parameters are the discount factors of the private sector and that of the government, β and β_g, respectively, the inflation target $\overline{\pi}$, the interest rate rule coefficient α_P, the volatility of the productivity innovations σ_z, the parameters of the default cost function $\{\lambda_0, \lambda_1\}$, and the parameter governing the magnitude of the enforcement shock ϱ_D. We target average nine moments in the data: averages of the means and standard deviations of CPI inflation and spreads, means of nominal domestic rate, standard deviations of output and consumption, the mean ratio of government debt to output, and the correlation of spread with output.[26]

Most parameters affect all moments, yet some moments are more informative for setting certain parameters. The average CPI inflation rate in the data is the most influential for $\overline{\pi}$. The weight of inflation in the interest rate rule α_P heavily affects the volatility of inflation. The volatility of productivity shocks is the main driver of output volatility. The enforcement shock parameter ϱ_D and the productivity default cost parameters are crucial for the dynamics of spreads. The volatility of the enforcement shock informs the mean and standard deviation of spreads, while the productivity cost parameters shape the correlation of spread with output as well as the debt level. The discount factor of the sovereign β_g affects the volatility of consumption and the level of debt, while the discount factor of the private sector β

[25] See, for example, Miao and Ngo (2021) for the mapping between the Calvo and Rotemberg parameters.

[26] We focus on CPI inflation because of data limitations with alternative price indices. See additional details about the data in C.1.

controls the average real domestic rate. We collect the values of all the parameters in Table 2.

We note that the parameters of the interest rate rule, α_P and $\overline{\pi}$, are in line with external estimates. The value of α_P is well within the range of estimates in the reaction functions we recovered for the eight emerging markets. Moreover, the resulting average rate of annual inflation, in our quarterly model, given by $\overline{\pi}^4 \approx 1.04$, is in line with the announced inflation targets in the countries of our sample. For example, the Central Bank of Brazil pursued a 4.5% target before 2018 and 3% in recent years, while South Africa's target has been 4.5% since 2017. The targets for Colombia and Chile were at 3% since the mid-2000s.

Table 3 reports the fit of the moment-matching exercise. Overall, we find that the model is able to replicate closely the targeted moments in the data. We compute model moments using a long simulated sample, from which we exclude default episodes and their associated international market exclusion spells because none of the countries in our data sample outright defaulted during the sample period.[27] CPI inflation, nominal domestic rates, and spreads are reported annualized. In the model and data, CPI inflation is about 3.9%, spreads are 2%, nominal domestic rates are 5.7%, and debt is about 16% of output. The model also replicates closely the standard deviation of output, inflation, and consumption. The volatility of spreads is 0.9% in both the data and the model. Output is negatively correlated with spreads, with similar correlations in the data and the model.

4.3 Policy Rules and Impulse Response Functions

To showcase the workings of the quantitative model, we describe policy functions and plot impulse response functions following monetary and productivity shocks. These enable us to illustrate how our mechanisms, default amplification and monetary discipline, are operational in the quantitative model.

Policy rules. Figure 4 presents policy rules as a function of debt B. To highlight the impact of default risk on policy functions, we plot two lines in each figure, a solid line for the variable of interest and a dotted line for the equilibrium, one-period-ahead default risk, using a second, right-side vertical axis. In the figures, B is scaled by average annual output in foreign goods and the functions are for the average values of the productivity and monetary shocks, with the focus on behavior conditional on not defaulting. As shown by the dotted lines in the plots, default probabilities increase with current debt B because debt due next period $B' = H_B(s, B)$ increases with B, which in turn makes a future default more likely.

Default risk impacts domestic allocations in our model through two main channels. First, through the expectation channel: default risk alters the expectation terms of the domestic Euler equation and

[27] In the model the default frequency is modest and equal to 1.75%, which resembles the average spread given risk-neutral pricing.

the NKPC. This channel was the focus of our theoretical analysis in Section 3. In that section, under a simplified set-up with a utility function linear in imported consumption C^f, default risk increased the expected marginal utility because of the productivity costs from default. In our quantitative model, preferences are concave and non-separable in imported consumption, which means expected marginal utility depends on future credit restrictions reflected in the bond price function. High debt due next period is associated with elevated default risk, which pushes up expected marginal utility, even absent an actual default, because it is expensive to roll over the high debt that the economy inherits. These effects on marginal utility tend to increase the expectation terms of the domestic Euler equation and the NKPC, namely F and M from equations (22) and (23). Panels 4(i) and 4(j) illustrate this expectation channel: both F and M functions increase with debt.

Second, in our general model, default risk also affects allocations through a terms-of-trade channel. Debt and default risk now affect the terms of trade contemporaneously through their impact on capital flows and imported consumption. To highlight the two channels, it is useful to describe the policy rules in Figure 4, by drawing a distinction between two regions: a region with positive default risk for levels of B above 20%, where the expectations channel is mostly at play, and another one with essentially no default risk, for lower debt levels, where the terms of trade channel dominates.

Panels 4(a) and 4(b) illustrate key outcomes of our general model, which align with the theoretical predictions from Proposition 1. Both the monetary wedge and inflation tend to be high with high default risk and high debt. The monetary wedge increases with B when default probabilities are positive. High default risk increases future expected marginal utility, and through the domestic Euler equation, it lowers current domestic consumption, as seen in Panel 4(e). Low demand for domestic consumption lowers output as well, as seen in 4(d) in the positive default risk region.

According to the NKPC equation (8), inflation is negatively related to the monetary wedge and positively related to the value of expected future inflation, encoded in F. The value of expected inflation is always increasing in debt—as shown in Panel 4(j)—and drives the overall inflation policy. In the low-default risk region, increases in debt lead to a depreciation of the terms of trade, which tends to increase employment and inflation. In response to high inflation, the monetary authority's interest rate rule calls for higher nominal rates, as captured in Panel 4(c).

Panel 4(g) plots the equilibrium capital inflows, given by $q(s, B')(B' - (1-\delta)B) - (r+\delta)B$ in our model with long-term debt. We express these inflows relative to average annual output in foreign goods. As default risk is reflected in the bond price schedule, government borrowing increases slower than current debt, and hence capital inflows decrease as a function of debt B, resulting in a decline in imported consumption C^f, as shown in Panel 4(f). In the region of low debt, with no default risk, this effect leads to a depreciation of the terms of trade 4(h), which boosts export demand and also modestly increases output.

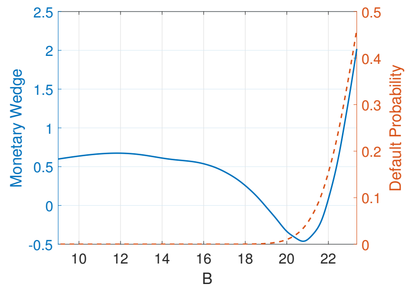
Note that the patterns in the low default region mirror results in standard models in the literature. As Blanchard, Ostry, Ghosh, and Chamon (2017) discuss, in the workhorse open-macro model, a reduction in capital inflows is expansionary because it depreciates the exchange rate, the so-called *expenditure switching* effect. The novel finding in our model with default risk is that a reduction in capital inflows can be recessionary, as exemplified in the high default region. This is because a reduction in capital inflows due to high default risk leads to a reduction in domestic consumption demand through the expectation channel, which in turn depresses production.[28]

Impulse response functions. We can further explore the mechanisms driving our model by plotting impulse responses (IRF) for the main variables, following monetary and productivity shocks. We construct the impulse response functions (IRFs) in our nonlinear model following Koop, Pesaran, and Potter (1996). We simulate a panel of $1,500,000$ units for $1,500$ periods. For the first $1,450$ periods, the shocks follow their underlying Markov chains so that the cross-sectional distribution converges to the ergodic distribution of the model. In period $1,451$, the impact period (normalized to 0 in the plots), we shock all units of the panel by the same amount. From period $1,452$ onward, shocks follow again their Markov processes. The impulse responses plot over time the cross-sectional average taken over units of the panel. The impulse responses are computed over all units, including those with defaults. Discarding defaults from the cross-sectional average does not alter the salient properties of the IRFs.

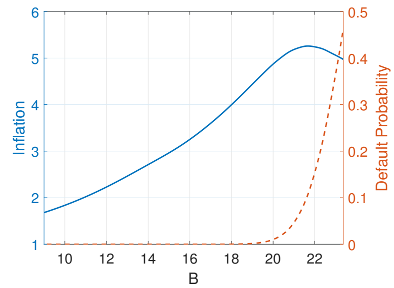
We start with IRFs for a contractionary monetary shock to illustrate the disciplining force in our model, namely that a high nominal interest rate lowers default risk. An increase in the monetary shock leads to dynamics that are standard in the New Keynesian literature: temporary increases in the nominal rate and temporary decreases in inflation, output, and consumption. In our NK-Default model, however, monetary shocks also impact the government's borrowing incentive. Contractionary monetary shocks encourage a reduction in borrowing, which reduces sovereign default risk and spreads, in line with the discipline mechanism.[29] The government reduces borrowing in response to contractionary shocks because doing so alleviates the monetary wedge induced by tight monetary policy. The responses in Panels 5(a) through 5(f) of Figure 5 imply that a contractionary monetary shock of about 3% increases nominal rates by 2, decreases inflation by about 0.7, and decreases spreads by about 0.1. The elasticities for nominal rates and inflation are within the bounds recently estimated by Ha, Kim, Kose, and Prasad (2025) using data from emerging markets. The average spread response masks a large heterogeneity of

[28] Alternative financial frictions, such as the collateral constraint of Mendoza (2010), can also generate output contractions from reductions in capital flows.

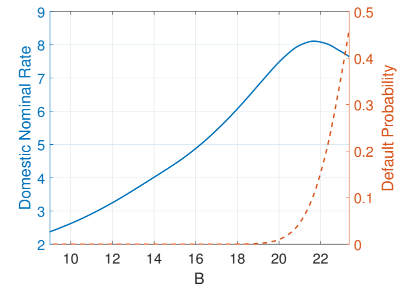
[29] Figure A3 in Appendix D shows that default risk decreases with monetary shocks, regardless of the current level of debt.



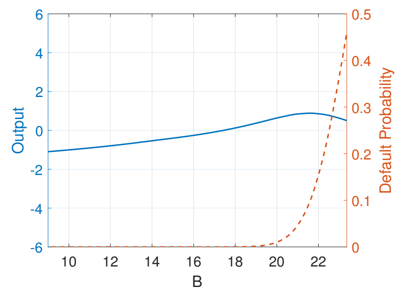
(a) Monetary Wedge



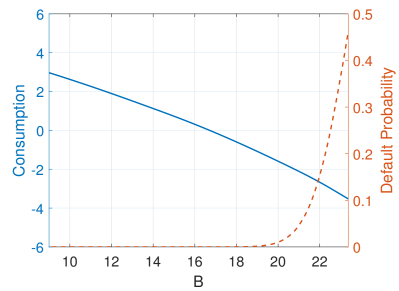
(b) Inflation



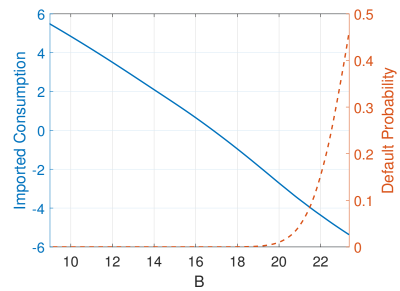
(c) Nominal Interest Rate



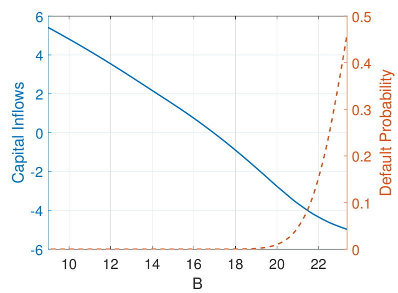
(d) Output



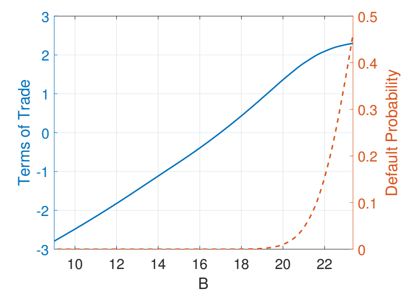
(e) Consumption, Domestic (C)



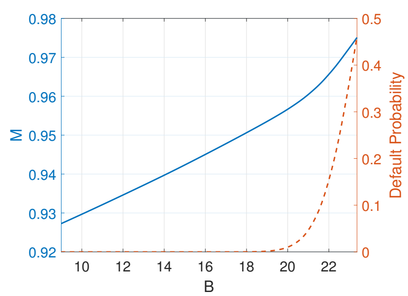
(f) Consumption, Imported (C^f)



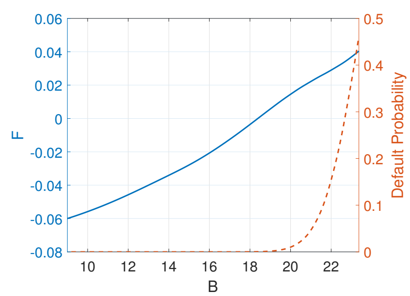
(g) Capital Inflows



(h) Terms of Trade



(i) Expectation term Domestic Euler (M)

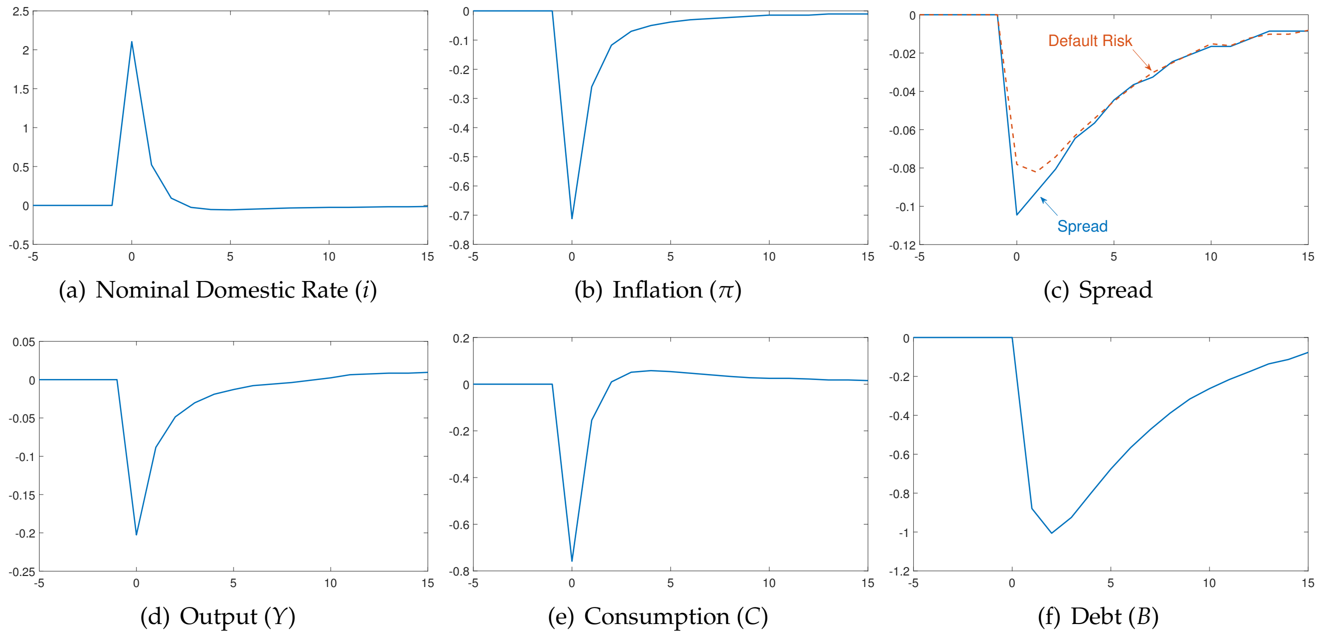


(j) Expectation term NKPC (F)

Figure 4: Equilibrium Policy Functions

Note: Inflation and the nominal interest rate as expressed in percentage points. Output, domestic consumption, imported consumption, and the terms of trade are expressed as log point deviations from the level at the lowest B on the horizontal axes. Capital inflows and the debt level scaled by average annual output in foreign goods. Quantities in panels 4(d)–4(f) share a common vertical axis range, to ease comparison.

the effect across units (in the limiting distribution), where it reaches a decrease of over 1.9%. This range of elasticities is consistent with our empirical findings and the inflation event analysis below, where we find a peak elasticity of -0.33. Output and consumption drop by about 0.2 and 0.7, respectively.



(a) Nominal Domestic Rate (i) (b) Inflation (π) (c) Spread

(d) Output (Y) (e) Consumption (C) (f) Debt (B)

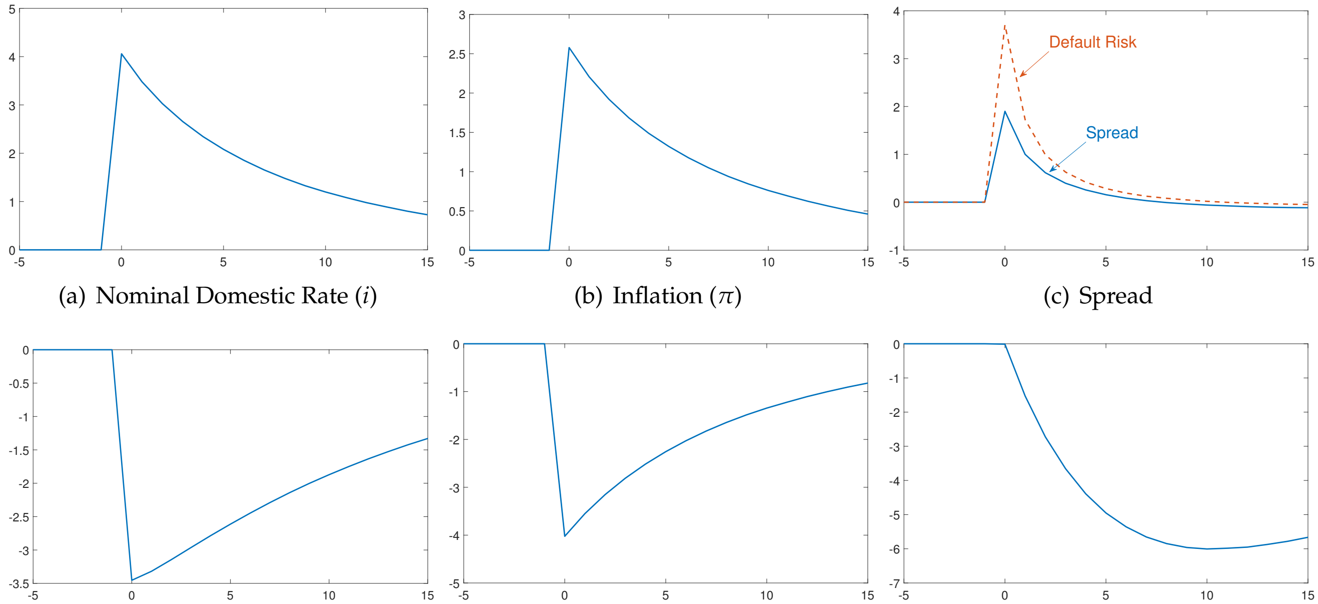
Figure 5: Impulse Response Functions to Monetary Shocks

Note: Impulse response functions to a contractionary monetary shock m. All variables are expressed as percentage deviations from their sample average, except for the spread and default risk, which are level differences.

