Macroprudential Policy When the Poor Cannot Borrow

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Abstract

Emerging markets with high levels of inequality tend to have fewer capital controls. We propose a novel dynamic real-exchange-rate distributional externality as a potential explanation of this pattern. We develop a small open economy model with nonhomothetic preferences, high-income borrowers subject to an occasionally binding collateral constraint, and low-income hand-to-mouth households. Borrowing generates an intertemporal distributional externality through the real exchange rate. A planner can improve redistribution by manipulating the terms of trade in favor of the poor. We decompose the optimal borrowing tax into Fisherian and distributional components. Quantitatively, incorporating inequality can lower the average optimal macroprudential tax substantially and even turn it into a subsidy. We extend our framework to a production economy and show that our mechanism remains quantitatively significant as long as wages are flexible.

Keywords: Inequality; Macroprudential policy; Nonhomothetic preferences; Sudden Stops

JEL Classifications: E32; F34; F41; H23

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Introduction

Emerging market economies frequently experience sudden stop crises, characterized by abrupt reversals in capital inflows, sharp exchange rate depreciations, and deep contractions in domestic consumption. These economies also exhibit persistently high income inequality and a large share of households with no access to financial markets. While there is a substantial literature on how credit booms affect low-income households in advanced economies, less attention has been given to how optimal macroprudential policies must adjust to this environment.

Figure 1 provides evidence related to capital control policy and inequality. We find that higher income inequality is associated with less restrictive overall capital controls among emerging markets (Panel (a)). The same association is also present among advanced economies, although it is weaker and not statistically significant (Panel (b)).[1] These correlations motivate our analysis of whether greater inequality weakens the case for restrictive capital controls by changing the trade-off between the distributional benefits of access to external borrowing and the costs of crisis risks.

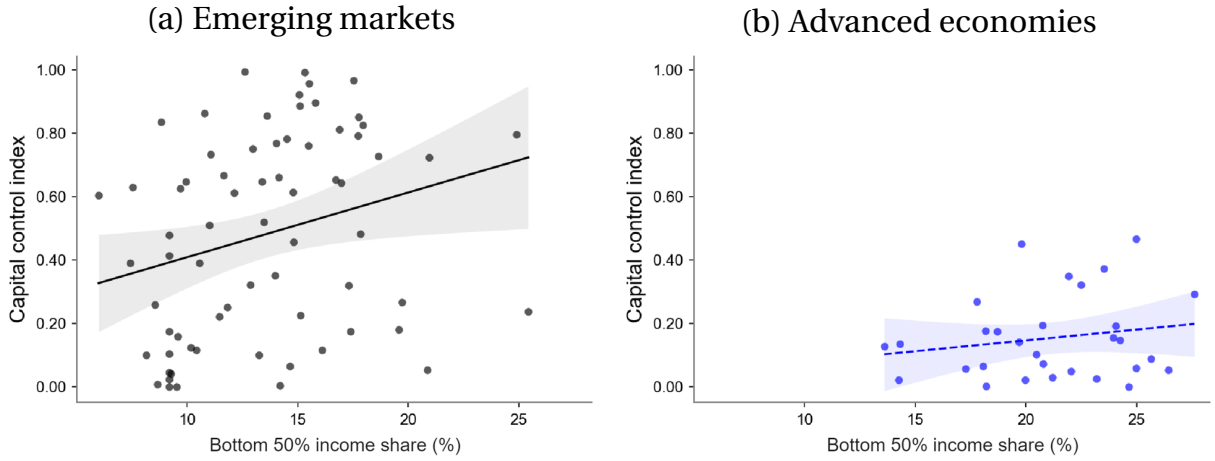


Figure 1: Capital Controls and Income Inequality

Note: The figure plots the country averages of the capital control index and of the income share of the bottom 50 percent over 1995–2019. Higher values of the capital control index indicate more restrictive controls. Linear fitted lines with 95% confidence bands are plotted. We use the overall capital control index constructed by Fernández et al. (2016) and income share data from the World Inequality Database. Appendix A.4 lists the countries.

We propose a novel dynamic real-exchange-rate distributional externality that can partially explain this pattern. A benevolent planner faces a trade-off between financial stability and redistribution through the terms of trade of the poor. We highlight this

[1] The results also hold for the inflow capital control index.

mechanism in a sudden stop model in the tradition of Mendoza (2002) and Bianchi (2011), with heterogeneous agents and nonhomothetic preferences. High-income households borrow internationally subject to an occasionally binding collateral constraint, while low-income hand-to-mouth households do not participate in financial markets. We compare the decentralized equilibrium with a constrained-efficient allocation in which a planner internalizes the aggregate borrowing and distributional externalities.

The model features two externalities operating through the real exchange rate. The standard Fisherian debt-deflation externality arises because borrowers do not internalize how higher debt amplifies future depreciation and deleveraging when the borrowing constraint binds. The distributional externality operates through the purchasing power of hand-to-mouth households. During credit expansions, these households are net sellers of nontradables and benefit from the exchange rate appreciation that improves their terms of trade. The expected deterioration in the next period does not neutralize this current benefit, because borrowers' demand for nontradables is also expected to decline as the credit cycle advances, so hand-to-mouth households will then sell less. In other words, by encouraging borrowing, the planner helps hand-to-mouth households sell a large quantity of nontradables at a high price today, even if tomorrow they will sell a smaller quantity at a lower price.

Our analysis asks how macroprudential policy should be designed given the income distribution that remains after existing fiscal redistribution. We take the prevailing tax-and-transfer system as given when choosing the borrowing tax, consistent with our calibration to after-tax income. This focus is particularly relevant for emerging market economies, where high informality and narrow tax bases limit the redistributive capacity of tax-and-transfer systems. With borrowing-tax revenues rebated to borrowers, the distributional motive operates through the effects of borrowing on relative prices and the purchasing power of hand-to-mouth households. Our results thus characterize how financial stability and distributional considerations jointly shape macroprudential policy after fiscal redistribution has occurred but substantial inequality remains.

We decompose the optimal borrowing tax into a Fisherian component, which captures the ex-ante incentive to limit future collateral losses, and current and future distributional components, which lower the tax when a credit expansion redistributes toward hand-to-mouth households today and raise it when repayment reverses this redistribution next period. The tax formula thus separates the intertemporal redistribution motive from the conventional financial-stability motive, allowing us to quantify their respective contributions to optimal policy. Quantitatively, household heterogeneity shifts

the optimal tax schedule down relative to representative-agent benchmarks. At low debt the current distributional benefit exceeds the combined future distributional and Fisherian costs, so a borrowing subsidy is optimal; as leverage rises, the Fisherian component strengthens and, in the baseline, the tax turns positive.

Nonhomotheticity partly offsets this dampening of optimal policy and also isolates our distributional externality more clearly. As shown in Rojas and Saffie (2022), it strengthens the Fisherian externality by making the real exchange rate more responsive to tradable consumption, amplifying the feedback between depreciation and collateral constraints. Quantitatively, however, its larger effect in our model is to weaken the net distributional incentive to subsidize borrowing. In the nonhomothetic baseline, hand-to-mouth households remain net sellers of nontradables whenever the planner's collateral constraint is slack. Borrowing-induced appreciation therefore improves their current terms of trade, while the expected distributional effects of future repayment partly offset this gain. Under homothetic preferences, this future offset is smaller at low debt, making borrowing subsidies larger. At higher debt, once borrowers begin repaying on net, hand-to-mouth households become net buyers of nontradables and net sellers of tradables, even before the collateral constraint binds. Depreciation then improves their terms of trade, so expected future repayment can generate distributional gains that further encourage borrowing. At our calibrated parameters, the homothetic economy consequently features an optimal borrowing subsidy on average, whereas the nonhomothetic baseline features a positive average tax.

In our baseline nonhomothetic economy, constrained efficiency delivers only modest reductions in crisis incidence and severity, leaving sudden stops more frequent than in the representative-agent economies despite lower average debt. Aggregate welfare gains are small and mask opposing effects across household types. High-income borrowers benefit from reduced Fisherian amplification and improved consumption smoothing. For hand-to-mouth households, however, the worsening of their terms of trade in states where the planner restrains borrowing outweighs the benefits of milder crises, resulting in small welfare losses.

A larger hand-to-mouth share and greater income inequality strengthen the distributional motive for accommodating borrowing, lowering the average optimal tax toward a subsidy and shifting welfare gains toward hand-to-mouth households. Stronger nonhomotheticity weakens the net distributional incentive, raising the average tax and shifting gains toward borrowers. Aggregate welfare gains remain small throughout, because much of the intervention redistributes welfare between household types.

We extend our framework to accommodate production and labor. Our distributional

mechanism remains quantitatively significant in this setup, provided that labor moves freely across sectors and wages are flexible. We then introduce downward wage rigidity and the possibility of unemployment following Schmitt-Grohé and Uribe (2016). We characterize the optimal macroprudential tax in this environment and show that the labor externality dominates. The planner then prioritizes financial stability, because avoiding unemployment also serves its redistributive motive.

Related Literature This paper contributes to the literature on sudden stops and macroprudential policy that builds on Mendoza (2002) and Bianchi (2011), in which borrowing taxes correct a Fisherian externality operating through collateral values. We identify a novel dynamic real-exchange-rate distributional externality. In the terminology of Dávila and Korinek (2018), this is a distributive pecuniary externality, governed by differences in marginal utilities, net trading positions, and price sensitivities, which can lead to either over- or underborrowing. Its novelty lies in its intertemporal structure, which parallels Costinot et al. (2014), where capital controls manipulate a country's intertemporal terms of trade. Here, borrowing taxes shape the path of the real exchange rate to redistribute between households that can and cannot borrow. The optimal tax therefore contains current and future distributional components, whose balance depends on the expected path of the real exchange rate. Our tax decomposition distinguishes the Fisherian and distributional components in optimal policy, whereas Dávila and Schaab (2025) decompose welfare effects into efficiency and redistribution components.

Modeling poor households as hand-to-mouth is motivated by the prevalence of financial exclusion in emerging market economies (Beck et al., 2007; Demirgüç-Kunt and Klapper, 2012; Demirgüç-Kunt et al., 2022). Consistent with limited consumption smoothing, Hong (2023) finds a mean annual marginal propensity to consume in Peru three times as large as in the United States, while Hong (2026) links asset illiquidity and precautionary saving to excess consumption volatility and studies fiscal liquidity provision. We examine how limited financial participation shapes optimal borrowing taxes through real-exchange-rate movements. A related literature studies the distributional consequences of sudden stops (Guntin et al., 2023; Villalvazo, 2026). In particular, Villalvazo (2026) examines how wealth and leverage heterogeneity shape crises through asset trading and how fiscal redistribution mitigates them. Our focus is on optimal borrowing taxes when borrowers affect financially excluded households through goods prices. This also distinguishes our framework from Arce and Tran-Xuan (2022), who assume that all households borrow internationally.

Biljanovska and Vardoulakis (2024) identify a distributional externality operating through a contemporaneous wage channel and study the joint design of borrowing and payroll taxes. In their framework, anticipated redistribution toward entrepreneurs during crises calls for a higher ex-ante borrowing tax. We identify a different distributional externality that operates through an intertemporal exchange-rate channel and creates an opposing force to lower the borrowing tax. The current distributional gains from exchange rate appreciation during credit expansions can outweigh future distributional losses from depreciation, potentially making borrowing subsidies optimal. Korinek and Sandri (2016) find that capital controls and macroprudential regulation should be tighter when inequality is higher. In our model, inequality also strengthens the Fisherian motive, but the distributional benefits of credit expansions dominate quantitatively, lowering the average optimal tax, consistent with the association in Figure 1. Fanelli and Straub (2021) identify a pecuniary externality that makes the real exchange rate excessively volatile without heterogeneity across domestic households. Other studies examine how exchange-rate movements and stabilization policies redistribute across heterogeneous households after shocks (de Ferra et al., 2020; Auclert et al., 2021; Guo et al., 2023; Oskolkov, 2023; Cugat, 2026). We characterize how the distributional effects of borrowing-induced exchange-rate dynamics shape optimal ex-ante intervention. The resulting subsidies also differ from the underborrowing generated by sectoral reallocation in Benigno et al. (2013). Our production extension uses the setup of Arce et al. (2025) and introduces a labor externality through downward wage rigidity as in Schmitt-Grohé and Uribe (2016).