Figure 6 collects the IRFs with respect to the productivity shock. Output declines about 3.5%, with a contractionary productivity shock of comparable magnitude. Consumption declines somewhat more because, as is typical in sovereign default models, low productivity tightens the bond price schedule due to elevated default risk. The tight bond price schedule leads to higher spreads and a reduction in debt, which tends to increase the volatility of consumption. Spreads rise about 2%, default risk rises about 3.7%, and debt contracts slowly, by about 6% of its average value. Spreads rise by less than default risk because the spread is the average default risk for the duration of the bond. Inflation rises about 2.5% on impact because of the high unit cost from low productivity and the increased default risk. The nominal domestic rate increases in response to the elevated inflation, about 4%. These dynamics illustrate that productivity shocks lead to a strong, positive comovement of spreads with inflation and nominal rates.

4.4 Business Cycle Moments and the Reference Model

We turn to our model's business cycle implications and compare them with the moments of a reference model without default risk. We show that our model can deliver key untargeted patterns in the data and



(a) Nominal Domestic Rate (i) (b) Inflation (π) (c) Spread

(d) Output (Y) (e) Consumption (C) (f) Debt (B)

Figure 6: Impulse Response Functions to Productivity Shocks

Note: Impulse response functions to a contractionary productivity shock, z. Panels plot variables expressed as a percentage deviation from the sample average, except for the spread and default risk, which are level differences.

that default risk amplifies the volatility of inflation. We start by introducing a reference model without default.

NK-Reference. To isolate the interactions between monetary frictions and default risk, we compare our findings with a reference model, labeled *NK-Reference*, which is a version of the Galí and Monacelli (2005) model with nominal rigidities and without default. The equilibrium of the NK-Reference model is characterized by the same private and monetary equilibrium of our baseline NK-Default model from Definition 1 and summarized in the Appendix by equations (32–37), the international Euler condition (18), and an exogenous debt-elastic bond price schedule to close the model, as in Schmitt-Grohé and Uribe (2003). The debt-elastic bond price schedule is $q^{\text{ref}}(B)^{-1} = \beta + \Gamma\left[\exp(B - \overline{B}) - 1\right]$, with Γ set to 10^{-5}, which gives a very loose borrowing schedule, and $\overline{B}$ set to give the same average debt level as our baseline. We solve the NK-Reference model with a first-order log-linear approximation of the equilibrium conditions, keeping all parameter values as in the baseline.

Business cycle statistics. The first two columns of Table 4 report the first and second moments for the emerging-market data and for simulated data from our baseline NK-Default model. The data consist of the series reported in Sections 4.1 and 4.2, for output, CPI inflation, nominal domestic rates, spreads, government debt to output, and aggregate consumption, as well as the trade-weighted nominal exchange rate depreciation. All moments are averages across the emerging markets in our sample and reported in percentage points.

Overall, the moments in the baseline model resemble those of emerging-market data. The mean CPI inflation, nominal domestic rate, spread, and debt, as well as the volatility of inflation, output, and spreads are targets in our moment-matching exercise. The model delivers volatility of the nominal rate comparable to the data, whereas it underestimates the high volatility in nominal exchange rates, reflecting the common disconnect between exchange rates and fundamentals in much of international business cycle theory. Our model mirrors the cyclical properties of the trade balance, with a correlation between the trade-balance-to-output ratio and output of -24% in the data versus -42% in the model.

The model delivers the key stylized fact that inflation correlates positively with spreads, close to 50% in the model and the data. In addition, the model generates a positive correlation between the nominal rate and the nominal depreciation rate with spreads. These correlations arise in our model because, across all state variables, namely, productivity shock z, monetary shock m, and debt B, inflation and spreads comove positively. These positive correlations are the implications of the amplification and disciplining mechanisms of our model. Finally, the model also delivers autocorrelations for output, inflation, spreads, and nominal domestic rates in line with those in the data.

To provide further evidence of the model's default amplification mechanism, which relates default risk to elevated inflation expectations, we assemble surveys of inflation expectations for several countries in our sample. As documented in Appendix C.3, we find that, in the data, a 1% increase in spreads is associated with an average 0.97% increase in inflation expectations for the following twelve months. The corresponding measure, in our baseline NK-Default model, is 1.14%, well within the 95% confidence interval of the estimated coefficient.

The third column of Table 4 reports the moments of the NK-Reference model, which is silent on default risk. Average CPI inflation and the nominal domestic rate are similar to the benchmark. The standard deviations of CPI inflation and the nominal interest rate are, however, only about 55% of those in the NK-Default baseline. Default risk makes inflation more volatile because it affects expected future inflation and the monetary wedge, as illustrated in Figure 4.[30] In Appendix H we also illustrate these amplification effects from default risk with IRFs. In the NK-Reference model, the response of inflation to productivity shocks are about half of the response in the baseline with default. In addition, monetary policy is also more effective in reducing inflation; the inflation response to contractionary monetary policy is more than double in the NK-Reference, relative to the baseline. This comparison shows that

[30] In this NK-Reference model monetary wedge and inflation policies are extremely flat as a function of debt because of flat expectations encoded in functions F and M in equations (22) and (23), unlike the functions in our baseline model.

an emerging market central bank targeting inflation must implement a more volatile interest rate policy due to sovereign default risk.

				NK-Default Alternative Rules	
	Data	NK-Default	NK-Reference	Strict Inflation	Inflation-Default
Mean					
CPI inflation	3.9	3.9	4.1	4.3	3.4
Nominal domestic rate	5.7	5.7	6.2	5.9	5.3
Spread	2.0	2.0	–	2.5	0.3
Debt	16	17	17	18	20
Standard Deviation					
Output	2.3	2.2	3.3	2.3	2.3
CPI inflation	1.8	1.8	1.0	0.2	0.4
Spread	0.9	0.9	–	0.7	0.1
Consumption aggregate	2.4	2.6	1.6	3.3	3.7
Nominal domestic rate	1.9	3.1	1.6	2.3	3.8
Depreciation rate	8.6	1.9	1.6	1.0	1.1
Correlations					
(Spread, Output)	−42	−53	–	−63	−59
(Spread, CPI inflation)	46	59	–	−13	59
(Spread, Nom. dom. rate)	30	78	–	56	93
(Spread, Depreciation rate)	37	52	–	−10	25
(CPI inf., Output)	−22	−15	−90	7	−10
(CPI inf., Nom. dom. rate)	59	90	90	−3	56
Autocorrelations (%)					
Output	84	69	94	71	74
CPI inflation	88	96	91	72	59
Spread	83	63	–	51	71
Nominal domestic rate	95	85	90	60	49

Table 4: Comparison of Moments Across Data and Models

Note: This table presents business cycle moments for the data and four models: the baseline "NK-Default" model, the reference model without default risk "NK-Reference", and two alternative monetary policy regimes, "Strict Inflation Targeting" and the "Inflation–Default" rule of Section 4.6, which also targets default risk. Appendix C.1 details the construction of our sample and the data moments.

4.5 Temporary Inflation Events

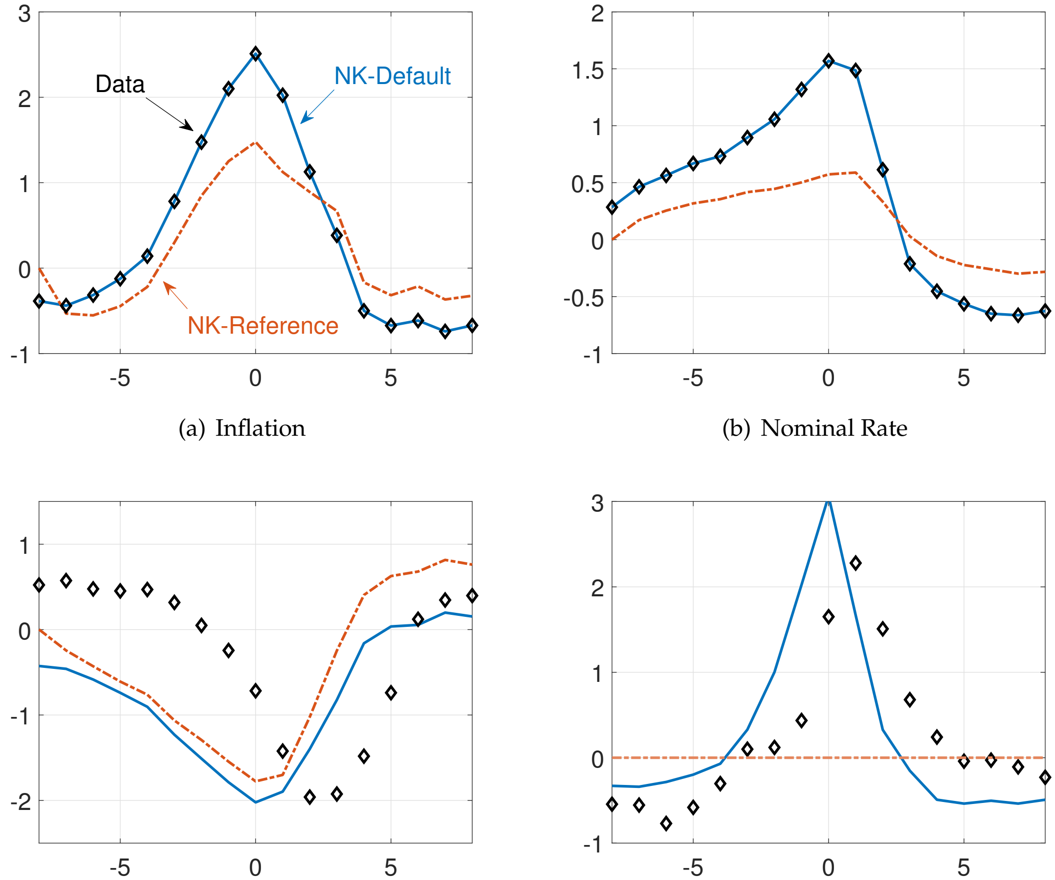
We revisit the temporary inflation events. We use our baseline model to evaluate its quantitative performance in matching the observed dynamics of the events discussed in Section 4.1. We perform two counterfactuals to assess the roles of default risk and monetary policy during such episodes, by comparing our baseline to an economy without default and one with tighter monetary policy.

To simulate the event, we start the model at the mean of the stationary distribution, with good credit standing, and feed in sequences of productivity and monetary shocks. The shocks are chosen such that the resulting paths of inflation and nominal interest rate in our NK-Default baseline model best fit the data in Figure 2. The solid blue lines in Figure 7 represent the resulting model time paths for inflation, nominal rates, output, and spreads. The black diamond markers correspond to the data. All series are standardized, as described in Section 4.1. The baseline model replicates well the paths for inflation and the nominal rate, as seen in the top two panels. Note that in our non-linear model with default risk, there is no guarantee that there exist shock paths which can deliver arbitrary paths for these variables, so we view this result as providing further validation of our model. Inflation increases temporarily, close to 2.5 standard deviations, in both model and data, and returns to low levels about a year after peaking. Nominal rates increase by 1.5 standard deviations as inflation picks up, and then they fall below their long-term average once inflation subsides. As shown in Figure A4 in Appendix D, inflation events result from the interaction of low productivity and expansionary monetary policy shocks.

The baseline model delivers comparable dynamics to the data for output and spreads, as illustrated in the bottom two panels of Figure 7. Output falls to about 2 standard deviations below average and spread increases by about 3 standard deviations, quickly returning to average levels within 6 quarters from the peak of inflation. In the data, nevertheless, the trough in output is about two quarters after the trough in the model. Given our model's account of these events, we use it to shed light on the role of default risk and monetary policy, through two counterfactuals.

For our first counterfactual, we assess the contribution of default risk to these dynamics by comparing our baseline NK-Default model to paths produced by the NK-Reference model without default risk. We feed the NK-Reference model the same time paths for productivity and monetary shocks, and start the episode in the steady state. The resulting series are the dashed red lines in Figure 7. Without default risk, the increase in inflation during the event is more muted than in the baseline, about 50%, from the start of the event to the peak. In contrast, the decrease in output in the NK-Reference model is comparable to that of the baseline model with default. The top right panel shows that the increase in nominal rates is smaller, reflecting the more muted rise in inflation. Finally, note that the NK-Reference model is silent on spread dynamics.

For a second counterfactual, we evaluate the role played by monetary policy in shaping temporary inflation events. We compare our baseline model time paths with a case in which monetary shocks are contractionary throughout, as presented in Figure A4. These shocks deliver a 1 standard deviation increase in the nominal rate at its peak, a 35% smaller increase in CPI inflation, and a slightly deeper recession, from the start of the event to the peak of inflation. Notably, the rise in spreads is much more modest, a reduction by about 70% compared to the baseline, over the same horizon. This exercise im-

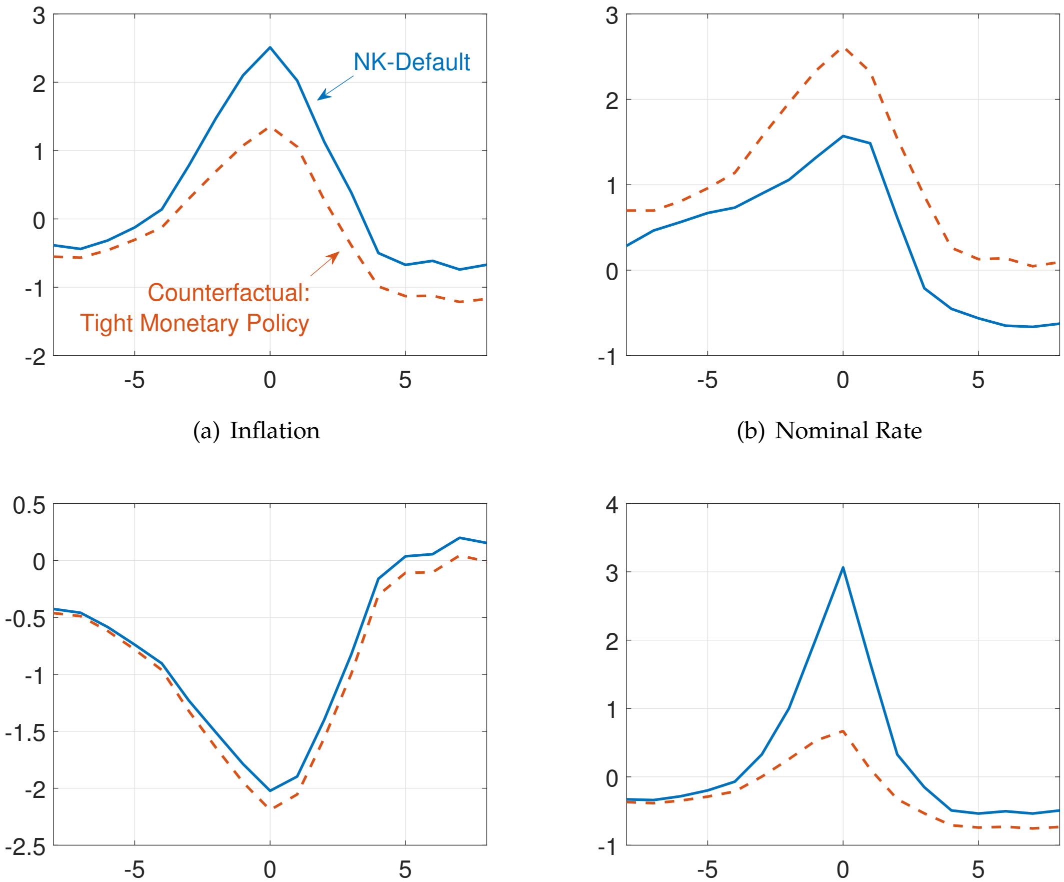


(a) Inflation (b) Nominal Rate

(c) Output (d) Spread

Figure 7: Inflation Event Analysis: Model Fit and the Role of Default Risk

Note: Time paths for productivity z and monetary shocks m are set to fit the paths of inflation and the nominal rate in the baseline model. Shock paths are plotted in Figure A4 in the Appendix. The data is in black diamond markers, the same quarterly paths as in Figure 2. The blue solid line is the baseline model and the dashed red line is the NK-Reference model without default.



(a) Inflation (b) Nominal Rate

(c) Output (d) Spread

Figure 8: Inflation Event Analysis: the Role of Monetary Policy

Note: See note in Figure 7. The solid blue line is the baseline model while the dashed red line is the counterfactual with tight monetary policy. Time paths for productivity z and monetary shocks m are plotted in Figure A4 in the Appendix.

plies that, at the peak of the event, a 1% increase in the monetary shock decreases spreads by 0.33%. Interestingly, the elasticity of spreads to monetary shocks is heterogeneous across the state space and ranges between -0.02 and -0.33 in this event counterfactual.

The first counterfactual shows that during the temporary inflation events default risk is an important driver of inflation. Low productivity and expansionary monetary shocks tend to raise default risk, which increases expected inflation. In turn, this higher expected inflation feeds into current inflation via the firms' pricing decisions and calls for more aggressive monetary policy in the form of a stronger response by nominal domestic rates. The message from this event analysis mirrors the findings from the business cycle comparisons in Table 4, default risk amplifies inflation volatility. Our second counterfactual illustrates how contractionary monetary policy can have a large impact on spreads, in addition to its traditional impact on inflation and activity, but also points to the state-contingent nature of these effects. To explore further the impact of monetary policy on the dynamics of the economy, we turn to alternative monetary policy rules in the next section.

4.6 Alternative Monetary Rules

We compare our baseline NK-Default model, with an inflation targeting monetary rule, to two different monetary policy regimes. The first alternative we consider is that of *strict inflation targeting*. Under this regime, the monetary authority sets nominal rates such that inflation π_t is at all times at the target level $\overline{\pi}$. Recall that this would be the optimal monetary regime for a model similar to ours, except without default risk. As in the theoretical analysis of Section 3, under strict inflation targeting, outcomes are those that would prevail under flexible prices.

The second alternative regime we consider is one under which monetary policy follows an augmented interest rate rule. Based on our theoretical analysis, we know that interest rate rules that respond to default risk can support better outcomes, therefore in this extension we propose a rule that responds to both inflation and default risk Φ_t. For the *inflation-default risk* regime, the interest rate rule is

$$i_t = \bar{i}\left(\frac{\pi_t}{\overline{\pi}}\right)^{\alpha_P}\left(\frac{\Phi_t}{\overline{\Phi}}\right)^{\alpha_D} m_t. \tag{31}$$

We focus on the case under which α_P is kept as in the baseline and where we fix a value for $\overline{\Phi}$ corresponding to a 0.25% annual default probability and an α_D of 8. In Section 6, we will vary both α_P and α_D and report the welfare consequences of these alternative parameter values.