Finally, the paper relates to studies of inequality over the business cycle in advanced economies (Storesletten et al., 2007; Primiceri and Van Rens, 2009; Kumhof et al., 2015; Broer, 2020) and to macroeconomic models with nonhomothetic preferences (Boppart, 2014; Comin et al., 2021). Cravino and Levchenko (2017) document that poorer households spend a larger share on tradables and faced larger cost-of-living increases after the Mexican devaluation, and Rojas and Saffie (2022) show that nonhomotheticity amplifies the Fisherian externality, whereas we show it matters more for the distributional externality, raising the optimal tax even at low debt, where the Fisherian externality is dormant.

Outline The paper is organized as follows. Section 1 describes the model of sudden stops and inequality. Section 2 presents the optimal policy decomposition. Section 3 shows the quantitative analysis, Section 4 conducts the sensitivity exercises, and Section 5 extends the analysis to production economies with flexible and downwardly rigid

wages. Section 6 concludes.

1 Model of Sudden Stops and Inequality

1.1 Environment

Time is discrete and indexed by $t = 0, 1, \ldots, \infty$. There are tradable and nontradable goods sectors. Only tradable goods can be traded internationally, and nontradable goods have to be consumed in the domestic economy. The economy is populated by two types of households $i \in \{L, H\}$: hand-to-mouth ($i = L$) households and borrowing households ($i = H$), with population shares π and $1 - \pi$, respectively.

The two household types differ along two dimensions: their shares of aggregate income and their access to international credit markets. Borrowing households receive a larger share of endowments and have access to international financial markets, whereas hand-to-mouth households receive a smaller endowment share and are financially excluded from international credit markets.

Endowment In each period t, household i receives a fraction s^i of endowment of tradable goods Y_t^T and nontradable goods Y_t^N, where $\pi s^L + (1 - \pi)s^H = 1$ and $s^H > s^L$, that is, borrowing households are richer than hand-to-mouth households. The tradable endowment follows a first-order Markov process. The nontradable endowment is constant and normalized to $Y_t^N = 1$ in every period. We assume that the numeraire is the tradable good.

Assets Borrowing households have access to one-period, non-state-contingent international bonds denominated in units of tradables. The bond is issued in international competitive credit markets at price Q. We assume that the discount factor and the international bond price are such that $\beta/Q < 1$. In each period t, borrowing households face a collateral credit constraint such that the market value of debt issuances Qb_{t+1}^H cannot exceed a fraction κ of the market value of current income.

In contrast, hand-to-mouth households lack access to international credit markets.

Allocation Individual household i's allocation on consumption and borrowing is $c_t^{T,i}, c_t^{N,i}, c_t^i, b_{t+1}^i$. Throughout the paper the aggregate allocation is denoted in the uppercase, i.e., $C^T = \pi c^{T,L} + (1 - \pi)c^{T,H}$.

Preferences Each household maximizes a utility function over a nonhomothetic CES consumption aggregator similar to Comin et al. (2021), that is,

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}, \quad \sigma > 0, \tag{1}$$

where $0 < \beta < 1$. The composite consumption $c_t = c(c_t^T, c_t^N)$ is defined by the implicit function

$$\left[\omega \left(c_t^T\right)^{-\eta} (c_t)^{\epsilon_T(1+\eta)-1} + (1-\omega) \left(c_t^N\right)^{-\eta} (c_t)^{\epsilon_N(1+\eta)-1}\right]^{-\frac{1}{\eta}} = 1, \quad \eta > -1,\ \omega \in (0,1),$$

where ω is a weight parameter, $1/(1+\eta)$ is the elasticity of substitution between c_t^T and c_t^N, and ϵ_j is the nonhomotheticity parameter that affects the income elasticity of good $j \in \{T, N\}$, which is

$$\nu_j = \frac{1}{1+\eta} + \frac{\eta}{1+\eta} \frac{\epsilon_j(1+\eta) - 1}{\vartheta_T \left[\epsilon_T(1+\eta) - 1\right] + \vartheta_N \left[\epsilon_N(1+\eta) - 1\right]}.$$

Here, ϑ_T and $\vartheta_N = 1 - \vartheta_T$ are the household's expenditure shares on tradables and nontradables. Income elasticities therefore vary with household income, and nontradables are luxuries ($\nu_N > 1 > \nu_T$) when $\epsilon_N > \epsilon_T$. We assume that $\epsilon_j > \frac{1}{1+\eta}$, for $j \in \{T, N\}$, such that the utility is strictly increasing in both tradable and nontradable consumption. c_t becomes a homothetic CES aggregator with elasticity of substitution $1/(\eta+1)$ between c_t^T and c_t^N when $\epsilon_T = \epsilon_N = 1$.

1.2 Decentralized equilibrium

Borrowing households Given the bond price Q and the price of nontradable goods in units of tradables P_t^N, borrowing households $i = H$ choose the allocation $\left\{c_t^{T,H}, c_t^{N,H}, b_{t+1}^H\right\}_{t \geq 0}$ that maximizes utility (1) subject to the budget constraint

$$c_t^{T,H} + P_t^N c_t^{N,H} + b_t^H = s^H \left(P_t^N Y_t^N + Y_t^T\right) + Q b_{t+1}^H, \tag{2}$$

and the credit constraint

$$Q b_{t+1}^H \leq \kappa s^H \left(Y_t^T + P_t^N Y^N\right). \tag{3}$$

This credit constraint can be seen as an implication of incentive-compatibility constraints on borrowers if limited enforcement prevents lenders from collecting more than a fraction κ of the value of current endowment owned by defaulting households.

Hand-to-mouth households Hand-to-mouth households ($i = L$) choose consumption $\left\{c_t^{T,L}, c_t^{N,L}\right\}_{t\geq 0}$ that maximizes utility (1) subject to the budget constraint

$$c_t^{T,L} + P_t^N c_t^{N,L} = s^L \left(P_t^N Y_t^N + Y_t^T\right). \tag{4}$$

Resource constraints The resource constraints in the tradable and nontradable goods sectors are

$$C_t^T + B_t = Y_t^T + QB_{t+1} \tag{5}$$

$$C_t^N = Y_t^N, \tag{6}$$

where C_t^T, C_t^N, B_t are aggregate tradable consumption, nontradable consumption, and debt.

Recursive formulation We consider the optimization problem of borrowing households in the recursive form. Borrowing households make decisions on current consumption and next-period debt based on the current individual debt b and the current exogenous shock on tradables Y^T. The optimization problem of borrowing households can be written as

$$V^H(b; Y^T, B) = \max_{c^T, c^N, b'} \quad \frac{c\left(c^T, c^N\right)^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^H(b'; Y^{T'}, B')$$

subject to

$$c^T + P^N c^N + b = s^H \left(Y^T + P^N Y^N\right) + Qb'$$

$$Qb' \leq \kappa s^H \left(Y^T + P^N Y^N\right)$$

$$P^N = P^N(B, Y^T), \quad B' = G(B, Y^T).$$

The solution to the household problem gives the individual allocation rule $\left\{c^{T,H}(\cdot), c^{N,H}(\cdot), b'(\cdot)\right\}$.

Hand-to-mouth households do not have access to international borrowing, and therefore their consumption choices depend on the current exogenous tradable

endowment Y^T and equilibrium prices. Their recursive problem is

$$V^L(Y^T, B) = \max_{c^T, c^N} \quad \frac{c\left(c^T, c^N\right)^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^L(Y^{T'}, B')$$

subject to

$$c^T + P^N c^N = s^L \left(Y^T + P^N Y^N\right)$$
$$P^N = P^N(B, Y^T), \quad B' = G(B, Y^T).$$

Since hand-to-mouth households cannot transfer resources across periods, their continuation value does not affect their current consumption choices. The solution to their problem gives the individual allocation rule $\left\{c^{T,L}(\cdot), c^{N,L}(\cdot)\right\}$.

We have the following definition for a recursive competitive equilibrium.

Definition 1.1. A *recursive competitive equilibrium* is an individual allocation rule $\left\{c^{T,i}, c^{N,i}, b'\right\}$, value functions $V^H(b; Y^T, B)$ and $V^L(Y^T, B)$, an aggregate allocation rule $\left\{C^T, C^N, B'\right\}$, a pricing function $P^N(B, Y^T)$, and an aggregate law of motion $G(B, Y^T)$ such that

- Household optimization: given P^N, G, $\left\{c^{T,H}, c^{N,H}, b'\right\}$ solves borrowing households' problem and V^H is the associated value function. Also, $\left\{c^{T,L}, c^{N,L}\right\}$ solves the hand-to-mouth households' problem, and V^L is the associated value function.
- Aggregation: $C^T = \pi c^{T,L} + (1-\pi) c^{T,H}$, $C^N = \pi c^{N,L} + (1-\pi) c^{N,H}$, and $B' = G(B, Y^T) = (1-\pi) b'$
- Market clearing: equations (5)–(6) hold

In equilibrium, the real exchange rate is determined as

$$P^N = \frac{1-\omega}{\omega} \left(\frac{c^{T,i}}{c^{N,i}}\right)^{1+\eta} (c^i)^{(\epsilon_N - \epsilon_T)(1+\eta)}, \ \forall i = \{H, L\} \tag{7}$$

1.3 Constrained efficiency

We now formulate the problem of a utilitarian social planner that puts equal weights on households' utilities. The social planner can directly choose the level of borrowing subject to the credit constraints, but allows goods markets to clear competitively. In contrast to the competitive equilibrium households that take prices as given, the social planner internalizes the effect of the borrowing decision on the price of nontradables.

The optimization problem of the social planner is choosing individual allocation to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ \pi \frac{(c_t^L)^{1-\sigma}}{1-\sigma} + (1-\pi) \frac{(c_t^H)^{1-\sigma}}{1-\sigma} \right\}, \tag{8}$$

subject to the households' budget constraints (2) and (4), the credit constraint (3), resource constraints (5)–(6), and the equilibrium price condition (7). We then define this problem in the recursive form as

Recursive social planner's problem

$$V^{SP}(B, Y^T) = \max_{\{c^{T,i}, c^{N,i}\}_{i\in\{H,L\}}, B'} \left\{ \pi \frac{c(c^{T,L}, c^{N,L})^{1-\sigma}}{1-\sigma} + (1-\pi) \frac{c(c^{T,H}, c^{N,H})^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^{SP}(B', Y^{T'}) \right\}$$

subject to

$$\begin{aligned}
c^{T,H} + P^N c^{N,H} + \frac{B}{1-\pi} &= s^H \left(Y^T + P^N Y^N \right) + \frac{QB'}{1-\pi} \\
QB' &\leq \kappa (1-\pi) s^H \left(Y^T + P^N Y^N \right) \\
c^{T,L} + P^N c^{N,L} &= s^L \left(Y^T + P^N Y^N \right) \\
P^N &= \frac{1-\omega}{\omega} \left(\frac{c^{T,i}}{c^{N,i}} \right)^{1+\eta} (c^i)^{(\epsilon_N - \epsilon_T)(1+\eta)}, \quad \forall i \in \{H, L\} \\
\pi c^{T,L} + (1-\pi) c^{T,H} + B &= Y^T + QB' \\
\pi c^{N,L} + (1-\pi) c^{N,H} &= Y^N.
\end{aligned} \tag{9}$$

Definition 1.2. A *recursive constrained-efficient allocation* consists of the allocation rules $\{c_{SP}^{T,i}(B, Y^T), c_{SP}^{N,i}(B, Y^T)\}_{i\in\{H,L\}}$, the borrowing rule $B'_{SP}(B, Y^T)$, and the value function $V^{SP}(B, Y^T)$ that solve (9).