Business cycle moments. Table 4 reports the business cycle moments for the alternative monetary policy regimes. The second column corresponds to our NK-Default baseline model while the fourth and fifth columns correspond to the strict inflation targeting and the inflation-default risk regimes, respectively. Under strict inflation targeting, the mean spread is roughly 50 basis points higher than in NK-Default while CPI inflation is substantially smoother. In this regime, the monetary discipline mechanism is disabled and, as a result, spreads are higher due to more aggressive sovereign borrowing. This model exhibits two counterfactual negative correlations, between spreads and CPI inflation and between spreads and the depreciation rate. As producer prices inflation is constant at target, all movements in CPI inflation are due to changes in the terms of trade, and the correlation between spreads and CPI inflation reflects terms of trade movements alone.

Turning to the inflation-default risk regime, we find that spreads are significantly reduced. One notable consequence of this rule that targets default is the much lower volatility of CPI inflation, about one-fifth, even though the α_P parameter is unchanged. This quantitative finding echoes Proposition 3 from our theoretical analysis of monetary discipline, where the default risk rule reduces both default risk and the monetary wedge, associated with inefficient movements in inflation.

In our quantitative analysis, we also find that strict inflation targeting is dominated by both the baseline monetary rule and the inflation-default risk rule. However, before we discuss these welfare results in detail in Section 6, we move to establish the robustness of our mechanisms in several extension economies.

5 Robustness Analysis and Monetary Discretion

We now examine several extensions of our baseline model. We consider economies with local currency debt, and alternative default costs, including monetary costs, a case without productivity costs of default, and domestic financial frictions. We show that, as in the baseline model, default risk amplifies monetary distortions and leads to high inflation volatility across these extension models. We also find that the disciplining effects of tight monetary policy are robust to these extensions. Finally, we use the local currency debt economy to compare monetary rules to monetary policy under discretion.

5.1 Local Currency Debt and Monetary Discretion

Our baseline NK-Default model features debt denominated in foreign currency. We turn to the case of local currency government debt, with a valuation that fluctuates with inflation. This assumption is also empirically relevant as many emerging market governments that are inflation targeters increasingly rely on domestic currency debt for their financing.

We also use this economy to study the effects of discretionary monetary policy. As is well known, monetary policy with discretion in these environments involves a trade-off between using inflation to devalue debt and incurring costly pricing frictions.[31] Moreover, monetary policy is time-inconsistent: ex-post, the government has incentives to inflate away debt, yet ex-ante would have liked to commit to not inflate, to receive better borrowing terms. In our economy with discretion, the government chooses local currency borrowing, default, and nominal interest rates, period-by-period. The details of these models are found in Appendix E.

Columns 2 and 3 in Table 5 report results for economies with local currency debt under the baseline monetary rule (10) and under discretion, respectively. For these experiments, we keep the parameters values of the baseline calibration. Under the rule, mean inflation is less than half of the inflation under discretion (4.1% versus 9.3%). This is because under discretion the government actively uses monetary policy to inflate away the debt. The low volatility of inflation under discretion means that the government keeps inflation elevated across shock levels. In terms of sovereign spreads, the economy under discretion features an average spread that is more than double the spread in the monetary policy rule economy.[32] The volatility of consumption is also much more elevated under discretion. These results show that relative to discretion, monetary rules not only deliver better inflation outcomes but also lower spreads and lower volatility for consumption.

The economy with local currency debt under the baseline monetary rule features similar dynamics in responses to shocks. Figures A7 and A8 in Appendix H contains IRFs for the variables of interest for monetary and productivity shocks. As in the baseline, spreads fall with contractionary monetary shocks, although the sensitivity is smaller in this economy. With domestic currency debt, contractionary monetary policy also increases the real value of the debt due to lower inflation, counteracting the disciplining effects.

For reference, column 1 of Table 5 lists the baseline calibration results. Recall that the local currency NK-Default economy employs the same parameter values as the baseline, and therefore any differences between these cases are exclusively due to the denomination of the debt. The patterns of inflation across these two economies are similar, but sovereign spreads are lower with local currency debt. Higher inflation during recessions induces a hedging advantage for local currency debt, useful to avoid borrowing at high interest rates and leading to lower spreads.

[31] We abstract from the potential benefits of discretionary monetary policy in the form of seigniorage revenue, a topic that Espino et al. (2024) explore in an environment with foreign currency defaultable debt.

[32] For comparability, we report sovereign spreads for synthetic foreign-denominated securities, priced in the economy with local currency debt. In practice, however, local currency spreads as defined by Du and Schreger (2016) have almost identical properties in our model.

	NK-Default	Local Currency Debt		Alt. Default Costs		
		NK-Default	Discretion	Monetary	No Prod.	Fin. Frictions
Mean						
CPI inflation	3.9	4.1	9.3	3.9	4.2	3.8
Nominal domestic rate	5.7	6.0	10.8	5.8	6.1	5.6
Spread	2.0	0.6	1.5	1.6	0.8	2.0
Debt to output	17	23	23	19	18	18
Standard Deviation						
Output	2.2	2.5	2.2	2.2	2.5	2.4
CPI inflation	1.8	1.7	0.4	1.9	1.7	1.8
Spread	0.9	0.3	0.4	0.7	0.1	1.0
Consumption aggregate	2.6	2.3	3.3	2.7	2.3	2.7
Nominal domestic rate	3.1	2.8	2.2	3.2	2.8	3.1
Depreciation rate	1.9	1.8	0.8	1.9	1.9	2.0
Correlations						
(Spread, Output)	−53	−42	−62	−56	−3	−50
(Spread, CPI inflation)	59	71	9	56	16	61
(Spread, Nom. dom. rate)	78	90	65	77	15	77
(Spread, Depreciation rate)	52	60	9	49	7	51
(CPI inf., Output)	−15	−3	−17	−17	−1	−12
(CPI inf., Nom. dom. rate)	90	86	−10	88	88	87
Autocorrelations (%)						
Output	69	67	72	69	69	68
CPI inflation	96	95	85	96	98	96
Spread	63	71	48	61	85	65
Nominal domestic rate	85	83	55	84	89	85

Table 5: Robustness Analysis and Monetary Discretion

Note: This table presents business cycle moments for six models. The first column repeats results for the baseline "NK-Default." In the second and third columns, government debt is denominated in local currency. For the "NK-Default" case, monetary policy follows the standard rule (10) while for the "Discretion" case monetary policy is chosen period-by-period by the government. Under the "Alt Default Costs, Monetary", default changes the monetary rule to be more accommodative. Under "Alt Default Costs, No Prod.", default does not lead to a decline in productivity but instead reduces utility. Under the "Alt Default Costs, Fin. Frictions", firms use working capital loans.

5.2 Alternative Costs of Default

We now turn to the robustness of our results with respect to the costs of default. We assess robustness because these costs play an important role in sovereign default models, and causal empirical estimates are scarce.[33] First, we evaluate a monetary cost of default, namely that the monetary rule becomes more accommodative during default. Second, we consider an economy where default leads to a cost in terms of utility, as opposed to the productivity penalty from the baseline. Third, we study an economy where default risk worsens credit conditions for firms. We find that our main mechanisms of amplification and discipline are robust to these alternative costs.

Monetary costs. In our baseline model, monetary policy is always committed to its interest rate rule, even during defaults. As default is a time of fiscal distress, the monetary authority could be under pressure to abandon its commitment to target inflation. We consider here the case where monetary policy is loose after default. The monetary authority sets lower policy rates during default, such that $i_t = \left(\bar{i} - \Delta\right)\left(\frac{\pi_t}{\overline{\pi}}\right)^{\alpha_p} m_t$, with $\Delta > 0$ if $\Theta = 1$ and zero otherwise. We set Δ to 0.25%, which implies that nominal rates increase by about an extra 1% in default, and keep all other parameters as in the baseline.

The results for this case are reported in the fourth column of Table 5, under "Alt. Default Costs, Monetary." Relative to the baseline, this economy features somewhat higher volatility of inflation and consumption and a lower mean and volatility of spreads. In this economy, the amplification mechanisms are stronger, raising the volatility of inflation and consumption. In response, the government borrows with less default risk to ameliorate the additional friction, resulting in lower and more stable spreads. Figures A9 and A10 of Appendix H report IRFs, which exhibit similar patterns to our baseline model. We conclude that our mechanisms, amplification and disciplining, are robust to environments when monetary policy is looser during defaults.

No productivity costs. In our baseline model, default leads to a reduction in productivity. To tease out the importance of this assumption, we consider instead a constant utility cost to defaulting. We assume that the enforcement shock ν now has a positive mean $\bar{\nu}$, which we set to reproduce the same debt to output ratio as in the baseline. All other parameters are fixed at their baseline values.

The simulated moments for this economy are in the fifth column of Table 5, under "Alt. Default Costs, No Prod." This economy generates moments for inflation and nominal rates comparable to the baseline NK-Default economy, but delivers very different moments for spreads and a lower volatility of consumption. The substantial inflation volatility of this model implies that the inflation amplifica-

[33] One clean piece of evidence comes from the study of Hébert and Schreger (2017), who use high frequency data and find that higher default risk causes declines in stock market valuation.

tion from default risk does not require productivity costs from default. Recall that inflation volatility, absent default (in the NK-Reference model) is much lower, at 1.0%. The spread, however, has a lower mean and volatility, is acyclical, and is only weakly correlated with inflation and the nominal rate. These spread differences lower the volatility for consumption. This failure to match spread dynamics is consistent with the findings in the sovereign debt literature that productivity costs of default are important quantitatively. Figures A9 and A10 in Appendix H, plot IRFs and document that our mechanisms are qualitatively robust to this alternative cost of default. The responses of inflation and nominal rates are comparable to the baseline, while the disciplining mechanism is more muted, as the spread reduction from contractionary monetary shocks is about half.

As in the baseline model, default risk here also brings inflation pressures by affecting allocations through the expectation channel, as it increases expected marginal utility and expected inflation. In fact, the functions M and F continue to be increasing in debt, as in the baseline model. In the simple example of Section 3, the productivity cost of default was the reason why expected marginal utility increased, but in the general model expected tight bond prices coupled with high debt further reinforce this effect. Expected inflation increases because marginal utility is especially high in states of low productivity and high inflation.[34] The message from these results is that inflation amplification from default risk does not require productivity costs from default, but these costs are important quantitatively for the disciplining mechanism and crucial for the model to replicate the patterns in the data.

Domestic financial frictions. In our baseline model we abstracted from credit market frictions for firms, but in practice both monetary policy and default risk can impact domestic credit conditions.[35] For this robustness exercise, we incorporate a standard working capital friction for firms and assume that firms need to pay their wage bill by taking a working capital loan, with interest rate i_{ft}. This interest rate faced by firms depends on the nominal interest rate set by monetary policy and also on sovereign spreads and default, as these affect the balance sheet of financial intermediaries. In this set up, there are additional endogenous costs of default risk because it can trigger a domestic credit crunch. Appendix F describes in detail this extension. For calibration, we use the empirical findings from Arellano et al. (2020) that measure a passthrough of 0.64 from sovereign spreads to firms' borrowing rates during sovereign debt crises, and keep all other parameter values as in the baseline model.

The results for this case are in the sixth column of Table 5, under "Alt. Default Costs, Financial Frictions." The properties of the model with financial frictions are similar to the baseline. However, the

[34] We also note that in this model although high debt is associated with high inflation and high expected marginal utility, high debt is not associated with positive and large monetary wedges (as in the baseline, illustrated in Figures 4).

[35] See Christiano, Eichenbaum, and Evans (2005) for the reference model of monetary policy's impact on working capital loans to firms and Bocola (2016) for domestic credit crunches from default risk, on which we build for this exercise.

mean and volatility of spreads are slightly higher because the additional, endogenous distortion of production, especially when default risk is high. These additional spillovers from default risk also result in a slightly higher volatility to consumption. This model also delivers the positive correlations of spreads with inflation, nominal rates, and depreciation rates, and produces comparable IRFs for productivity and monetary shocks, as seen in Figures A9 and A10 in the Appendix.

6 Welfare Implications

Finally, we evaluate the welfare implications of monetary policy rules and regimes. We consider welfare under different parameter values for the monetary rule (31), in the baseline NK-Default economy, as well as for the extension economies. We also study two other monetary policy regimes: strict inflation targeting and monetary discretion. A robust finding is that strict inflation targeting is not an optimal monetary policy in economies with default risk. Monetary rules that are sufficiently responsive to inflation or default risk provide disciplining benefits for sovereign debt.

6.1 Baseline NK-Default Model

We start with the welfare implications of alternative monetary policy regimes for the baseline model, as covered by Table 4. We report the welfare of domestic households at a state given by a debt level of zero ($B = 0$) and all shocks at their median levels ($z = m = 1$), while the economy enjoys good credit standing.[36]

Figure 9 compiles the findings. It plots welfare expressed as a consumption equivalent percentage, by varying the monetary rule (31) parameters, relative to the strict inflation targeting regime. In the left panel, we vary α_P, the coefficient controlling the response of domestic nominal rates to deviations of inflation from target, while keeping $\alpha_D = 0$. The red diamond marks the value from our baseline parameterization, which indicates that households marginally prefer the rule to strict inflation targeting. For low enough levels of α_P, strict inflation targeting is preferable. However, when the monetary policy rule calls for more aggressive responses to inflation, the disciplining mechanism lowers default risk enough, so that a regime exhibiting some inefficient production due to pricing frictions, but where default risk is low, is better than outcomes under strict inflation targeting.

The right panel of Figure 9 turns to our findings for the inflation-default risk monetary policy rule. Here, α_P is kept at the baseline level and the horizontal axis varies α_D, starting at its baseline value of

[36] We compared welfare at a particular debt level because we want to hold constant the level of wealth across model economies. Moreover, the welfare ranking presented here persists across the entire state space, although welfare differences tend to decrease slowly with debt and flatten out for sufficiently high debt, but remain positive.

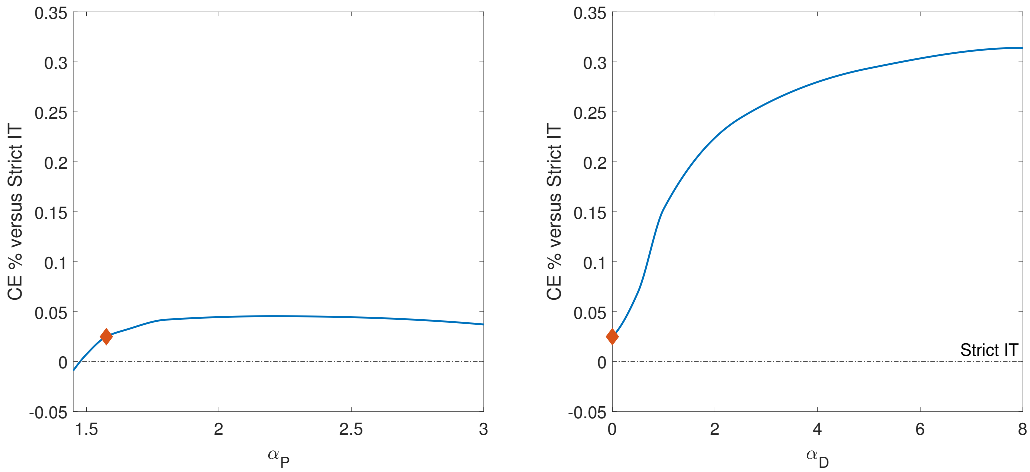


Figure 9: Welfare Comparison Across Monetary Policy Regimes

Note: Welfare gains of the monetary rule (31) expressed in consumption equivalent measures, relative to the *strict inflation targeting* regime, corresponding to the horizontal dashed black line at zero. The red diamond marks the level associated with our baseline NK-Default model. The left panel fixes $\alpha_D = 0$ and varies α_P. The right panel fixes $\alpha_P = 1.575$ as in our baseline parameterization, and varies α_D.

0. The welfare gains from adopting this rule over strict inflation targeting are potentially sizable and increase with α_D. As α_D approaches 8, households would be willing to forego 0.3% of their consumption on average, for policy to switch to the inflation-default risk rule instead of strict inflation targeting. We summarize these welfare results in the first four rows of the Table 6.

6.2 Model Extensions

We compile and summarize the welfare implications of different policy regimes, across the various model extensions. Table 6 reports consumption equivalent welfare, all relative to the baseline economy under a strict inflation targeting policy. As before, the welfare statistics are computed for mean shocks and debt equal to zero. We also report the mean spread and inflation for each of the economies.

Table 6 reports welfare for economies with local currency debt, where firms face financial frictions, and with alternative default costs, which were discussed in Section 5. We also compare welfare in the baseline economy, across sovereign debt duration, by lowering it by two years, since maturity is a known determinant of the welfare losses from debt dilution (Hatchondo et al., 2016). We evaluate several monetary regimes under each economy.

Consider welfare in the economy with local currency debt. The baseline policy rule delivers sizable gains relative to strict inflation targeting (0.253% relative to 0.081%). These gains arise because the rule lowers spreads substantially and also because inflation patterns endow debt with a hedging ad-

	Welfare (%)	Spread	Inflation
Baseline Economy			
Strict Inflation Target	—	2.5	4.3
Baseline Monetary Rule	0.025	2.0	3.9
Less Responsive Monetary Rule	−0.009	2.1	3.8
Inflation-Default Risk Rule	0.314	0.3	3.4
Local Currency Debt			
Strict Inflation Target	0.081	1.9	4.3
Baseline Monetary Rule	0.253	0.6	4.1
Inflation-Default Risk Rule	0.354	0.1	4.4
Discretion	−0.195	1.5	9.3
Financial Frictions			
Strict Inflation Target	0.020	2.3	4.3
Baseline Monetary Rule	0.025	2.0	3.8
Inflation-Default Risk Rule	0.342	0.2	5.4
Monetary Costs			
Baseline Monetary Rule Pre-Default	0.056	1.6	3.9
No Productivity Costs			
Baseline Monetary Rule	0.326	0.8	4.2
Shorter Duration Debt			
Strict Inflation Target	0.080	1.2	4.2
Baseline Monetary Rule	0.084	0.7	4.0

Table 6: Welfare, Spreads, and Inflation Across NK-Default Economies and Monetary Policy Rules

Note: This table reports welfare, mean spread, and mean CPI inflation across economies and monetary policy rules. Welfare is consumption equivalence evaluated for zero debt and the mean level of shocks. Welfare is reported relative to the Baseline Economy under a strict inflation targeting monetary policy.

vantages for the sovereign. The gains from the rule are double when compared to discretion (0.253% versus -0.195%). Discretion is the most detrimental monetary arrangement among all that we consider, because it generates high inflation and high spreads, relative to the case of local currency debt and rule-based policy. The table also illustrates how issuing local currency debt welfare-dominates issuing foreign currency debt, because of its aforementioned hedging properties.

For the economy with domestic financial frictions, the welfare ranking and magnitudes across monetary regimes are comparable to the baseline economy. These exercises are informative because they show that our welfare results in the baseline are robust to the inclusion of endogenous costs of default, from worsening domestic financial frictions.[37] Economies with monetary costs encode harsher costs from default, which leads to greater debt sustainability, lower spreads, and less default, all contributing to higher welfare. The case with no productivity costs features instead an additional punishment, in utils, making welfare not directly comparable to the baseline. However, this case exhibits very little default in equilibrium, which contributes to its higher household welfare.

Finally, the table also shows that the economy with shorter debt duration delivers higher welfare relative to the baseline, for a given monetary regime, consistent with prior work on sovereign debt maturity. In addition, the monetary rule continues to be better than strict inflation targeting, but the gains are smaller than in the baseline case of longer duration, because of less debt dilution.

Comparing outcomes across these economies suggests that the fiscal and monetary regimes that deliver the best outcomes are those that result in fewer defaults and lower inflation. In Figure 10, we illustrate how economies with higher welfare tend to have lower mean spreads. The discretion economy features the lowest welfare level, even though its spreads are not exceptionally high. The low welfare of this economy is driven by its high average inflation rate. Interestingly, both the worst and the best policy regime features local currency debt: the worst is discretionary policy with local currency debt while the best outcomes for households are achieved with local currency debt and the inflation-default risk monetary policy rule.

7 Conclusion

We proposed a framework that combines two important aspects of current policy in emerging markets: sovereign risk in government debt and inflation targeting as monetary policy. It allowed us to identify novel mechanisms shaping the interplay of monetary policy, sovereign spreads, and domestic activity. We have employed our framework to study temporary inflation events in emerging markets, which have been accompanied by higher sovereign spreads and tighter monetary policy. We also provide support

[37] See Table A4 in Appendix F for business cycle moments of this economy across monetary regimes.

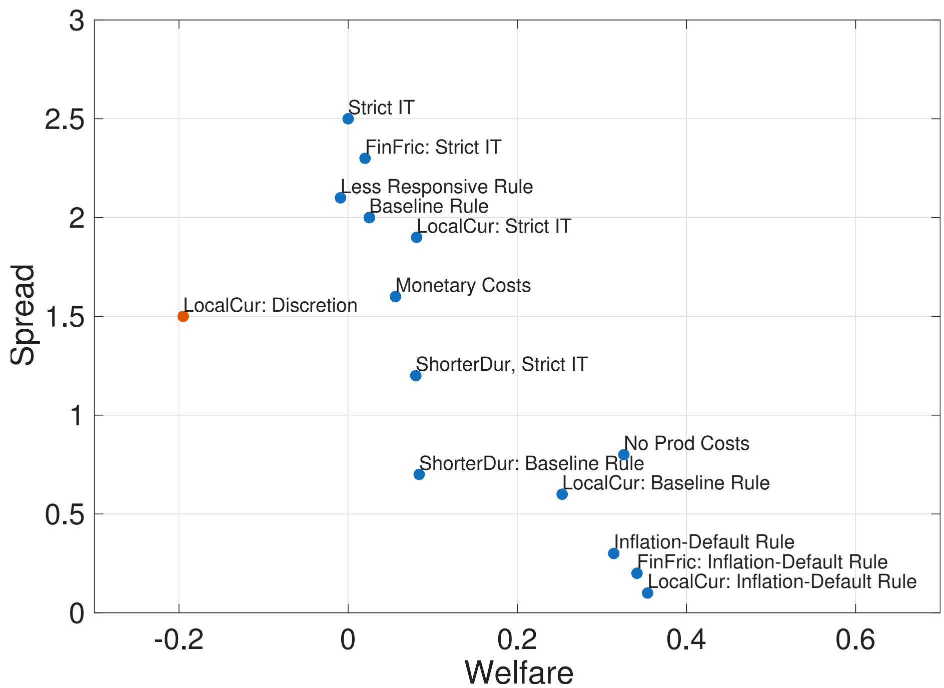


Figure 10: Welfare and Spread Across Economies

Note: Welfare is expressed as consumption equivalent, relative to the strict inflation targeting regime in the baseline economy.

for the relevance of the mechanism of our model by combining empirical analysis using panel data of 8 emerging market inflation targeters with a quantitative evaluation of our model. Using our model as a building block, we established the robustness of our mechanisms to several extensions, including the currency denomination of the debt and domestic financial frictions for firms. Finally, our work speaks to the design of optimal monetary policy in emerging markets and finds that strict inflation targeting is not optimal in the presence of default risk.

In developing an integrated New Keynesian sovereign default model, we have necessarily abstracted from important features affected by both nominal rigidities and sovereign risk. Some of these include unemployment, investment, trade policies, the spillovers of US monetary policy to emerging market economies (Kalemli-Özcan, 2019), alternative assumptions about price stickiness such as local currency pricing (Corsetti et al., 2010) or dominant currency pricing (Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller, 2020), or other financial stability policies such as capital controls. We conjecture that some of the policy implications may be substantially altered when analyzed in a New Keynesian framework with sovereign risk.

Our framework could also be useful for the study of other episodes with elevated inflation or sovereign spreads. During the recent 2022 inflation outbreak, several European countries experienced increases in inflation and spreads jointly, similarly to the emerging market episodes we studied. In contrast, during the 2012 European debt crisis the increases in spreads were not accompanied by inflation (De Ferra and Romei, 2023). We leave for future work the question of whether a combination of supply and demand shocks can rationalize these distinct patterns within the context of our framework.

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Appendix to "Monetary Policy and Sovereign Risk in Emerging Economies (NK-Default)"

by Cristina Arellano, Yan Bai, and Gabriel Mihalache

A Characterization of the Equilibrium

In this appendix, we summarize the conditions of the private and monetary equilibrium and derive the optimal borrowing condition for the government.

A.1 Conditions for Private and Monetary Equilibrium

Given $S = (s, B, \Theta, B')$, the private and monetary equilibrium can be summarized with six variables: domestic and foreign goods consumption $\{C, C^f\}$, labor N, inflation π, the nominal domestic rate i, and the terms of trade e, that satisfy the following system of six equations:

$$C + e^{\rho}\xi = \left[1 - \frac{\varphi}{2}\left(\pi - \overline{\pi}\right)^2\right] z(\tilde{z}, \Theta) N \tag{32}$$

$$e^{\rho}\xi = e[C^f + (1-\Theta)((r+\delta)B - q(s, B')(B' - (1-\delta)B))] \tag{33}$$

$$\frac{u_{C^f}}{u_C} = \frac{\rho}{\rho - 1} e \tag{34}$$

$$\left(\pi - \overline{\pi}\right)\pi = \frac{\eta - 1}{\varphi}\left(-\frac{u_N}{z(\tilde{z}, \Theta) u_C} - 1\right) + \frac{\beta}{u_C z(\tilde{z}, \Theta) N} F(s, B', \Theta) \tag{35}$$

$$u_C = i\beta\, M(s, B', \Theta) \tag{36}$$

$$i = \bar{i}\left(\frac{\pi}{\overline{\overline{\pi}}}\right)^{\alpha_p} m, \tag{37}$$

for given functions z, F, M, and q. Condition (32) is the resource constraint, condition (33) is the balance of payments condition, condition (34) is the intratemporal optimality of domestic and foreign goods consumption, condition (35) is the NKPC, condition (36) is the domestic Euler equation, and condition (37) is the monetary policy rule. The solution of this system of equations results in the policy functions $C(S), C^f(S), N(S), \pi(S), e(S), i(S)$.

The functions F and M are the expectations in the firms' pricing condition (NKPC) and the households' Euler condition given by

$$F(s, B', \Theta) = \mathbb{E}\left[z(\tilde{z},' \Theta') N(S') u_C(S')\left(\pi(S') - \overline{\pi}\right)\pi(S')\right], \tag{38}$$

$$M(s, B', \Theta) = \mathbb{E}\frac{u_C(S')}{\pi(S')}, \tag{39}$$

where the future private state $S' = (s', B', H_\Theta(s', \nu', B', \Theta), H_B(s', B'))$ depends on the future government borrowing policy $H_B(\cdot)$ and the evolution of credit standing $H_\Theta(\cdot)$ given by (11).

The function for the bond price q compensates lenders for losses in default and depends on the government's policy functions for default and borrowing

$$q(s, B') = \frac{1}{1+r}\mathbb{E}\left[(1 - H_D(s', \nu', B'))(r + \delta + (1-\delta)q(s', H_B(s', B'))\right]. \tag{40}$$

where $H_D(\cdot)$ is the government's default policy.

The equilibrium conditions (32) to (37) are analogous to those arising in the standard New Keynesian small open economy of Galí and Monacelli (2005). The difference in our model is that the government understands that its choice of default D and borrowing B' affect the state S and the equilibrium. Moreover, the government's choices determine the next period's state variables, which means that future allocations and prices also depend on the government's current choices. These future effects are encoded in the functions $F(s, B', \Theta)$, $M(s, B', \Theta)$, and $q(s, B')$.

A.2 Derivation of Optimal Government Borrowing

We derive the government's optimal borrowing condition, equation (17) from Section 2.8. To illustrate the government's borrowing incentives, we assume that all the policy functions are differentiable with respect to state B and that the first-order conditions are sufficient for the government's optimization problem. Conditional on not defaulting, $\Theta = 0$, the government chooses $\{C, C^f, N, \pi, B'\}$ to solve the following problem:

$$W(s, B) = \max_{\{C, C^f, N, \pi, B'\}} u(C, C^f, N) + \beta_g \mathbb{E}\left\{\int_{\hat{\nu}(s', B')} W(s', B') dF_\nu(\nu') + \int^{\hat{\nu}(s', B')} [W^d(s') - \nu'] dF_\nu(\nu')\right\} \tag{41}$$

subject to the constraints imposed by the Private and Monetary Equilibrium, which can be characterized by the following four conditions:

$$[\lambda]\;\; C + [C^f + (\delta + r)B - q(s, B')\left(B' - (1-\delta)B\right)]^{\frac{\rho}{\rho - 1}} = \left[1 - \frac{\varphi}{2}\left(\pi - \overline{\pi}\right)^2\right]\tilde{z}N, \tag{42}$$

$$[\lambda_e]\;\; \frac{u_{C^f}}{u_C} = \frac{\rho}{\rho - 1}[C^f + (\delta + r)B - q(s, B')\left(B' - (1-\delta)B\right)]^{\frac{1}{\rho - 1}}, \tag{43}$$

$$[\gamma]\;\; \frac{\eta - 1}{\varphi}\left(-\frac{u_N}{\tilde{z}u_C} - 1\right) + \beta\frac{1}{u_C\tilde{z}N}F(s, B', \Theta) = \left(\pi - \overline{\pi}\right)\pi, \tag{44}$$

$$[\kappa]\;\; \bar{i}\left(\frac{\pi}{\overline{\pi}}\right)^{\alpha_P} m\, \beta M(s, B', \Theta) = u_C, \tag{45}$$

where the default cutoff $\hat{\nu}(s', B') = W^d(s') - W(s', B')$ and we used $z(\tilde{z}, \Theta = 0) = \tilde{z}$. We have also normalized $\xi = 1$. The government takes as given the functions $F(s, B', \Theta)$, $M(s, B', \Theta)$, and $q(s, B')$.

Let λ, λ_e, κ, and γ be the Lagrange multipliers associated with the resource constraint (42), the relative demand condition (43), the domestic Euler condition (45), and the NKPC condition (44), respectively. Note that the multiplier κ reflects the marginal value of the nominal interest rate. To see this, we use the envelop theorem and take the derivative of value W over $\bar{i}$:

$$\frac{\partial W}{\partial \bar{i}} = -\kappa \frac{u_c}{\bar{i}} \quad \Rightarrow \quad \kappa = -\frac{\partial W}{\partial \bar{i}} \frac{\bar{i}}{u_c}.$$

Given that $\bar{i} > 0$ and $u_c > 0$, the multiplier κ is positive when the value decreases with the nominal rate $\bar{i}$, $\partial W / \partial \bar{i} < 0$.

The first-order conditions over C, C^f, N, π, and B' are

$$\begin{aligned}
& u_C - \lambda - \lambda_e \frac{u_{CC^f} u_C - u_{CC} u_{C^f}}{(u_C)^2} + \kappa u_{CC} + \gamma \frac{u_{CC}}{u_C}\left[-\frac{\eta-1}{\varphi}\frac{u_N}{\tilde{z} u_C} + \beta \frac{F(s,B',0)}{\tilde{z} N u_C}\right] = 0, \\
& u_{C^f} - \lambda \frac{\rho}{\rho-1} e + \lambda_e \left(\frac{\rho e^{2-\rho}}{(\rho-1)^2} - \frac{u_{C^f C^f} u_C - u_{CC^f} u_{C^f}}{(u_C)^2}\right) \\
& \qquad + \kappa u_{CC^f} + \gamma \frac{u_{CC^f}}{u_C}\left[-\frac{\eta-1}{\varphi}\frac{u_N}{\tilde{z} u_C} + \beta \frac{F(s,B',0)}{\tilde{z} N u_C}\right] = 0, \\
& u_N + \lambda \left[1 - \frac{\varphi}{2}(\pi - \overline{\pi})^2\right] \tilde{z} - \gamma \left(\frac{\eta-1}{\varphi}\frac{u_{NN}}{\tilde{z} u_C} + \beta \frac{F(s,B',0)}{N^2 \tilde{z} u_C}\right) = 0, \\
& -\lambda \varphi (\pi - \overline{\pi}) \tilde{z} N - \kappa \alpha_P \frac{u_C}{\pi} + \gamma (2\pi - \overline{\pi}) = 0,
\end{aligned}$$

$$\begin{aligned}
& \left[q + \frac{dq}{dB'}\left(B' - (1-\delta) B\right)\right] \left\{\lambda \frac{\rho}{\rho-1} e - \lambda_e \frac{1}{\rho-1}\frac{\rho}{\rho-1} e^{2-\rho}\right\} - \beta i \frac{\partial M}{\partial B'} \kappa - \beta \frac{1}{u_C \tilde{z} N} \frac{\partial F}{\partial B'} \gamma \\
& = \beta_g \mathbb{E}(1 - D')(r + \delta + (1-\delta) q(s', B'')) \left\{\lambda' \frac{\rho}{\rho-1} e' - \lambda_e' \frac{1}{\rho-1}\frac{\rho}{\rho-1} (e')^{2-\rho}\right\}.
\end{aligned} \tag{46}$$

Let borrowing wedges τ_m^X and τ_m^C be defined by

$$\tau_m^X \equiv 1 - \frac{1}{u_{Cf}}\left[\lambda \frac{\rho}{\rho-1} e - \lambda_e \frac{1}{\rho-1}\frac{\rho}{\rho-1} e^{2-\rho}\right], \qquad \tau_m^C \equiv \beta i \frac{\partial M}{\partial B'} \kappa + \beta \frac{1}{u_C z N} \frac{\partial F}{\partial B'} \gamma.$$

By plugging the two borrowing wedges τ_m^X and τ_m^C into equation (46), we obtain the Euler equation (17) from Section 2.8.

We can show that monetary frictions alone give rise to these wedges, that is, when $\kappa = \gamma = 0$ then

$\tau_m^X = \tau_m^C = 0$. To see this, note that when $\kappa = \gamma = 0$ the first order conditions become

$$
\begin{aligned}
& u_C - \lambda - \lambda_e \frac{u_{CC^f} u_C - u_{CC} u_{C^f}}{(u_C)^2} = 0, \\
& u_{C^f} - \lambda \frac{\rho}{\rho - 1} e + \lambda_e \left(\frac{\rho e^{2-\rho}}{(\rho-1)^2} - \frac{u_{C^f C^f} u_C - u_{CC^f} u_{C^f}}{(u_C)^2} \right) = 0, \\
& u_N = -\lambda \tilde{z}.
\end{aligned}
$$

We can guess and verify that $\lambda_e = 0$. We guess $\lambda_e = 0$ and show that the government's optimization implies that $\lambda_e = 0$, that the relative demand condition is slack. Substituting in $\lambda_e = 0$, we have

$$
\begin{aligned}
& u_C - \lambda = 0, \\
& u_{C^f} - \lambda \frac{\rho}{\rho - 1} e = 0, \\
& u_N = -\lambda \tilde{z}.
\end{aligned}
$$

Together, these reduce to $u_C = -\frac{u_N}{\tilde{z}}$, and $u_{C^f} = u_C \frac{\rho}{\rho-1} e$, so that the optimal conditions of government require the relative demand condition (43) to hold. This implies that indeed we have $\lambda_e = 0$ when $\kappa = \gamma = 0$, and therefore $\tau_m^X = \tau_m^C = 0$.

B Proofs

B.1 Proof of Proposition 1

The proof consists of two parts. In the first part, we prove that higher borrowing B' increases the risk of default in the future. In the second part, we show that under Assumption 1, current inflation, the nominal domestic rate, and the monetary wedge increase with B'.

It is useful to collect Private and Monetary Equilibrium under the quasi-linear preferences in (21). In state $S = (s, B, \Theta, B')$, the equilibrium satisfies the following conditions

$$C + (C(\rho - 1)/\rho))^{\rho} = z(\tilde{z}, \Theta) N \left[1 - \frac{\varphi}{2} (\pi - \overline{\pi})^2 \right], \tag{47}$$

$$C^f = (C(\rho - 1)/\rho))^{\rho - 1} + (1 - \Theta) \left[q(s, B')(B' - (1 - \delta)B) - (r + \delta)B \right], \tag{48}$$

$$(\pi - \overline{\pi})\pi = \frac{\eta - 1}{\varphi} \left(\frac{C N^{1/\zeta}}{z(\tilde{z}, \Theta)} - 1 \right) + \beta \frac{C}{z(\tilde{z}, \Theta) N} F(s, B', \Theta), \tag{49}$$

$$\bar{i} \left(\frac{\pi}{\overline{\overline{\pi}}} \right)^{\alpha_P} m\beta M(s, B', \Theta) = \frac{1}{C} \tag{50}$$

where we have used the relations $u_{C^f}/u_C = \rho e/(\rho - 1)$, $u_{C^f} = 1$, $u_C = 1/C$, and $-u_N = N^{1/\zeta}$. It will also be useful to define μ as the monetary wedge, which is

$$1+\mu = \frac{z(\tilde{z},\Theta)}{N^{1/\xi}C} \tag{51}$$

Note that under quasi-linear preferences, it is immediate that given a borrowing choice B', the state for debt B does not affect $\{C, N, \pi, i\}$ and is simply absorbed by C^f. This means that $\{C, N, \pi, i\}$ are functions of (s, Θ, B'), but C^f is a function of the entire state (s, B, Θ, B'). In what follows, we consider how B' affects default risk and the Private and Monetary Equilibrium when the economy is in good credit standing, $\Theta = 0$, and for simplicity suppress the dependence of the functions on Θ.

Higher B' increases default risk $\Phi(s, B')$. We first show that the government's value under repayment, $W(s, B)$ is decreasing in B, that is $W(s, B_0) > W(s, B_1)$ for any given s for $0 < B_0 < B_1$.