1.4 Optimal macroprudential policy

We characterize the optimal macroprudential policy that decentralizes the constrained-efficient allocation. Crucially, the planner faces the same household budget constraints as in the decentralized equilibrium and cannot make direct transfers across household types. Redistribution occurs indirectly through borrowing choices and their effects on equilibrium prices. Therefore, the constrained-efficient allocation can be decentralized with a tax or subsidy on borrowing by high-income households, with the proceeds re-

bated lump-sum to the borrowing households so that the policy does not directly transfer resources across types.

In particular, the recursive problem of a high-income borrowing household under the decentralized equilibrium with taxes is

$$V^H(b, Y^T) = \max_{c^T, c^N, b'} \quad \frac{c\left(c^T, c^N\right)^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^H(b', Y^{T'})$$

subject to

$$c^T + P^N c^N + (1+\tau)b = s^H \left(Y^T + P^N Y^N\right) + Qb' + T$$
$$Qb' \leq \kappa s^H \left(Y^T + P^N Y^N\right),$$

where τ denotes the predetermined tax on the repayment of current debt b, and T is a lump-sum rebate of tax revenues. In equilibrium, $T = \tau b$.

Define $\Lambda \equiv \partial \left(\pi u(c^L) + (1-\pi)u(c^H)\right)/\partial C^T$ as the period social marginal value of aggregate tradable consumption. Let μ^{SP} denote the multiplier on the collateral constraint in the planner's problem. The planner's first-order condition for borrowing can be written as

$$\Lambda + \mu^{SP}(1-\pi)\kappa s^H Y^N \frac{\partial P^N}{\partial C^T} = \frac{\beta}{Q}\mathbb{E}\left[\Lambda' + \mu^{SP\prime}(1-\pi)\kappa s^H Y^N \frac{\partial P^{N\prime}}{\partial C^{T\prime}}\right] + \mu^{SP} \tag{10}$$

When the current borrowing constraint of the planner is slack, the planner's first-order condition simplifies to

$$\Lambda = \frac{\beta}{Q}\mathbb{E}\left[\Lambda' + \mu^{SP\prime}(1-\pi)\kappa s^H Y^N \frac{\partial P^{N\prime}}{\partial C^{T\prime}}\right], \tag{11}$$

In the decentralized equilibrium with taxes, the corresponding first-order condition of a borrowing household is

$$U_T^H = \frac{\beta}{Q}(1+\tau)\mathbb{E}\left[U_T^{H\prime}\right], \tag{12}$$

where $U_T^H = (c^H)^{-\sigma}\frac{\partial c^H}{\partial c^{T,H}}$. Then we have the following proposition.

Proposition 1.1 (Optimal macroprudential tax)**.** *The constrained-efficient allocation can be decentralized by a state-contingent tax on debt issued by high-income households, with tax revenues rebated to these households via a lump-sum. At states in which the current borrowing constraint is slack at the constrained-efficient allocation, the optimal macroprudential tax is*

$$\tau = \frac{U_T^H}{\Lambda} \frac{\mathbb{E}\left[\Lambda' + \mu^{SP\prime}(1-\pi)\kappa s^H Y^N \frac{\partial P^{N\prime}}{\partial C^{T\prime}}\right]}{\mathbb{E}\left[U_T^{H\prime}\right]} - 1 \tag{13}$$

Proof. Follows equations (11) and (12). □

2 Decomposition of Optimal Macroprudential Policy

The optimal macroprudential policy balances the financial stability costs of external borrowing against its distributional effects through the real exchange rate. To characterize this trade-off, we decompose the optimal tax in Proposition 1.1 into a Fisherian component and two distributional components. The latter capture the welfare effects of the relative-price changes induced by a credit expansion and the subsequent repayment of debt.

We first define the wedges associated with these externalities. The Fisherian wedge Ψ_F is defined as

$$\Psi^F \equiv (1-\pi)\kappa s^H Y^N \frac{\partial P^N}{\partial C^T}, \tag{14}$$

which measures the value of relaxing the collateral constraint induced by a marginal increase in aggregate tradable consumption. The distributional wedge Ψ_D is the difference between the social and private marginal values of aggregate tradable consumption:

$$\Lambda = U_T^H + \Psi^D, \qquad \Psi^D \equiv \pi\left(U_T^L - U_T^H\right)\left(s^L Y^N - c^{N,L}\right)\frac{\partial P^N}{\partial C^T}. \tag{15}$$

This wedge captures the welfare effect of the redistribution of purchasing power induced by the associated change in the relative price of nontradables. Using these wedges, we have the following decomposition.

Proposition 2.1 (Decomposition of the optimal macroprudential tax)**.** *The optimal macroprudential tax in equation* (13) *can be decomposed as*

$$\tau = \underbrace{\frac{\mathbb{E}\left[\mu^{SP'}\Psi^{F\prime}\right]}{\mathbb{E}\left[U_T^{H\prime}\right]}}_{\textit{Fisherian}} - \underbrace{\frac{Q}{\beta}\frac{\Psi^D}{\mathbb{E}\left[U_T^{H\prime}\right]}}_{\textit{current distributional}} + \underbrace{\frac{\mathbb{E}\left[\Psi^{D\prime}\right]}{\mathbb{E}\left[U_T^{H\prime}\right]}}_{\textit{future distributional}}. \tag{16}$$

Proof. See Appendix B.3. □

Fisherian externality The first term in equation (16) reproduces the optimal borrowing tax formula in Bianchi (2011). It captures the standard Fisherian debt-deflation ex-

ternality in which higher borrowing reduces future tradable resources and can amplify the decline in collateral values when the future borrowing constraint binds. Borrowing households fail to internalize this effect of their borrowing. With a positive relative-price response, the Fisherian component provides an ex-ante motive for taxing borrowing.