Since (C, N, π, i) does not depend on B and C^f can take any real value, every B' that is feasible for the government with debt B_1 is also feasible with debt B_0. Moreover, $(1-\delta)q(s, B')B_0 + (r+\delta)B_0 < (1-\delta)q(s, B')B_1 + (r+\delta)B_1$ since $q(s, B') \geq 0$ and $r + \delta > 0$. This implies $C^f(s, B_0, B') > C^f(s, B_1, B')$ for any given (s, B'). Let B'_1 and B'_0 be the optimal borrowing levels associated with B_1 and B_0, respectively. The following inequalities hold

$$\begin{aligned}
W(s, B_1) &= u\left(C(s, B'_1), C^f(s, B_1, B'_1), N(s, B'_1)\right) + \beta_g \mathbb{E}V(s', B'_1) \\
&< u\left(C(s, B'_1), C^f(s, B_0, B'_1), N(s, B'_1)\right) + \beta_g \mathbb{E}V(s', B'_1) \\
&\leq u\left(C(s, B'_0), C^f(s, B_0, B'_0), N(s, B'_0)\right) + \beta_g \mathbb{E}V(s', B'_0) \\
&= W(s, B_0).
\end{aligned}$$

Note that the first inequality holds because $C^f(s, B_0, B') > C^f(s, B_1, B')$, and the second inequality holds because, under B_0, B'_1 is feasible yet B'_0 is the optimal choice. Hence for $B_0 < B_1$, $W(s, B_0) > W(s, B_1)$ for any given s.

The default cutoff given by $\hat{v}(s, B) = W^d(s) - W(s, B)$ increases with B as the repaying value $W(s, B)$ decreases with B for any given s and the defaulting value $W^d(s)$ is independent of B. This makes the default risk $\Phi(s, B') = E_{s'|s}F_v(\hat{v}(s', B'))$ increase with B for any given s.

Higher B' increases inflation, the nominal rate, and the monetary wedge. B' impacts $\{C, N, \pi, i\}$ exclusively through its effect on the F and M functions. We approximate the system of equations (47) and (49–51) with a first-order Taylor expansion around the equilibrium given state S, namely $(\overline{C}, \overline{N}, \overline{\pi}, \overline{i}, \overline{\mu})$, and when inflation is close to the target. We solve for deviations of these equilibrium variables. In the solution, holding shocks constant $d\tilde{z} = dm = 0$, the deviation of inflation $d\pi$, nominal domestic rates di, and the monetary wedge $d\mu$ are

$$d\pi = a_1\left[-\frac{1}{a_0}dM + dF\right], \quad di = \alpha_P\frac{\bar{i}}{\overline{\pi}}d\pi, \quad d\mu = a_2\left[\frac{\beta\bar{i}}{\theta}dM + \alpha_P dF\right], \tag{52}$$

where the positive constants a_1 and a_2 are a convolution of parameters,
$a_1 = \dfrac{\alpha_C}{\overline{\pi}^2 + \alpha_p\dfrac{\eta-1}{\varphi}(1+\dfrac{1}{\zeta}(\alpha_C+\rho(1-\alpha_C)))} > 0$, $a_2 = \dfrac{(1+\dfrac{1}{\zeta}(\alpha_C+\rho(1-\alpha_C)))\alpha_C}{1+\alpha_p\dfrac{\eta-1}{\varphi}(1+\dfrac{1}{\zeta}(\alpha_C+\rho(1-\alpha_C)))} > 0$, and $\alpha_C = \overline{C}/\overline{N} > 0$. The deviations of inflation, nominal rates, and the monetary wedge derived in the system (52) together with Assumption 1 prove the result.

B.2 Characterization of Constrained Efficient Allocations

We start by characterizing the reference model, which has no pricing frictions and constrained-efficient borrowings. After default, the country is permanently excluded from international financial markets. Hence, the defaulting value is given by

$$W^d = \max_{C,C^f,N} u(C,C^f,N)/(1-\beta)$$

subject to the resource constraint and the balanced trade conditions,

$$C + e^{\rho} = z(\bar{z},\Theta)N, \quad e^{\rho} = eC^f.$$

The optimal allocations in default $\{C_d,\ N_d,\ e_d\}$ satisfy the following resource constraint and the two first-order conditions,

$$C + e^{\rho} = z(\bar{z},\Theta)N, \quad C = \rho/(\rho-1)e, \quad N^{1/\zeta}C = z(\bar{z},\Theta), \tag{53}$$

with $z(\bar{z},\Theta = 1) = z_d$, and where we substituted the derivatives $u_C = 1/C$, $u_{C^f} = 1$, and $u_N = N^{1/\zeta}$. Once we know e_d, the balanced trade condition determines imported consumption $C_d^f = e_d^{\rho-1}$.

The problem for the government conditional on not defaulting, $\Theta = 0$, consists on choosing (C,C^f,N,B') to solve the following problem

$$W(B) = \max_{\{C,C^f,N,B'\}} u(C,C^f,N) + \beta\left\{\left[1-F_\nu(\hat{\nu}(B'))\right]W(B') + \int^{\hat{\nu}(B')}(W^d-\nu)dF_\nu(\nu)\right\}, \tag{54}$$

subject to the following resource constraint, the balanced trade condition, and the bond price function

$$C + e^{\rho} = \bar{z}N, \quad e^{\rho} = e\left[C^f + (1+r)B - q(B')B'\right], \quad q(B') = \left[1-F_\nu(\hat{\nu}(B'))\right], \tag{55}$$

where we have substituted that $z(\bar{z},\Theta = 0) = \bar{z}$. The default cutoff $\hat{\nu}(B')$ satisfies $\hat{\nu}(B) = W^d - W(B)$.

The constrained efficient optimal allocations for $\{C^\star, N^\star, e^\star\}$ also satisfy the system of equations (53) but with $z(\bar{z}, \Theta = 0) = \bar{z}$. Define the constant $u^\star = \log C^\star - \dfrac{(N^\star)^{1+1/\zeta}}{1+1/\zeta} + (e^\star)^{\rho-1}$, which summarizes the constant utility from the allocations $\{C^\star, N^\star, e^\star\}$. We can then simplify the government's problem by

$$W(B) = \max_{B'} \; u^\star - (1+r)B + q(B')B' + \beta \left\{ \left[1 - F_\nu(\hat{\nu}(B'))\right] W(B') + \int^{\hat{\nu}(B')} (W^d - \nu) dF_\nu(\nu) \right\}. \tag{56}$$

The optimal borrowing $B^\star$ satisfies the following Euler equation

$$1 - h(\hat{\nu}(B'))B' = \beta(1+r), \tag{57}$$

where h is the hazard function of enforcement shock ν. Using this optimal borrowing B^*, we can evaluate the value $W^\star$ as,

$$W^\star = u^\star - (1+r)B^\star + [1 - \Phi(\hat{\nu}^\star)]B^\star + \beta \left\{ [1 - F_\nu(\hat{\nu}^\star)] \, W^\star + \int^{\hat{\nu}^\star} (W^d - \nu) dF_\nu(\nu) \right\},$$

where the optimal default cutoff satisfies $\hat{\nu}^\star = W^d - W^\star$. Furthermore, for arbitrary initial debt B, the government's repayment value and default cutoff become

$$W(B) = W^\star + (1+r)B^\star - (1+r)B, \quad \hat{\nu}(B) = W^d - W^\star - (1+r)B^\star + (1+r)B.$$

Hence, $W(B)$ is linear and decreasing in B, and the default cutoff function $\hat{\nu}^\star(B)$ increases with B.

B.3 Proof of Lemma 1

We show that the monetary authority can deliver $\overline{\pi}$ with $i = i^{ST}$ in period 0 by constructing this equilibrium in the one-time deviation economy. Suppose that the monetary authority can deliver strict inflation targeting (ST) with a choice of $i = i^{ST}$. The government here solves a similar problem as the constrained efficient one, namely it does not face pricing frictions, but now it discounts the future with β_g in period 0: (C, C^f, N, B') to solve the following problem

$$\max_{\{C, C^f, N, B'\}} \; u(C, C^f, N) + \beta_g \left\{ \left[1 - F_\nu(\hat{\nu}(B'))\right] W(B') + \int^{\hat{\nu}(B')} (W^d - \nu) dF_\nu(\nu) \right\}, \tag{58}$$

subject to the conditions in (55). The cutoff function $\hat{\nu}(B)$ and the future value function W and W^d are the same as those in the constrained efficient case (54). Optimal borrowing B^{ST} satisfies the government's Euler equation

$$1 - h(\hat{\nu}(B^{ST}))B^{ST} = \beta_g(1+r). \tag{59}$$

Delivering strict inflation targeting, namely $\pi = \overline{\pi}$, requires that i^{ST} satisfies the domestic Euler equation under the optimal government's borrowing B^{ST} such that domestic consumption is equal to the efficient level $C^\star$,

$$\frac{1}{C^\star} = \beta i^{ST}/\overline{\pi}\left[\frac{1-F_\nu(\hat{v}(B^{ST}))}{C^\star} + \frac{F_\nu(\hat{v}(B^{ST}))}{C_d}\right].$$

Note that since inflation is at the target, (C, N, e) solve (53) with $z = \overline{z}$ under no default. This construction shows that the monetary authority can deliver strict inflation targeting by setting the appropriate level of the nominal interest rate.

We show that default risk is higher under strict inflation targeting. Using the implicit function theorem, we can find the derivative of B' with respect to β_g using the Euler (59),

$$\frac{\partial B'}{\partial \beta_g} = -\frac{1+r}{\frac{\partial h}{\partial v}\frac{\partial v}{\partial B'}B' + h} < 0.$$

The derivative is negative due to the assumption of an increasing hazard $\partial h/\partial \hat{v} > 0$ and that the default cutoff increases in B', $\partial v/\partial B' > 0$. The optimal borrowing for the constrained efficient economy depends on the discount factor β, as shown in (57), while the optimal borrowing for strict inflation targeting depends on β_g. Given that $\beta_g < \beta$ and $\partial B'/\partial \beta_g < 0$ gives that $B^{ST} > B^\star$ and $\Phi^{ST} = F_\nu(\hat{v}(B^{ST})) > \Phi^\star = F_\nu(\hat{v}(B^\star))$.

Furthermore, the welfare under strict inflation targeting is lower than that in the constrained efficient economy. Here is the reason. Both programs, the constrained efficient program and the strict inflation targeting program, face the same future value, default cutoff function, and bond price schedule. B^{ST} is available for the constrained efficient economy. However, the optimal choice is $B^\star$. It must be the case that for households, $W^{ST} \leq W^\star$.

B.4 Proof of Lemma 2

Here, we prove that default risk increases the monetary wedge for a given monetary policy i when the monetary wedge is positive. We consider the response of the private economy to the government's borrowing B' when the economy is in credit standing, $\Theta = 0$. Higher B' pushes up the default risk, which affects the consumption and production of domestic goods through the domestic Euler equation. Specifically, for any given B', domestic consumption C, labor N, monetary wedge μ, and inflation π satisfies the following four equations,

$$C + \left(\frac{\rho-1}{\rho}C\right)^\rho = \left[1 - \frac{\varphi}{2}(\pi - \overline{\pi})^2\right]\overline{z}N \tag{60}$$

$$\frac{1}{1+\mu} = 1 + \frac{1}{\eta - 1}\varphi(\pi - \overline{\pi})\pi \tag{61}$$

$$1 + \mu = \frac{\overline{z}}{N^{1/\xi}C} \tag{62}$$

$$\frac{1}{C} = \frac{\beta i}{\overline{\pi}}\left[\frac{1-F_\nu(\hat{v}(B'))}{C^\star} + \frac{F_\nu(\hat{v}(B'))}{C_d}\right] \tag{63}$$

where we replaced the terms of trade e using $C = \dfrac{\rho}{\rho - 1}e$. From the domestic Euler equation (63), we can solve for C as a function of default risk $F_v(\hat{v}(B'))$ and the given monetary policy i:

$$C = \frac{\overline{\pi}}{\beta i} \frac{1}{\left[\dfrac{1 - F_v(\hat{v}(B'))}{C^\star} + \dfrac{F_v(\hat{v}(B'))}{C_d}\right]}.$$

Given that $C^\star > C^d$, it is easy to see that higher default risk $F_v(\hat{v}(B'))$ lowers C. Hence, the domestic Euler equation determines domestic consumption C for any given B'.

We prove that the monetary wedge μ increases with default risk. From the NKPC, we can solve π as a function of monetary wedge μ[38]

$$\pi(\mu) = \frac{\overline{\pi} + \sqrt{\overline{\pi}^2 - 4\dfrac{\eta - 1}{\varphi}\dfrac{\mu}{1+\mu}}}{2}. \tag{64}$$

Here, we abuse the notation and write the equilibrium π as a function of the monetary wedge μ. Note that $\frac{d\pi}{d\mu} \leq 0$, and when $\mu > 0$, inflation is lower than target $\pi(\mu) < \overline{\pi}$. We can then replace N in the resource constraint (60) with (51) to get a mapping between the monetary wedge and domestic consumption,

$$C^{1+\xi} + \left(\frac{\rho - 1}{\rho}\right)^{\rho} C^{\rho+\xi} = \left\{1 - \frac{\varphi}{2}[\pi(\mu) - \overline{\pi}]^2\right\} (1+\mu)^{-\xi}(\overline{z})^{1+\xi}. \tag{65}$$

Given that C is pinned down by the domestic Euler equation, the condition (65) solves for the monetary wedge μ for any C.

Given that high default risk decreases C, we need to show that when C is low, the monetary wedge is high, namely $\partial\mu/\partial C \leq 0$. Using the implicit function theorem, we have

$$\frac{\partial \mu}{\partial C} = -\frac{(\overline{z})^{-(1+\xi)}(1+\mu)^{1+\xi}\left[(1+\xi)C^{\xi} + (\rho+\xi)\left(\dfrac{\rho-1}{\rho}\right)^{\rho} C^{\rho+\xi-1}\right]}{\xi\left\{1 - \frac{\varphi}{2}[\pi(\mu) - \overline{\pi}]^2\right\} + \varphi(1+\mu)\left[\pi(\mu) - \overline{\pi}\right]\frac{d\pi}{d\mu}}. \tag{66}$$

Let's consider the fraction in the derivative (66). The numerator is non-negative. The denominator has two terms. The first term is positive since the economy will not use all its output on inflation cost, i.e., $\left\{1 - \frac{\varphi}{2}[\pi(\mu) - \overline{\pi}]^2\right\} \geq 0$. The second term $\varphi(1+\mu)\left[\pi(\mu) - \overline{\pi}\right]\frac{d\pi}{d\mu}$ is also positive because $d\pi/d\mu \leq 0$ and $\pi(\mu) \leq \bar{\pi}$ when $\mu \geq 0$, according to our previous discussion. Therefore, both the numerator and denominator are positive. With a minus sign in the front of the fraction, this implies $d\mu/dC < 0$.

Hence, higher default risk decreases C and leads to a higher monetary wedge μ, when $\mu \geq 0$. □

[38]Note that there are two solutions for inflation from NKPC, $\pi_1 = \frac{\overline{\pi} + \sqrt{\overline{\pi}^2 - 4\frac{\eta-1}{\varphi}\frac{\mu}{1+\mu}}}{2}$, $\pi_2 = \frac{\overline{\pi} - \sqrt{\overline{\pi}^2 - 4\frac{\eta-1}{\varphi}\frac{\mu}{1+\mu}}}{2}$. However the inflation cost $\varphi(\pi - \overline{\pi})^2/2$ under π_2 is higher than under π_1. Hence, the optimal solution should be $\pi = \pi_1$.

B.5 Proof of Proposition 2: (Discipline)

Using the utility function (21) and conditions (intra $C - C^f$) and (balance payments), we can simplify the government problem (26) as

$$\max_{B',C,N,\pi} \log C + \left(\frac{\rho-1}{\rho}C\right)^{\rho-1} - (1+r)B + q(B')B' - \frac{N^{1+1/\zeta}}{1+1/\zeta}$$
$$+ \beta_g \left\{ \left[1 - F_\nu(\hat{\nu}(B'))\right] W(B') + \int^{\hat{\nu}(B')} (W^d - \nu) dF_\nu(\nu) \right\} \tag{67}$$

subject to (bond price) and the private equilibrium conditions

$$C + \left(\frac{\rho-1}{\rho}C\right)^{\rho} = \left[1 - \frac{\varphi}{2}\left(\pi - \overline{\pi}\right)^2\right] zN \tag{68}$$
$$\frac{N^{1/\zeta}C}{z} = 1 + \frac{1}{\eta-1}\varphi\left(\pi - \overline{\pi}\right)\pi \tag{69}$$
$$\frac{\beta i}{\overline{\pi}}\mathbb{E}u_{C'}(B') \equiv \frac{\beta i}{\overline{\pi}}\left[\frac{1 - F_\nu(\hat{\nu}(B'))}{C^\star} + \frac{F_\nu(\hat{\nu}(B'))}{C_d}\right] = \frac{1}{C}. \tag{70}$$

Let $(\lambda, \gamma, \kappa)$ be multipliers for conditions (68), (69), and (70) respectively. We can derive the following first-order conditions:

over C

$$\frac{1}{C}\left[1 + (\rho-1)e^{\rho-1}\right] - \lambda\left[1 + (\rho-1)e^{\rho-1}\right] - \gamma\frac{N^{1/\zeta}}{z} - \kappa\frac{1}{C^2} = 0$$

over N

$$-N^{1/\zeta} + \lambda\left[1 - \frac{\varphi}{2}\left(\pi - \overline{\pi}\right)^2\right] z - \gamma\frac{1}{\zeta}\frac{N^{1/\zeta-1}C}{z} = 0$$

over π

$$-\lambda\varphi(\pi - \overline{\pi})zN + \gamma\frac{1}{\eta-1}\varphi(2\pi - \overline{\pi}) = 0$$

over borrowing

$$1 - h(\hat{\nu}(B'))B' - \frac{\kappa}{1 - F_\nu(\hat{\nu}(B'))}\left[\frac{\partial \mathbb{E}u_C(B')}{\partial B'}\frac{1}{C\,\mathbb{E}u_C(B')}\right] = \beta_g(1+r). \tag{71}$$

where we have used condition (bond price). We can solve for the multipliers λ, γ, and κ from FOC's on π, N, and C:

$$\lambda = \frac{N^{1/\zeta}}{z}\frac{1}{\left[1 - \frac{\varphi}{2}\left(\pi - \overline{\pi}\right)^2\right] - (\eta-1)\frac{\pi - \overline{\pi}}{2\pi - \overline{\pi}}\frac{1}{\zeta}\frac{N^{1/\zeta}C}{z}}$$

$$\gamma = \lambda(\eta-1)\frac{\pi - \overline{\pi}}{2\pi - \overline{\pi}}zN$$

$$\kappa = \frac{C\left[1+(\rho-1)e^{\rho-1}\right]}{1+\mu}\left\{1+\mu-\frac{1+\dfrac{1}{\left[1+(\rho-1)e^{\rho-1}\right]}(\eta-1)\dfrac{\pi-\overline{\pi}}{2\pi-\overline{\pi}}N^{1/\zeta+1}}{\left[1-\dfrac{\varphi}{2}\left(\pi-\overline{\pi}\right)^2\right]-(\eta-1)\dfrac{\pi-\overline{\pi}}{2\pi-\overline{\pi}}\dfrac{1}{\zeta}\dfrac{1}{1+\mu}}\right\}. \tag{72}$$

with the monetary wedge μ defined as (51).

We prove by contradiction that whenever $i > i^{ST}$ the monetary wedge is positive, $\mu > 0$.

Suppose that when $i > i^{ST}$, $\mu \leq 0$. With this configuration, $\pi \geq \overline{\pi}$ according to (61). Furthermore, $\kappa \leq 0$ from (72) since $1+\mu < 1$, $2\pi \geq \overline{\pi}$, the numerator of the second term in the brackets is larger than 1, and the denominator of this term is less than 1.

Optimal borrowing under strict inflation targeting (59) differs from that under the one-time deviation (71) economy given monetary policy i, by the additional term $-\kappa\left[\dfrac{\partial \mathbb{E}u_C(B')}{\partial B'}\dfrac{1}{C\,\mathbb{E}u_C(B')}\right]$. The sign of this term depends on the sign of the domestic Euler multiplier κ given that expected marginal consumption increases with B'. With $\kappa < 0$, $B' \geq B^{ST}$.

Domestic consumption depends on the nominal rate i and default risk through the domestic Euler condition (71). With $B' \geq B^{ST}$ and $i > i^{ST}$, $C < C^{ST}$. The proof of Lemma 2 indicates that the monetary wedge decreases with C; hence, from that result, if $C < C^{ST}$, $\mu > 0$. We have a contradiction. Hence when $i > i^{ST}$, the monetary wedge is positive, $\mu > 0$. A positive monetary wedge $\mu > 0$ implies that $\pi < \overline{\pi}$ and $\kappa > 0$ from (61) and (72). A positive multiplier, $\kappa > 0$, lowers the government's incentive to borrow from (71). Hence, $B' < B^{ST}$ and default risk is lower under the one-time deviation when $i > i^{ST}$.

B.6 Proof of Proposition 3: (Default Risk Monetary Rule)

Given fiscal policy, the allocations for C, N, and π in an economy with the default risk monetary rule satisfy three conditions: (68) and (69), and the following domestic Euler equation

$$\frac{1}{C} = \beta\bar{i}(\Phi(B')/\Phi^{\star})^{\alpha_D}\mathbb{E}u_C(B').$$

The government's optimal borrowing condition in turn is

$$1-h(\hat{v}(B'))B' - \frac{\kappa}{1-\Phi(\hat{v}(B'))}\left[\frac{\partial \mathbb{E}u_C(B')}{\partial B'}\frac{1}{C\mathbb{E}u_C(B')}+\alpha_D\frac{f_v(\hat{v}(B'))}{CF_v(\hat{v}(B'))}\right] = \beta_g(1+r).$$

This condition contains an additional term relative to the condition (71), derived for the case of monetary policy determined by i, that depends on the sensitivity of nominal rates with respect to default risk, namely $\alpha_D u_C\dfrac{f_v(\hat{v}(B'))}{F_v(\hat{v}(B'))}$.

We first express allocations C, N, and π as functions of μ using conditions (68), (69), and the fact that the monetary wedge μ maps into the marginal rate of substitution between labor and consumption, condition (51). Note that for an arbitrary μ, these allocations do not depend on B'. In addition, given these allocations, the terms of trade e and the multiplier κ can be expressed as a function of μ through conditions (intra $C - C^f$) and (72).

We turn to the case when $\mu = \varepsilon$, an arbitrary positive small number. Let C_ε and κ_ε be the consumption and multiplier associated with such monetary wedge.

The monetary authority can implement those allocations and the efficient level of borrowing $B^\star$, and therefore default risk $\Phi(B') = \Phi^\star$, by setting a monetary rule $\bar{i}(\Phi(B')/\Phi^*)^{\alpha_D}$ with parameters $\bar{i}$ and α_D that satisfy

$$\frac{1}{C_\varepsilon} = \beta\bar{i}\mathbb{E}u_C(B^\star)$$

$$\kappa_\varepsilon \frac{1}{1-\Phi(\hat{v}(B^\star))}\left[\frac{\partial \mathbb{E}u_C(B^\star)}{\partial B'}\frac{1}{C_\varepsilon \mathbb{E}u_C(B^\star)} + \alpha_D \frac{f_v(\hat{v}(B^\star))}{C_\varepsilon F_v(\hat{v}(B^\star))}\right] = (\beta - \beta_g)(1+r).$$

These conditions induce the government to borrow efficiently. Given that $\varepsilon > 0$, $\kappa_\varepsilon > 0$ and therefore $\alpha_D > 0$, for $\beta > \beta_g$. Note that in this equilibrium $i \approx i^\star$ and $\pi \approx \bar{\pi}$.

C Data and Empirical Evidence

This section contains four subsections. First, we present the data sources of national accounts, prices, and sovereign spreads. Second, we demonstrate the robustness of our empirical results that illustrate our monetary disciplining mechanism. Third, we provide evidence from inflation expectations to validate the default amplification mechanism. Lastly, we examine the 2021 inflation episode.

C.1 Data

Considering data availability, our analysis focuses on eight countries that have adopted inflation targeting. These countries include Brazil, Chile, Colombia, Mexico, Peru, the Philippines, Poland, and South Africa (refer to Roger (2009) for more details).

Data Sources

To ensure consistency in our analysis and account for the transition period of implementing the policy, we examine the data from 2004Q1 to 2019Q4 for all the countries and relevant data series.

Our data series include the emerging markets bond index (EMBI), consumer price index (CPI), central banks' policy rates, nominal exchange rate, and national accounts.

Spreads. We use the commercial GFDatabase of Global Financial Data (2022) for monthly Emerging Markets Bond Index (EMBI) spreads. The primary source for EMBI is JPMorgan Chase. To align with our quarterly model, we aggregated the data to a quarterly frequency by calculating the quarterly averages from the raw series.

Consumer price index and inflation. All consumer price indices are sourced from the International Financial Statistics (IFS) compiled by the International Monetary Fund (IMF). These series are provided at a quarterly frequency. We then use consumer price indices to construct the quarterly inflation by using the current CPI divided by CPI four quarters ago.

Policy rates and nominal exchange rates. The policy rates and nominal exchange rates utilized in our analysis have been sourced from the Bank for International Settlements (BIS).

In particular, for the period spanning from 2004Q1 to 2019Q4, the monthly policy rates were derived from the following sources:

Brazilian central bank target for money market (SELIC) overnight rate; Chile official monetary policy rate; Colombia 1 day repo rate; Mexico bank funding rate from Nov 3, 1998, to Jan 20, 2008, and money-market overnight rate from Jan 21 2008 onwards; Peru official monetary policy rate; Philippines Official market intervention representative rate; Poland official 7-day central bank bill yield; South Africa official repo rate.

For each country, we took the broad indices of the nominal effective exchange rate from BIS, the nominal exchange rate against a broad basket (64 economies) of currencies.

In our analysis, we constructed quarterly policy rates and nominal effective exchange rates by calculating the quarterly averages of their respective monthly series.

National accounts. We used the commercial CEIC (`https://www.ceicdata.com`, 2022) for National Accounts data except for Colombia, whose data is from the OECD.

CEIC obtains its real national account data primarily from the OECD and its nominal national account data primarily from the International Monetary Fund's International Financial Statistics (IFS). For our sample countries, these include Brazil, Chile, Mexico, Poland, and South Africa. For Peru, the national account data is sourced from the Central Reserve Bank of Peru, while the data for the Philippines comes from the Philippine Statistics Authority.

Government debt. We use annual debt data from the World Development Indicators of the World Bank for the countries available (Argentina, Brazil, Colombia, Mexico, Peru, Philippines, South Africa) for 2004 through 2019. The debt is the external public debt (public and publicly guaranteed) relative to nominal GDP in dollars. For Chile, we use measures of central government debt from CEIC.

Inflation targeting monetary policy in emerging market economies. The countries in our sample have adopted inflation targeting as their monetary policy regime. In Table A1 we compile references to the web pages where each Central Bank describes its mandate, operating procedures, and their inflation targets. For these countries, using interest rate policies to stabilize prices, under flexible exchange rates, is the norm.

Brazil	https://www.bcb.gov.br/en/monetarypolicy/Inflationtargeting
Chile	https://www.bcentral.cl/en/web/banco-central/areas/monetary-politics
Colombia	https://www.banrep.gov.co/en/monetary-policy
Mexico	https://www.banxico.org.mx/monetary-policy/interest-rate-operational-tar.html
Peru	https://www.bcrp.gob.pe/en/monetary-policy/informative-notes-on-the-monetary-program.html
Philippines	https://www.bsp.gov.ph/Pages/PriceStability/InflationTargetting.aspx
Poland	https://nbp.pl/en/monetary-policy/
South Africa	https://www.resbank.co.za/en/home/what-we-do/monetary-policy

Table A1: Web Pages Describing Inflation Targeting Monetary Policy

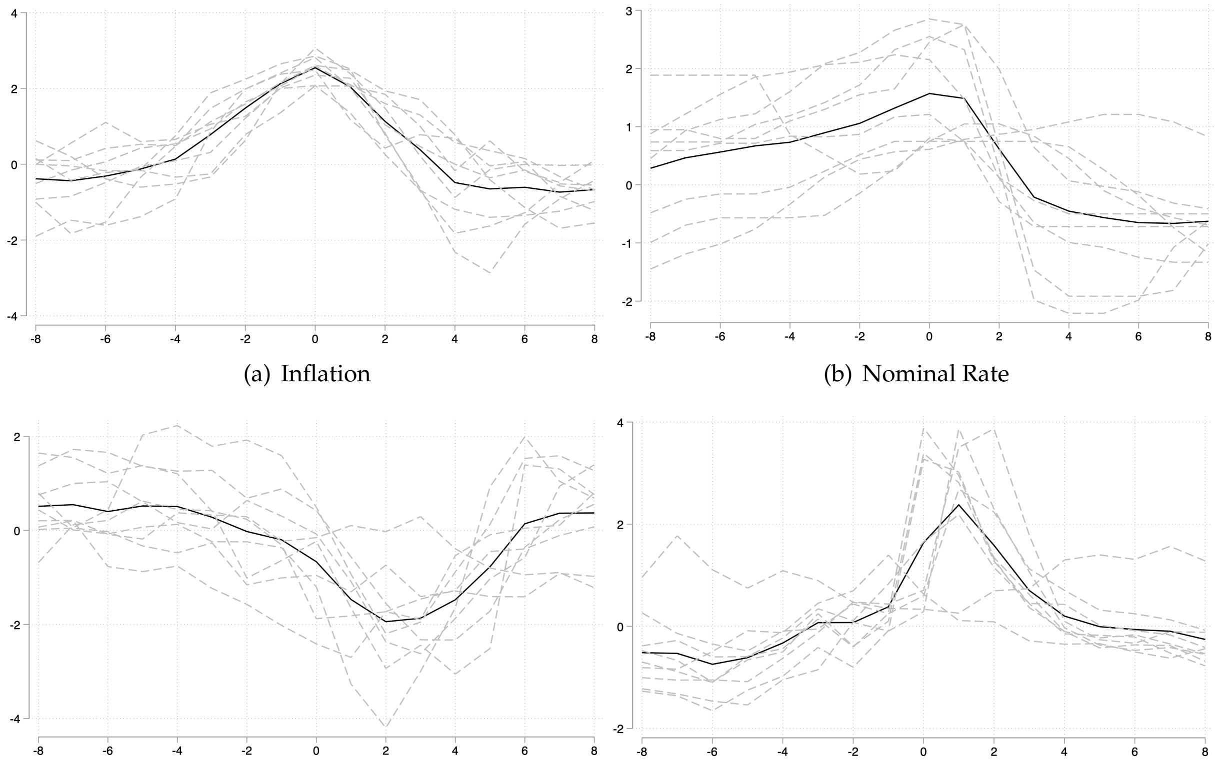
Inflation Events

The inflation events are defined as the time periods when a country experiences inflation higher than two standard deviations above its mean (across 2004Q1-2019Q4). The nine events peak at Brazil 2015Q4, Chile 2008Q3, Colombia 2008Q4 and 2015Q2, Mexico 2008Q4 and 2017Q4, Peru 2008Q4, Philippines 2008Q4, South Africa 2008Q3. The event window is defined as a 2-year window around the peak of each event.

In Figure A1 we plot the paths for inflation, nominal rates, output, and spreads for these events, where the horizontal axis is quarters and 0 is the quarter with the peak of inflation. In the event analysis of Section 4.4, we use the average paths of these events, which are plotted in the solid lines of Figure A1. The dashed lines of the figure are individual paths for each of the nine events. The figure shows that in all episodes, elevated inflation is temporary and tends to be associated with elevated nominal rates and spreads, as well as recessions. Despite the common patterns, we can also see some differences in the timing and magnitude of the fluctuations.

C.2 Empirical Robustness of Disciplining Effect

This appendix provides robustness on the empirical result that illustrates our monetary disciplining mechanism. These results are based on monthly data for the 8 countries in our sample: Brazil, Chile, Colombia, Mexico, Peru, the Philippines, Poland, and South Africa. The data consists of CPI inflation, industrial production growth, policy rates, and sovereign spreads. The data run from 2004 through 2022, and inflation and growth are constructed as yearly changes. As described in Section 4.1, we first recover monetary policy shocks by estimating standard interest rate rules country by country. We then standardize all series at the country level and estimate the projections in (29) with the panel data.



(a) Inflation (b) Nominal Rate

(c) Output (d) Spread

Figure A1: Temporary Inflation Events Paths

Table A2 contains the values of the regression coefficients for monetary policy shocks β_h. The first column contains the results for our baseline specification, also illustrated in Figure 3. Positive monetary shocks, which indicate tighter monetary shocks, tend to reduce spreads in the short run. The median short-run effect across the first three months is -0.07, indicating that a one-standard-deviation increase in monetary shocks tends to decrease spreads by 0.07 standard deviations. The effect is short-lived, with a negative coefficient for 3 months. The baseline specification contains as controls contemporaneous and six lags for industrial production growth and inflation, as well as country fixed effects. Errors in all our specifications are clustered in two ways: across countries and time.

In column 2, we consider a specification with 9 lags for monetary shocks, industrial production, and inflation. The results are very comparable to the baseline specification. In column 3, we re-run our baseline specification, but do not standardize the variables; instead, we run the specification in levels. The effects from this specification are very comparable to the baseline, although the median point estimate elasticity during the first quarter of -0.4, and the effects are significant for longer.

Dependent variable: Spreads	(1) Baseline	(2) More Lags	(3) Levels
Monetary shock	-0.09^{**}	-0.09^{**}	-0.45^{***}
Monetary shock (-1)	-0.07^{**}	-0.07^{***}	-0.40^{**}
Monetary shock (-2)	-0.05	-0.04	-0.28^{**}
Monetary shock (-3)	0.01	0.00	0.01
Monetary shock (-4)	0.05	0.04	0.15
Monetary shock (-5)	0.06	0.06	0.24
Monetary shock (-6)	0.05	0.06	0.18
Industrial production lags	Yes	Yes	Yes
Inflation lags	Yes	Yes	Yes
More lags	No	Yes	No
Country Fixed Effects	Yes	Yes	Yes
No. Observations	1483	1459	1483
R^2	0.38	0.38	0.50

Table A2: Robustness on Disciplining Mechanism

Note: The table contains the regression coefficients of sovereign spreads on monetary policy shocks from estimating equation (29) using monthly data for Brazil, Chile, Colombia, Mexico, Peru, Philippines, Poland, and South Africa. In columns (1) and (2) series are standardized at the country level. Standard errors in all specifications are clustered across time and country.

C.3 Evidence from Inflation Expectations

A prediction of our model is that high default risk increases expected inflation, which is a key element in the default amplification mechanism. In this Appendix, we provide direct evidence of default amplification mechanism and its expectation channel, based on available inflation expectation data from emerging markets. Several countries in our sample conduct consumer expectations surveys, which include questions about households' beliefs regarding inflation over the subsequent 12 months. We compile this data for Brazil (FGV Consumer Survey), Chile (Chile Economic Expectation Survey), Colombia (Consumer Opinion Survey), the Philippines (Consumer Expectations Survey), and South Africa (BER Household Inflation Expectation Survey) and relate it with the EMBI sovereign spreads measure, at a quarterly frequency.

Table A3 explores the relation between inflation expectations and EMBI spreads, using pooled and fixed effects estimates, with optional controls for the output growth rate and/or the nominal depreciation. We find that, on average, a 1% increase in spreads is robustly associated with a 0.9–1.0% increase in expected inflation over the following year, with some variation across countries.

We construct a measure of expected CPI inflation over the upcoming year in our baseline quantitative model and estimate the same specification as in the data. We find a coefficient of 1.14, within the 95% confidence interval of our empirical specifications, e.g., [0.727, 1.202] for the specification with both con-

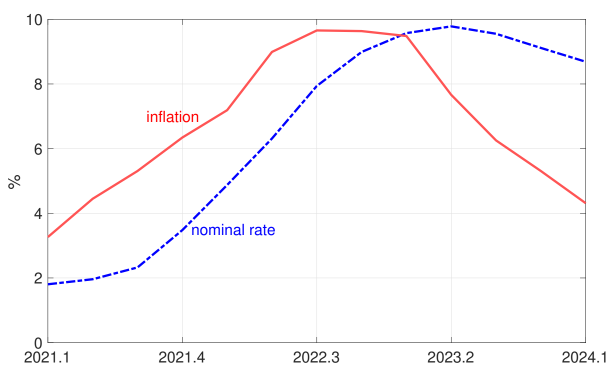
Inflation Expectations	(1)	(2)	(3)	(4)	(5)
EMBI	1.452***	0.922***	0.934***	0.883***	0.965***
	(0.136)	(0.181)	(0.147)	(0.112)	(0.121)
GDP Growth			0.054*		0.051***
			(0.035)		(0.023)
Nominal Depreciation				−0.010	−0.006
				(0.007)	(0.007)
Country Fixed Effect	No	Yes	Yes	Yes	Yes
N	244	244	234	230	226
R^2	0.32	0.32	0.36	0.31	0.36

Table A3: Inflation Expectations and EMBI Spreads

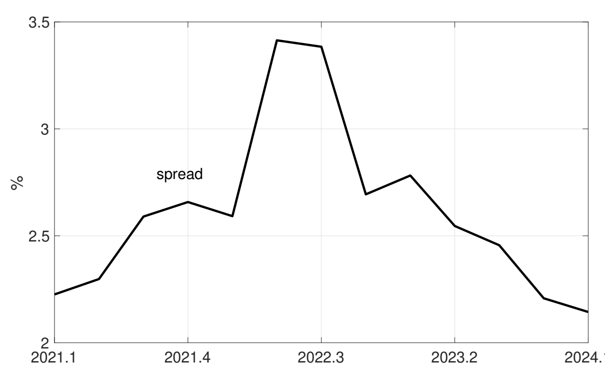
trols, column (5). This finding confirms that the association between spreads and inflation expectations is quantitatively similar between the model and the data, supporting our amplification mechanism.