Dynamic real-exchange-rate distributional externality The remaining terms capture the dynamic real-exchange-rate distributional externality. The current component measures how an additional unit of borrowing changes inequality today, and the future component how it changes inequality next period. A credit expansion raises borrowers' demand for nontradables and appreciates the real exchange rate. When hand-to-mouth households are net sellers of nontradables, as in the nonhomothetic baseline whenever the planner's constraint is slack, this raises their purchasing power and lowers inequality today. Next period, more indebted borrowers demand fewer nontradables, lowering the price of the good hand-to-mouth households sell. Borrowing households internalize neither effect.[2]

Equation (15) highlights how the distributional externality operates. The distributional wedge Ψ^D depends on the marginal-value gap, $U_T^L - U_T^H$, the relative-price response, $\partial P^N/\partial C^T$, and the hand-to-mouth households' net supply of nontradables, $s^L Y^N - c^{N,L}$. In the baseline nonhomothetic economy, the marginal-value gap and the relative-price response are positive. A real exchange rate appreciation therefore redistributes purchasing power toward low-income hand-to-mouth households, who have higher marginal value of tradable consumption and are net sellers of nontradables, implying $\Psi^D > 0$. When these households are net buyers of nontradables, the distributional effect reverses and $\Psi^D < 0$. The wedge scales with the hand-to-mouth population share, π, and can be nonzero even when the borrowing households' collateral constraint is slack. Thus, in general, the current distributional component will push the planner toward a lower macroprudential tax when $\Psi^D > 0$, while the future component will push for a higher tax when $\mathbb{E}[\Psi^{D\prime}] > 0$.

Importantly, the Fisherian externality is activated when there is a positive probability that the collateral constraint binds for the planner, while the distributional externality matters regardless of how slack the collateral constraint is.

Heterogeneity Household heterogeneity can therefore dampen optimal macroprudential policy because increasing borrowing has a contemporaneous distributional

[2]With homothetic preferences, hand-to-mouth households become net buyers of nontradables once borrowers repay on net ($Qb' < b$), which reverses the signs of both components; see Section 3.3.

benefit. In the absence of hand-to-mouth households, $\Psi^D = 0$, and equation (16) reduces to the conventional Fisherian tax. With heterogeneity, the net distributional contribution is negative whenever $(Q/\beta)\Psi^D > \mathbb{E}[\Psi^{D\prime}]$. In these states, the current distributional benefit exceeds the expected future distributional cost and offsets part of the Fisherian component. Consequently, the planner chooses a lower borrowing tax than would be warranted by the Fisherian externality alone.

When the current distributional benefit exceeds the combined future distributional and Fisherian costs, this dampening is sufficiently strong to turn the borrowing tax into a subsidy. As shown in the quantitative analysis below, this condition holds at low debt in the baseline economy. At higher debt, the net subsidizing effect of the distributional components weakens, while greater exposure to future states with binding collateral constraints strengthens the Fisherian component, resulting in a tax on borrowing.

Nonhomotheticity Nonhomotheticity affects both the Fisherian and distributional channels. As shown in Rojas and Saffie (2022), the higher expenditure elasticity of nontradables makes their demand fall more sharply during a contraction. This leads to a larger real depreciation, lowering collateral values, and amplifying deleveraging. The stronger relative price response $\partial P^N/\partial C^T$ thus strengthens the Fisherian channel.

In addition, nonhomotheticity implies that low-income hand-to-mouth households devote a larger expenditure share to tradables, making their purchasing power more sensitive to real exchange rate movements. Together with the stronger relative price response, this magnifies the distributional gain from appreciation during a credit expansion but also the distributional loss from depreciation during repayment. Nonhomotheticity effect on optimal policy depends on how these forces alter the current distributional benefit relative to the expected future distributional and Fisherian costs.

3 Quantitative Analysis

To assess the quantitative importance of the Fisherian and distributional externalities, we calibrate the decentralized nonhomothetic model to Peruvian data and compare the decentralized equilibrium with the constrained-efficient allocation. We first show the quantitative significance of Fisherian and distributional components in the optimal policy. We then examine how the planner's intervention affects aggregate and distributional outcomes.

3.1 Parameterization and values

Functional forms and assumptions The endowment of nontradable goods in every period is normalized to $Y_t^N = 1$. The endowment of tradable goods Y_t^T follows a first-order autoregressive process in logs:

$$\log Y_t^T = \rho_y \log Y_{t-1}^T + \epsilon_t^y, \qquad \epsilon_t^y \sim \mathcal{N}(0, (1-\rho_y^2)\sigma_y^2),$$

where ρ_y is the persistence parameter and σ_y is the standard deviation of tradable endowment. We discretize the tradable endowment process into a Markov chain using Tauchen's method with 20 evenly spaced nodes.

Parameter values Table 1 reports the parameter values used in the analysis. The calibration relies on Peruvian macroeconomic time series and the Peruvian household survey ENAHO to discipline the model targets. Parameters governing the risk-free interest rate, risk aversion, and the elasticity of substitution between tradable and nontradable consumption are set following Bianchi (2011).

The nonhomotheticity parameters are set as follows. The tradable nonhomotheticity parameter, ϵ_T, is normalized to one, while the nontradable parameter, ϵ_N, is estimated by GMM from household-level tradable and nontradable expenditures in the ENAHO. This estimation follows Arce and Tran-Xuan (2022), which adopts the methodology developed by Comin et al. (2021). At the estimated value, the income elasticity of nontradables in the model's ergodic distribution averages 1.08 (1.09 for hand-to-mouth households and 1.07 for borrowers), against 0.86 for tradables. The preference weight on tradable consumption is chosen so that the model replicates an average tradable output share in the data. Tradable output is defined as total output from agriculture, fishing, manufacturing, mining, and energy.

Parameters governing the tradable endowment process are estimated using an AR(1) specification for the log HP-filtered tradable output series for Peru. The persistence parameter is set equal to the empirical persistence of tradable output, and the standard deviation of the tradable shock is calibrated to match the volatility of the tradable output series. The share of borrowing households is chosen to match statistics from the Global Findex Database on financial inclusion, specifically on the share of adults who borrow or have access to financial institutions.[3] The endowment shares s^H and s^L are normalized such that $\pi s^L + (1-\pi)s^H = 1$ and are calibrated to match the average relative

[3]The 2021 Global Findex survey (Demirgüç-Kunt et al., 2022) estimates that 41.5 percent of adults aged 15 and older in Peru reported borrowing money from any source during the preceding 12 months.