C.4 The 2021 Inflation Episode

Like much of the world, emerging markets have also experienced an uptick in inflation starting in 2021. Figure A2 plots the evolution of inflation and the nominal rate (Panel (a)), and spreads (Panel (b)), averaged across our sample countries.[39] Inflation increased in all of the 8 countries, on average about 6.4%, with a range of 4.3% to 13.6% across countries. Central banks responded aggressively, with increases of nominal rates between 4.5% and 11.5%, by 8% on average. At the same time, spreads spiked by 0.9% to 2.4%, with a cross-country average of 1.3%. Importantly, by early 2024, inflation is well on its way towards target, and the increase in spreads is fully reverted.



(a) Inflation and the Nominal Rate



(b) Spread

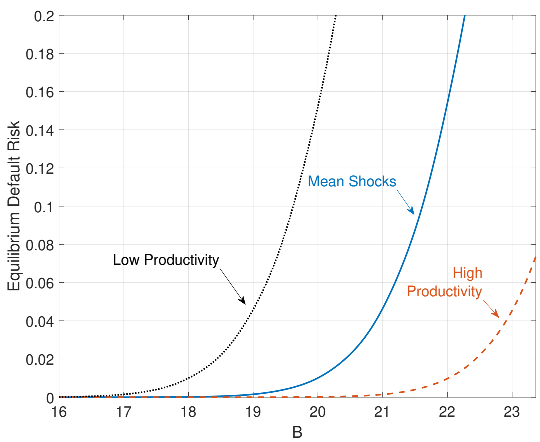
Figure A2: Inflation and Spreads During the 2021 Episode

[39]The EMBI spread data is only available for 5 countries during this period.

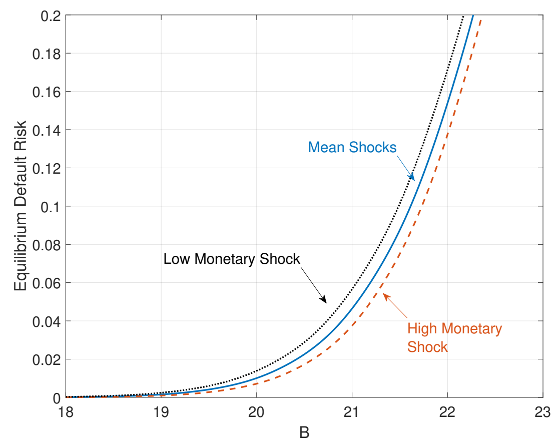
D Default Risk Function and Shocks in Event

Here we present how the equilibrium default risk varies with the state variables. We also show the implied shocks during temporary inflation events.

Default risk function. Figure A3 plots the equilibrium default risk as a function of state variables: debt B, productivity shock z, and monetary shock m. Consistent with the standard sovereign default literature, higher debt or lower productivity increases default risk either through increased borrowing for consumption smoothing or a tightened bond price schedule. Our model additionally generates a novel prediction for monetary shocks: higher m shocks lower inflation through the monetary discipline effect uncovered in our analysis.



(a) By Productivity Shock



(b) By Monetary Shock

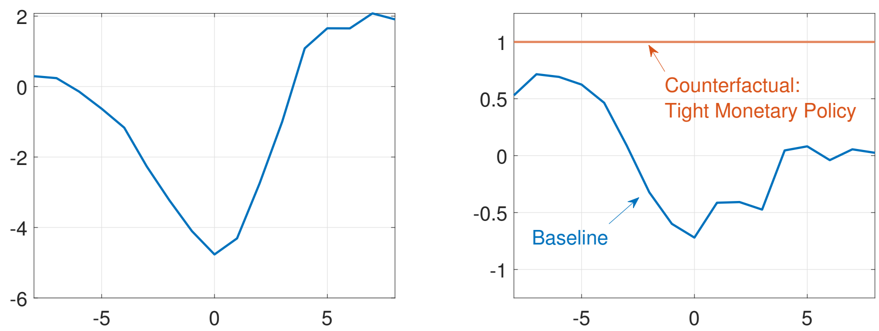
Figure A3: Equilibrium Default Risk

Note: These figures show how the equilibrium default risks vary with state variables: debt B, productivity z, and monetary shock m.

Shocks in event. Figure A4 plots the time paths of the productivity and monetary shocks used to fit jointly the event paths for inflation and the nominal rate in Figure 7. Panel (b) includes the monetary shocks for the counterfactual in Figure 8, in red. Shocks are expressed in quarterly percentages.

E Local Currency Debt and Monetary Discretion

We consider versions of our model, with local currency debt under two monetary regimes: an interest rate rule and monetary discretion. With the rule, the monetary authority employs a Taylor rule, as in



(a) Productivity Shock (b) Monetary Shock

Figure A4: Inflation Event Analysis: Shocks

our benchmark model. For monetary discretion, we study a consolidated problem where the domestic policymaker simultaneously chooses international borrowing, default, and inflation. It sets nominal interest rates to implement desired inflation outcomes.

Local currency debt and NK-Default. The model with local currency debt is identical to the baseline economy, except for the government's budget constraint and the bond price schedule. The nominal government budget constraint in local currency is given now by

$$T_t + \tau W_t N_t = (1-\Theta)\left[q_t^{\text{lc}}\left(B_{t+1}^{\text{lc}} - (1-\delta)B_t^{\text{lc}}\right) - (r+\delta)\, B_t^{\text{lc}}\right] + \tau_f P_t^f C_t^f,$$

where nominal local currency government debt is B_{t+1}^{lc} and $\Theta = 1$ denotes a bad credit standing. We deflate this budget constraint by the price of domestic goods P_t^d and combine it with the budget constraint of households to obtain the balance of payments condition,

$$e^{\rho}\xi = eC^f + (1-\Theta)\left[(r+\delta)\frac{b}{\pi} - q^{\text{lc}}(s,b')\left(b' - (1-\delta)\frac{b}{\pi}\right)\right]$$

where real government debt, in terms of domestic goods, is $b_t = \frac{B_t^{lc}}{P_{t-1}^d}$. This expression makes it explicit that inflation π_t affects the real debt burden. The price for local currency bonds, in recursive notation, satisfies

$$\frac{1}{e}q^{\text{lc}}(s,b') = \frac{1}{1+r^*}\mathbb{E}\left\{\frac{1-\mathbb{D}(s',b')}{e(s',b')\pi(s',b')}\left[r+\delta+(1-\delta)q^{\text{lc}}(s',b'')\right]\right\}. \tag{73}$$

This no-arbitrage condition implies that lenders need to be compensated not only for default risk, but also for the expected nominal exchange rate depreciation.

For spreads, we take two approaches, which both yield essentially identical moments. First, we price a hypothetical foreign currency bond, as in our baseline, using the sovereign's default and borrowing policies. We then compute the Local Currency Credit Spread, following Du and Schreger (2016), which here we express as

$$\text{spread}_t = \frac{r+\delta}{q_t^{\text{lc}}} - \frac{r+\delta}{q_t^*}$$

where q_t^* is the risk-free local currency bond price and is defined recursively as

$$\frac{1}{e(s,b)} q^*(s,b) = \frac{1}{1+r} \mathbb{E} \frac{1}{e(s',b')} \frac{1}{\pi(s',b')} (r+\delta+(1-\delta)q^*(z',b')).$$

Local currency debt and discretionary policy. Under discretion, conditional on not defaulting, the government chooses $\{C, C^f, N, \pi, b'\}$ to solve the following problem:

$$W(s,b) = \max_{\{C,C^f,eN,\pi,b'\}} u(C,C^f,N) + \beta_g \mathbb{E} \left\{ \int_{\hat{v}(s',b')} W(s',b') dF_v(v') + \int^{\hat{v}(s',b')} [W^d(s') - v'] dF_v(v') \right\} \quad (74)$$

subject to the constraints imposed by the private equilibrium, summarized by the following four conditions:

$$C + e^\rho = \left[1 - \frac{\varphi}{2} (\pi - \overline{\pi})^2\right] \tilde{z} N, \quad (75)$$

$$e^\rho = eC^f + (1-\Theta) \left[(r+\delta) \frac{b}{\pi} - q^{\text{lc}}(s,b') \left(b' - (1-\delta) \frac{b}{\pi} \right) \right] \quad (76)$$

$$\frac{u_{C^f}}{u_C} = \frac{\rho}{\rho - 1} e, \quad (77)$$

$$\frac{\eta - 1}{\varphi} \left(-\frac{u_N}{\tilde{z} u_C} - 1 \right) + \beta \frac{1}{u_C \tilde{z} N} F(s,b',\Theta) = (\pi - \overline{\pi}) \pi, \quad (78)$$

where the default cutoff is $\hat{v}(s',b') = W^d(s') - W(s',b')$ and we used $z(\tilde{z}, \Theta = 0) = \tilde{z}$. We have normalized $\xi = 1$, as in the baseline. The government takes as given the functions $q^{\text{lc}}(s,b')$ from (73), and $F(s,b',\Theta)$ $M(s,b',\Theta)$ given by

$$F(s,b',\Theta) = \mathbb{E} \left[z(\tilde{z},' \Theta') N(S') u_C(S') \left(\pi(S') - \overline{\pi} \right) \pi(S') \right], \quad (79)$$

$$M(s,b',\Theta) = \mathbb{E} \frac{u_C(S')}{\pi(S')}. \quad (80)$$

The government can implement its choice of inflation $\pi(s,b)$ by setting the nominal interest rate $i(s,b)$ to satisfy the domestic Euler equation $i(s,b) \beta M(s,b'(s,b),\Theta) = u_C(s,b)$.

F Domestic Financial Frictions

In our baseline model, the assumed productivity loss caused by default could reflect several mechanisms through which sovereign default impacts domestic production. In this appendix, we evaluate the robustness of our results to an additional endogenous cost of default, induced by financial frictions in the domestic banking sector. In particular, we add a banking sector which faces collateral constraints and extends domestic working capital loans to producers, as in Gertler and Karadi (2015) and Bocola

(2016).

We assume that intermediate goods producers face working capital requirements, which they meet by borrowing from domestic, competitive, and homogeneous banks. At the beginning of each period, following the government's default decision, domestic households acquire a fraction φ of the government's outstanding bonds. These households subsequently sell these holdings at the end of the period. Note that in the event of government default, households do not purchase any government bonds. Thus, this transaction does not alter the budget constraints of domestic households.

At the beginning of the period, households endow domestic banks with both the purchased government bonds and a nominal amount $P_t\overline{\omega}$. Thus, banks' initial total net worth Λ_t, in domestic currency, is given by

$$\Lambda_t = P_t\overline{\omega} + \varphi\varepsilon_t\left(1 - D_t\right)q_t(1-\delta)B_t,$$

where, as before, ε_t is the nominal exchange rate, D_t is the government's default decision, q_t is the bond price, and $(1-\delta)B_t$ is the stock of outstanding government debt at the beginning of period t.

Banks take deposits from households at the domestic nominal rate i_t, and lend to firms at a local currency nominal rate i_{ft}, while facing Gertler-Karadi-type collateral constraints. Both the deposit rate i_t and lending rate i_{ft} are endogenously determined, and the deposit rate is the same as the monetary policy rate.

The bank's problem. Taking interest rates as given, a bank chooses deposits a_t and working capital loans to firms b_{ft} to maximize its return: $\max_{b_{ft},a_t}\left\{-i_t a_t + i_{ft}b_{ft}\right\}$, subject to the budget constraint $b_{ft} = \Lambda_t + a_t$ and the collateral constraint, $a_t \leq \theta b_{ft}$. We can rewrite the bank's problem as

$$\max_{b_{ft]}}\left\{-i_t\left(b_{ft} - \Lambda_t\right) + i_{ft}b_{ft}\right\},$$

subject to the collateral constraint

$$b_{ft} \leq \frac{1}{1-\theta}\Lambda_t. \tag{81}$$

Let γ_t be the multiplier on the collateral constraint (81). The first-order condition for b_{ft} implies

$$i_{ft} = i_t + \gamma_t.$$

When the collateral constraint is not binding, the lending rate equals the deposit rate, $i_{ft} = i_t$. Otherwise, lending commands a premium, $i_{ft} > i_t$, and the collateral constraint binds

$$b_{ft} = \frac{1}{1-\theta}\Lambda_t = \frac{1}{1-\theta}\left[P_t\overline{\omega} + \varphi\varepsilon_t\left(1 - D_t\right)q_t(1-\delta)B_t\right]. \tag{82}$$

The equilibrium lending rate i_{ft} is shaped by three key factors: (1) the domestic nominal rate i_t, (2) the government's default decision D_t, and (3) the risk of default, as encoded in the bond price q_t. When the government defaults or faces higher default risk (lower q_t), banks experience a reduction in their net worth Λ_t, directly constraining their capacity to lend, due to the tightened collateral constraint. As a result, the multiplier γ_t on the collateral constraint increases, and banks charge a higher lending rate i_{ft} to compensate for the more severe financial frictions.

Firms' problem. Firms face working capital requirements. They must finance their wage bills using domestic bank borrowing, at interest rate i_{ft}. As before, they face price adjustment costs. A firm j chooses price and quantity to maximize its lifetime, discounted nominal profits, using households' stochastic discount factor:

$$\max_{\{p_{jt},y_{jt}\}} E_0 \sum_t \frac{u_{c,t}}{u_{c,0}} \frac{P_0}{P_t} \left\{ p_{jt}y_{jt} - (1-\tau)W_t i_{ft} \frac{y_{jt}}{z_t} - \frac{\varphi}{2} \left(\frac{p_{jt}}{p_{jt-1}} - \bar{\pi} \right)^2 P_t Y_t \right\}$$

subject to the demand schedule for its good $y_{jt} = \left(\frac{p_{jt}}{P_t}\right)^{-\eta} Y_t$, where W_t and P_t are nominal wage and domestic price level, respectively.

In a symmetric equilibrium, firms' optimization yields a modified New Keynesian Phillips Curve (NKPC), given by

$$(\pi_t - \overline{\pi})\, \pi_t = \frac{(\eta - 1)}{\varphi} \left[i_{ft} \frac{w_t}{z_t} - 1 \right] + E_t \left[\beta \frac{u_{c,t+1}}{u_{c,t}} \frac{Y_{t+1}}{Y_t} \left(\pi_{t+1} - \overline{\pi} \right) \pi_{t+1} \right]. \tag{83}$$

This case differs from the standard NKPC (8) because the marginal cost of producing depends on the nominal lending rate i_{ft}, due to the working capital requirement. This creates a direct channel through which monetary policy and sovereign default affect firms' pricing and production.

Private-monetary equilibrium. The private-monetary equilibrium in this extended model is similar to that of the benchmark model, characterized by equations (32)-(37). There are two differences: First, the NKPC incorporates domestic financial frictions through the direct influence of the lending rate i_f, as captured by equation (83). Second, banks' lending rate i_{ft} equals the monetary rate i_t if banks' collateral constraint is slack; otherwise i_{ft} is such that the collateral constraint is satisfied

$$w_t N_t = \frac{\overline{\omega} + \varphi e_t \left(1 - D_t\right) q_t (1-\delta) B_t}{1-\theta}, \tag{84}$$

where we substitute firms' working capital demand $b_{ft} = W_t N_t$ into equation (82) and express both sides in real terms by dividing by P_t.

		Domestic Financial Frictions		
	Baseline NK-Default	NK-Default	Strict Inflation	Inflation-Default
Mean				
CPI inflation	3.9	3.8	4.3	5.4
Nominal domestic rate	5.7	5.6	5.9	7.3
Spread	2.0	2.0	2.3	0.2
Debt to output	17	18	19	19
Standard Deviation				
Output	2.2	2.4	2.4	2.6
CPI inflation	1.8	1.8	0.2	0.8
Spread	0.9	1.0	0.8	0.1
Consumption aggregate	2.6	2.7	3.3	3.0
Nominal domestic rate	3.1	3.1	2.8	2.5
Depreciation rate	1.9	2.0	1.0	1.2
Correlations				
(Spread, Output)	−53	−50	−55	−45
(Spread, CPI inflation)	59	61	−14	−45
(Spread, Nom. dom. rate)	78	77	54	72
(Spread, Depreciation rate)	52	51	−12	−35
(CPI inf., Output)	−15	−12	24	14
(CPI inf., Nom. dom. rate)	90	87	4	2
Autocorrelations (%)				
Output	69	68	70	69
CPI inflation	96	96	69	88
Spread	63	65	61	82
Nominal domestic rate	85	85	35	38

Table A4: Domestic Financial Frictions Costs

Note: This table presents business cycle moments for the baseline "NK-Default" model and three models with domestic financial frictions costs under three monetary policy regimes. The second column considers the baseline monetary rule in (10), the third column contains strict inflation targeting regime, and the fourth column is the inflation-default risk rule in (31).

Results. To highlight the implications of these additional domestic financial frictions, we compute the extended model using the same parameter values as those of our calibrated baseline. There are 3 additional parameters: the share of government bonds held by domestic banks φ, the collateral coefficient θ, and banks' initial net worth $\overline{\omega}$. We set $\varphi = 0.28$ to match the share of developing government bonds held by domestic banks, as documented by Fang, Hardy, and Lewis (2025), and $\theta = 0.8$ based on the average capital to asset ratio in Mexican banks. Given these values, the initial net worth $\overline{\omega}$ determines the passthrough of sovereign spread to firms' borrowing rate. We calibrate $\overline{\omega} = 0.17$ to match the passthrough coefficient of 0.64 in Arellano et al. (2020). The passthrough is captured by the β_1 coefficient on the sovereign spread in the regression: $i_{f,t} - i_t = \beta_1 \, \text{spread}_t + \beta_2 x_t + \varepsilon_t$, on model-simulated data. We include as controls the log of the productivity shock and debt as well as a constant, and consider only simulation periods in which the country is not in default, so that the sovereign spread is well-defined.

We conduct two types of analyses: (1) We compare the benchmark NK-Default model with our extended model incorporating domestic financial frictions, examining impulse response functions under monetary and productivity shocks, as well as spread and business cycle moments; and (2) we evaluate this extended model under alternative monetary policy frameworks—strict inflation targeting and the inflation-default risk rule. Both alternative specifications use benchmark parameters, together with the previously discussed values for φ, θ, and $\overline{\omega}$. These results document the robustness of our monetary discipline mechanism and illustrate how domestic financial frictions that endogenously interact with sovereign default influence this mechanism.

Figure A9 compares the IRFs to a contractionary monetary shock, between the benchmark NK-Default and this extended model with domestic financial frictions. The monetary disciplining effect also appears in the extended model: an increase in the monetary shock leads to a reduction in sovereign debt and spreads. The quantitative difference between the two models is largely reflected in average levels, but it is modest in terms of response to shocks. Figure A10 contrasts how negative productivity shocks propagate through either model. As expected, lower productivity increases inflation and nominal rates, which in turn raise input costs and amplify the contraction of output and consumption in the extended model. Inflation and nominal rates respond further and become even higher.

Consistent with the productivity IRFs, the model with domestic financial frictions generates greater output volatility, with a standard deviation of 2.4 versus 2.2 in the benchmark model (Table A4). The average spreads are similar across the two models. Government borrowing increases modestly in the extended model, from 17% to 18% of output.