Table 1: Parameters and Values

Parameter	Description	Value	Target
r^*	Risk-free rate	0.04	Standard literature value
σ	Risk aversion	2	Standard literature value
η	Substitution parameter	0.205	Elasticity of substitution T-NT $= 0.83$
ϵ_T	Tradable nonhomotheticity	1	Normalized
ϵ_N	Nontradable nonhomotheticity	2.162	GMM estimate, ENAHO
ω	Preference weight of tradables	0.37	Tradable output share = 37%
ρ_y	Tradable endowment persistence	0.59	Tradable output persistence
σ_y	Std. dev. of tradable shock	0.048	Std. dev. of tradable output
π	Share of hand-to-mouth households	0.6	Share of adults borrowing = 40%
s^H/s^L	Relative endowment share	2.25	Top 40%/bottom 60% income $= 1.5$
β	Discount factor	0.92	NFA of private sector = -20%
κ	Credit constraint coefficient	0.33	Sudden-stop probability = 5.1%

Note: The table reports the parameter values used in the calibration exercise. The targets for the risk-free rate, the risk aversion, and the elasticity of substitution between tradable and nontradable goods are taken from Bianchi (2011). The nonhomotheticity parameter ϵ_N is estimated by GMM from ENAHO household expenditure data, and the preference weight is chosen to replicate the tradable output share for Peru. The persistence and volatility of tradable endowments match observed moments of Peruvian tradable output Household heterogeneity is computed using ENAHO household survey data, and the household borrowing share is taken from the Global Findex Database. The discount factor targets the private sector net foreign asset position, while the credit constraint parameter is chosen to replicate the observed frequency of sudden-stop episodes in Peru.

income share of top and bottom earners in the ENAHO.[4]

The discount factor is calibrated to match the net foreign asset position of the private sector in Peru, and the credit constraint coefficient to match the sudden-stop probability of 5.1%.[5]

3.2 Debt issuance

We first analyze how the social planner's constrained-efficient debt issuance decisions differ from those of borrowing households. Figure 2 shows the debt issuance policies under decentralized equilibrium (DE) and the social planner's constrained-efficient allocation (SP) across four model specifications. A clear difference emerges between heterogeneous-agent and representative-agent economies. In heterogeneous-agent economies (Panels (a) and (b)), the planner chooses greater debt issuance than borrow-

[4]The calibration uses after-tax labor income rather than pre-tax total income. This choice reflects our focus on optimal macroprudential policy conditional on existing fiscal redistribution, with fiscal policy taken as given. The resulting lower level of income inequality provides a relatively conservative baseline for assessing the strength of the distributional mechanism.

[5]We approximate the net foreign asset position of the private sector as the country's net foreign asset position times the private sector's share of external debt, using data from Lane and Milesi-Ferretti (2007).

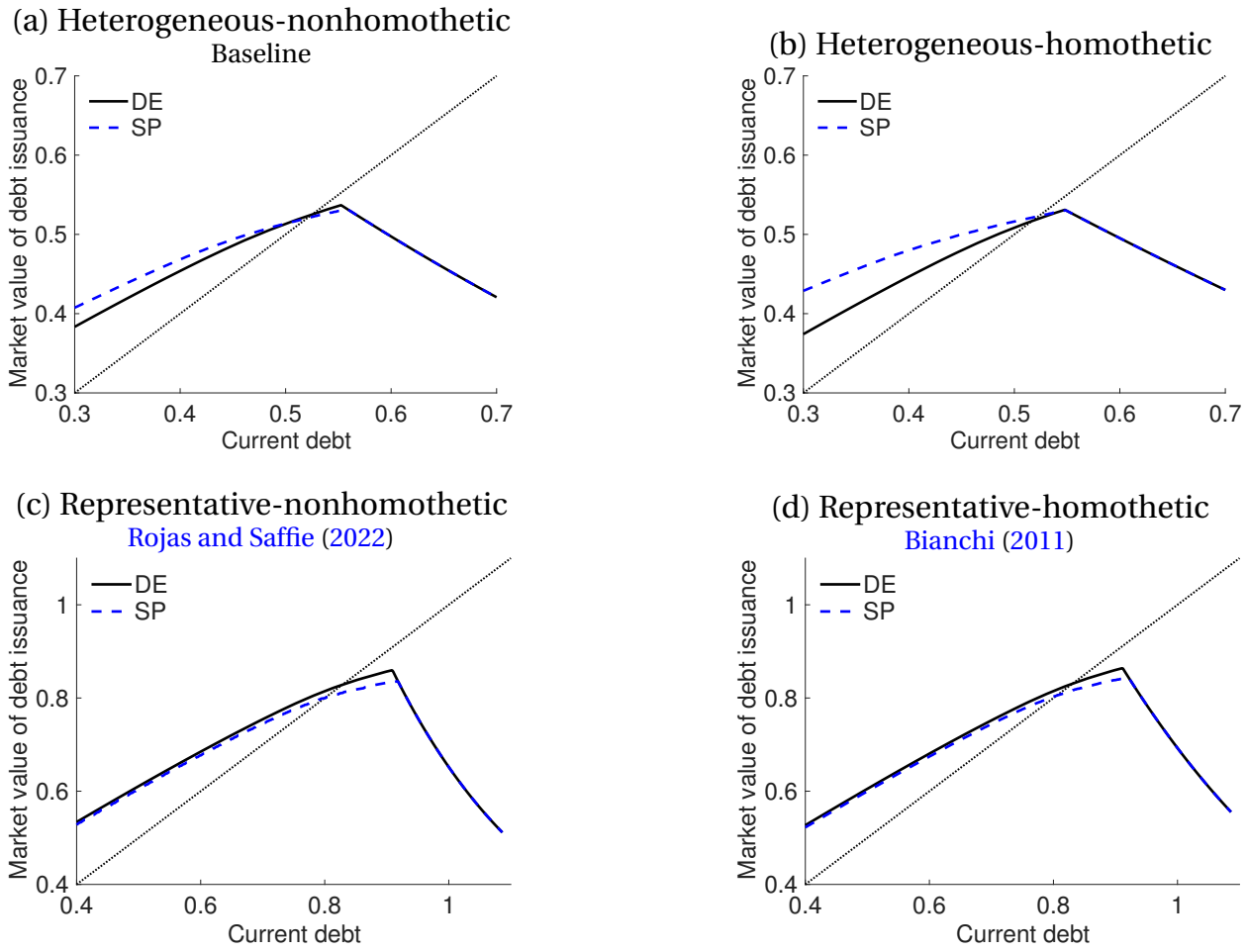


Figure 2: Debt issuance policy

Note: Market value of debt issuance, Qb', at the median income shock; debt is aggregate in the heterogeneous-agent economies. Below the dotted 45-degree line, the economy repays on net.