Introducing domestic financial frictions generates two opposing effects. On one hand, domestic frictions distort the economy and tend to increase default risk. On the other hand, the government internalizes that higher borrowing could further accelerate inflation, raise nominal rates, and exacerbate production distortions through working capital requirements. This second effect leads the government to reduce its borrowing. These two forces largely balance each other. As a result, business cycle moments and monetary discipline effects in the extended model are similar to those in the benchmark.

Lastly, we revisit alternative monetary policy regimes, strict inflation targeting and the inflation-default risk rule, in our model with financial frictions. Table A4 presents moments across monetary policy regimes. The two key mechanisms in our main analysis prove robust. First, the monetary discipline effect persists: the model with the baseline interest rate rule exhibits higher CPI inflation volatility but smaller sovereign spreads compared to strict inflation targeting. Specifically, while strict inflation targeting achieves lower inflation volatility (0.2 versus 1.8), the extended model with the interest rate rule delivers lower spreads (2.0% compared to 2.3% under strict inflation targeting). Second, the inflation-default risk rule continues to generate both smoother sovereign spreads and more stable CPI inflation relative to the standard rule.

G Numerical Algorithm

The model is subject to uncorrelated AR(1) productivity shocks z and monetary shocks m, which we discretize over a grids with $\#z = 25$ and $\#m = 31$ points spanning ± 3 and ± 4 standard deviations of their unconditional distribution. The B grid consists of $\#B = 660$ points equally spaced over $[0, 1.25]$.

The algorithm proceeds as follows:

1. We start with initial guesses for the value functions V_0, W_0^d and the bond price schedule q_0, together with guesses for the F_0 and M_0 functions and the default and borrowing policies. We assume the probability of default is 1 and $B' = B$ with probability one, everywhere in the state space.

2. We solve for the private and monetary equilibrium (PME) everywhere in the state space, for arbitrary B'. We restrict attention to B' values that do not induce capital inflows or outflows that are "too large," for which a solution to the private and monetary system of equations might not exist, and confirm that this restriction does not bind in equilibrium:

$$\left|-(r+\delta)B + q(s, B')\left[B' - (1-\delta)B\right]\right| \leq 0.125 \qquad \text{(Capital Flow Bound)}$$

We solve the private and monetary equilibrium via root-finding using Powell's hybrid method, on a system of two equations in two unknowns, C^f and N:

(a) Using the current guess of $\langle C^f, N \rangle$ and the capital inflow, we compute the terms of trade e from the balance of payments condition.

(b) We compute the implied level of exports X associated with the terms of trade e.

(c) Given C^f and e, we can recover domestic consumption C from the relative consumption condition.

(d) Given C and the government's borrowing choice B', we compute the domestic nominal rate i from the domestic Euler equation.

(e) Given i, we use the interest rate rule to compute the level of PPI inflation π.

(f) We use these quantities to compute equation residuals for the New Keynesian Phillips curve and the domestic resource constraint.

The solution to the PME yields policy functions $C(s,B,B')$, $C^f(s,B,B')$, $N(s,B,B')$, $\pi(s,B,B')$, $i(s,B,B')$, $e(s,B,B')$.

3. We solve the PME in default similarly. In particular, in default, trade is balanced and the capital inflow term is zero, and productivity is penalized. The solution constitutes policy functions in default: $C_d(s)$, $C^f_d(s)$, $N_d(s)$, $\pi_d(s)$, $i_d(s)$, $e_d(s)$.

4. Using PME results, we compute the value of the government in each state (V) and in default (W^d) and solve for the borrowing and default policies, by augmenting the model with Extreme Value Type I shocks, following Dvorkin et al. (2021). We detail this implementation below.

5. Given borrowing and default policies, we update the bond price schedule q and the expectation functions M and F.

6. We check for the convergence of the bond price schedule, value functions, and expectation functions. We stop if values are closer than $1e^{-6}$ and prices are closer than $1e^{-5}$ in the sup norm. Otherwise, we fully update and iterate.

Discrete choice shocks. We implement the ν shock by associating the repayment and default options, each, with a iid shock drawn from a Extreme Value Type I/Gumbel distribution, with scale parameter ϱ_D and location parameter $-\varrho_D \times \langle\text{Euler-Mascheroni constant}\rangle$, so that the expected value of the shock is zero. The difference of two Gumbel shocks follows the Logistic distribution. These shocks induce choice probabilities over default and repayment. At the start of the period, with state $\langle z, m, B\rangle$, there is additional uncertainty in the default policy coming from these taste shocks, and ϱ_D controls the degree to which this shock can alter the value of defaulting.

Analogously, conditional on not defaulting, the sovereign must choose B', the debt position for next period. This choice is over the same fine grid as the B state, and we again perturb it with small iid

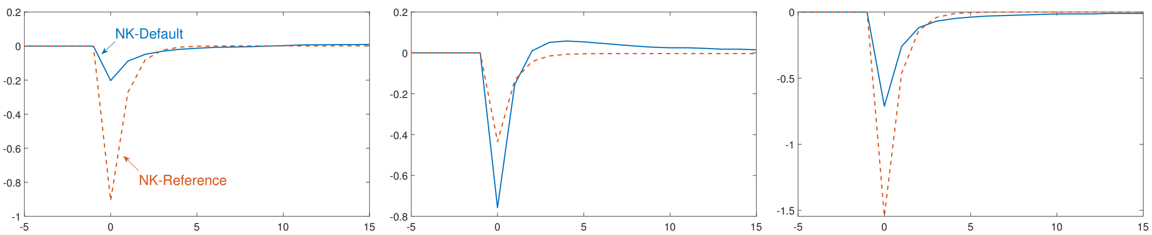
Gumbel shocks, with scale ϱ_B and location normalized such that the expectation is zero. We set ϱ_B to 6×10^{-7}, the smallest value that induced robust convergence across all our policy regimes and model extensions.

See Mihalache (2020), Dvorkin et al. (2021), and Arellano, Bai, and Mihalache (2023) for recent applications of these discrete choice methods in sovereign default models, and Mihalache (2025) for a pedagogical exposition, in the context of a simpler, textbook model. Chatterjee and Eyigungor (2012) also make the case for treating B and B' as discrete, and subject the choice to iid shocks, to achieve convergence and smoothness of policies and values, although employing a different iid shock specification.

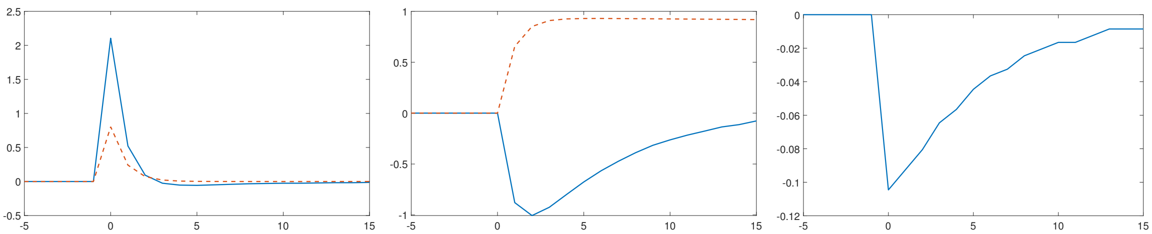
Simulation. Model statistics are computed over a simulation of $500,000$ periods in length, excluding periods in default and the 20 periods (5 years) following the return to market. Without recovery, the sovereign returns to the market without obligations and accumulates debt quickly over the following few periods. If we include these transitional debt dynamics in the sample used to compute model moments, we find the results are largely unaltered, with the exception of the cyclical patterns of the trade balance. By including all periods outside of default, the trade balance becomes acyclical, while with our selection criterion, the trade balance is countercyclical, as in the data.

For our highly nonlinear model, impulse response functions are computed following Koop et al. (1996), by simulating a panel of 1.5 million countries for $1,500$ periods, enough for the cross-sectional distribution of the panel to converge to the model's ergodic distribution. In all IRF figures, we plot a 21 period window around the period of the shock, $t = 1,451$, normalized as $t = 0$ in the plots.

H Additional Impulse Response Functions

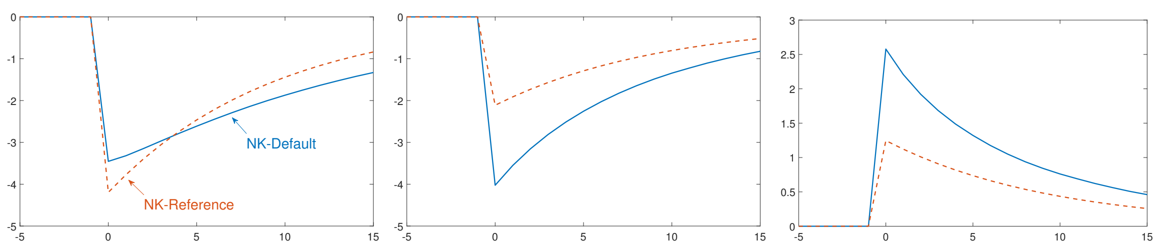


(a) Output (Y) (b) Consumption (C) (c) Inflation (π)

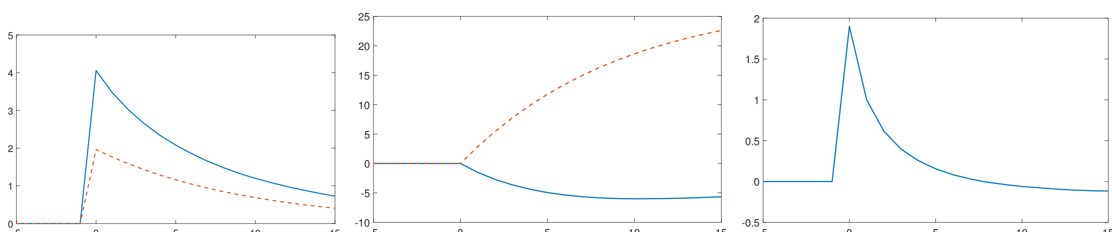


(d) Nominal Domestic Rate (i) (e) Debt (B) (f) Spread

Figure A5: Impulse Response Functions to Monetary Shocks: NK-Default vs NK-Reference

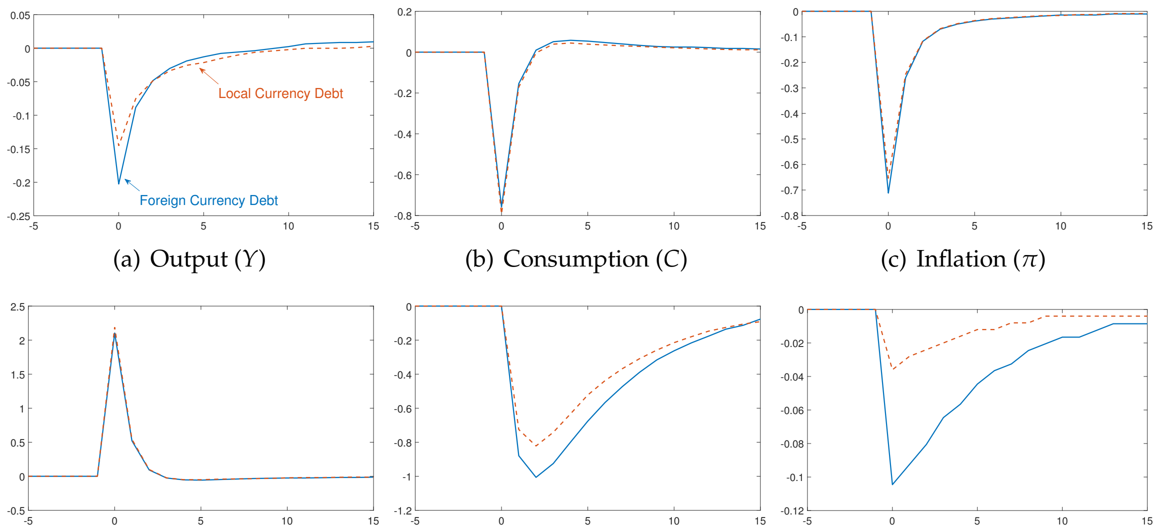


(a) Output (Y) (b) Consumption (C) (c) Inflation (π)



(d) Nominal Domestic Rate (i) (e) Debt (B) (f) Spread

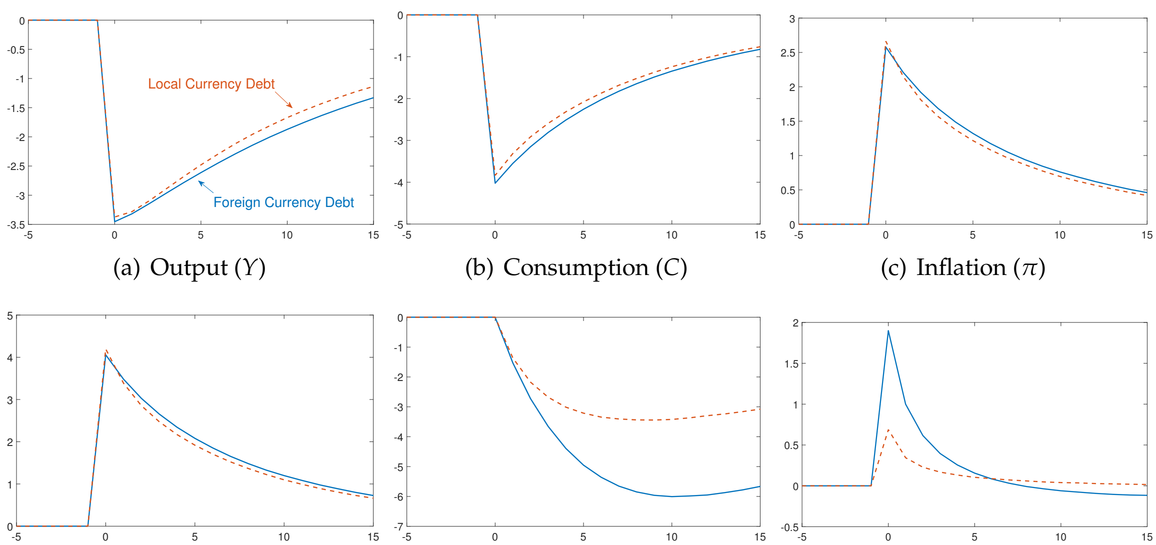
Figure A6: Impulse Response Functions to Productivity Shocks: NK-Default vs NK-Reference



(a) Output (Y) (b) Consumption (C) (c) Inflation (π)

(d) Nominal Domestic Rate (i) (e) Debt (B) (f) Spread

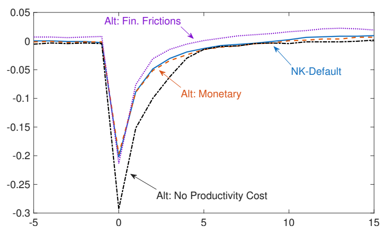
Figure A7: Impulse Response Functions to Monetary Shocks: Currency Denomination



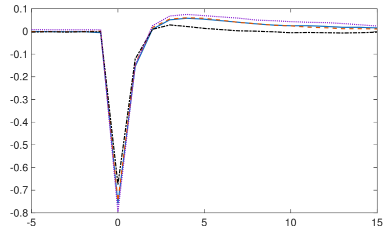
(a) Output (Y) (b) Consumption (C) (c) Inflation (π)

(d) Nominal Domestic Rate (i) (e) Debt (B) (f) Spread

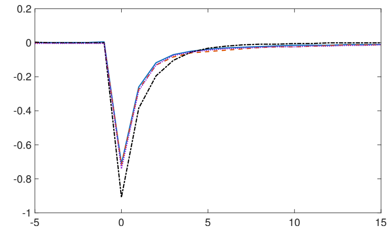
Figure A8: Impulse Response Functions to Productivity Shocks: Currency Denomination



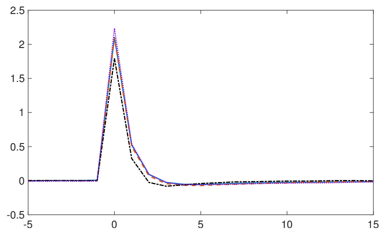
(a) Output (Y)



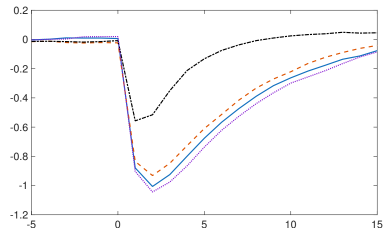
(b) Consumption (C)



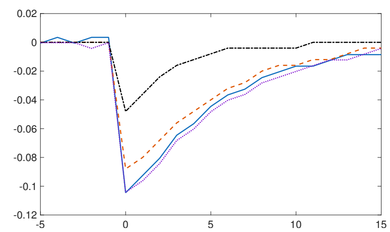
(c) Inflation (π)



(d) Nominal Domestic Rate (i)

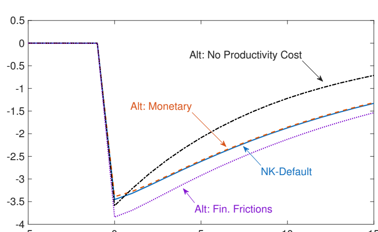


(e) Debt (B)

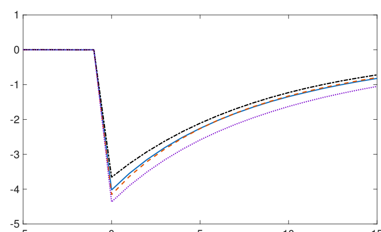


(f) Spread

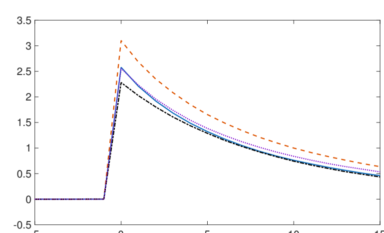
Figure A9: Impulse Response Functions to Monetary Shocks: Alternative Costs of Default



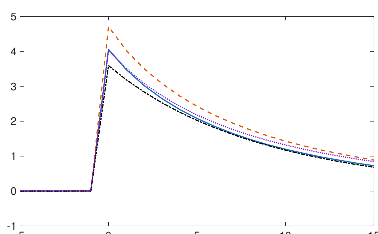
(a) Output (Y)



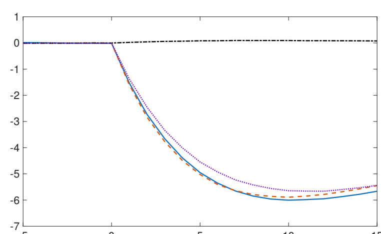
(b) Consumption (C)



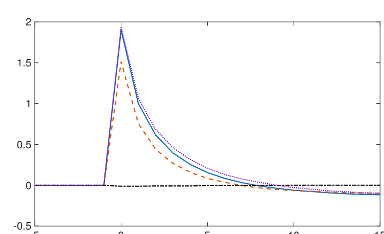
(c) Inflation (π)



(d) Nominal Domestic Rate (i)



(e) Debt (B)



(f) Spread

Figure A10: Impulse Response Functions to Productivity Shocks: Alternative Costs of Default