ing households at low levels of current debt, and the difference narrows as current debt approaches the point at which the collateral constraint begins to bind. This contrasts with the standard pattern in the representative-agent economies (Panels (c) and (d)), in which the planner chooses lower debt issuance and the gap between DE and SP widens as current debt approaches the binding region. These contrasting patterns reflect the distributional incentive for credit expansion introduced by household heterogeneity, which is active even at levels of debt where the standard Fisherian effect is not. Non-homotheticity dampens the planner's credit expansion relative to the decentralized equilibrium in the heterogeneous-agent economies. At low levels of initial debt, the gap between SP and DE debt issuance is substantially smaller in the nonhomothetic baseline (Panel (a)) than under homothetic preferences (Panel (b)). In the baseline, the gap closes before the collateral constraint binds, and the planner eventually chooses

lower issuance than its DE counterpart. Thus, the expansionary debt policy response associated with our distributional channel is *less* pronounced under nonhomothetic than under homothetic preferences.

The effect of nonhomotheticity in the representative-agent economies exists but is constrained to operate through the Fisherian channel only. As current debt approaches the point at which the collateral constraint binds, the planner reduces debt issuance more in Panel (c) than in Panel (d). With no distributional externality in these economies, this pattern is consistent with the amplification of the Fisherian channel highlighted by Rojas and Saffie (2022). The stronger response in the heterogeneous-agent economies points to an important interaction between nonhomotheticity and the distributional externality.

3.3 Optimal macroprudential policy

Optimal tax across models Figure 3 compares the optimal borrowing tax functions across model specifications. In the heterogeneous-agent economies in Panel (a), optimal policy subsidizes borrowing at low debt. Under homothetic preferences, the subsidies are larger and persist over almost the entire debt range. The nonhomothetic baseline instead features smaller subsidies that give way to positive taxes as current debt approaches the point at which the collateral constraint binds.

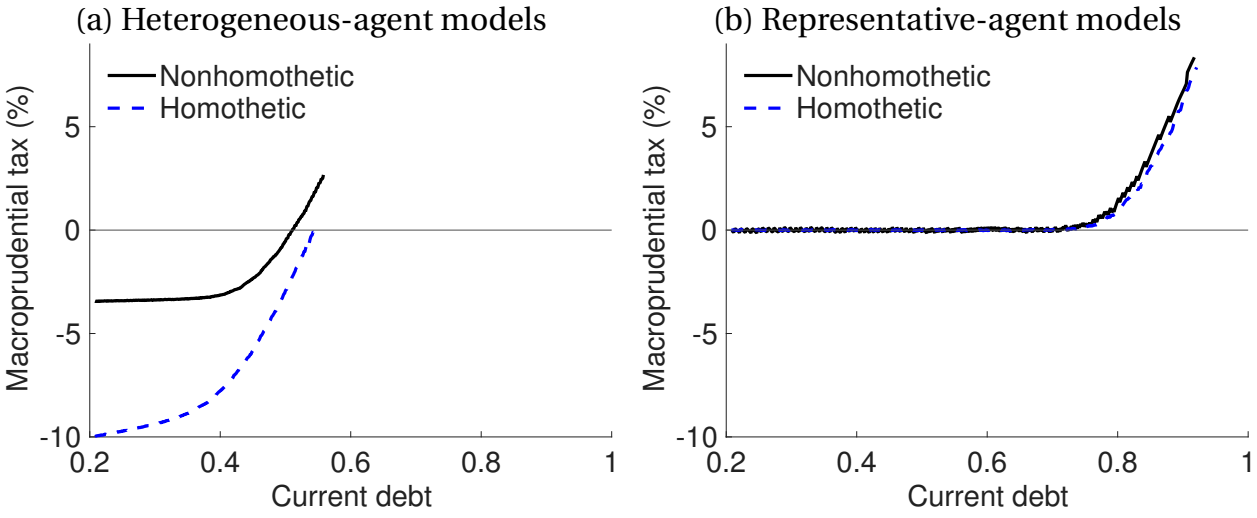


Figure 3: Optimal macroprudential policy across models

Note: The figure reports the optimal borrowing tax as a function of current aggregate debt at the median income shock.

The representative-agent benchmarks in Panel (b) display the standard pattern. The

optimal borrowing tax is zero at low debt and rises sharply as higher leverage increases the prospect of binding future collateral constraints. Nonhomotheticity strengthens this increase via its interaction with the Fisherian externality. Nonhomotheticity therefore shifts the tax schedule upward in both sets of economies, but the change is substantially larger with heterogeneous agents because of the interaction between nonhomotheticity and our dynamic real-exchange-rate distributional externality.

Optimal tax decomposition Figure 4 identifies the contributions of the Fisherian and distributional externalities to the optimal borrowing taxes. In the baseline economy in Panel (a), the negative current distributional component more than offsets the positive future distributional component at low debt, while the Fisherian component is negligible. As debt rises, the current distributional subsidy shrinks and the positive future distributional component also declines. Their combined contribution gradually becomes less negative. At the same time, the Fisherian component increases, reflecting the expected shadow cost of future binding collateral constraints. The tax becomes positive when the Fisherian contribution exceeds the remaining net distributional subsidy. Distributional considerations dampen the optimal borrowing tax throughout the entire debt range.

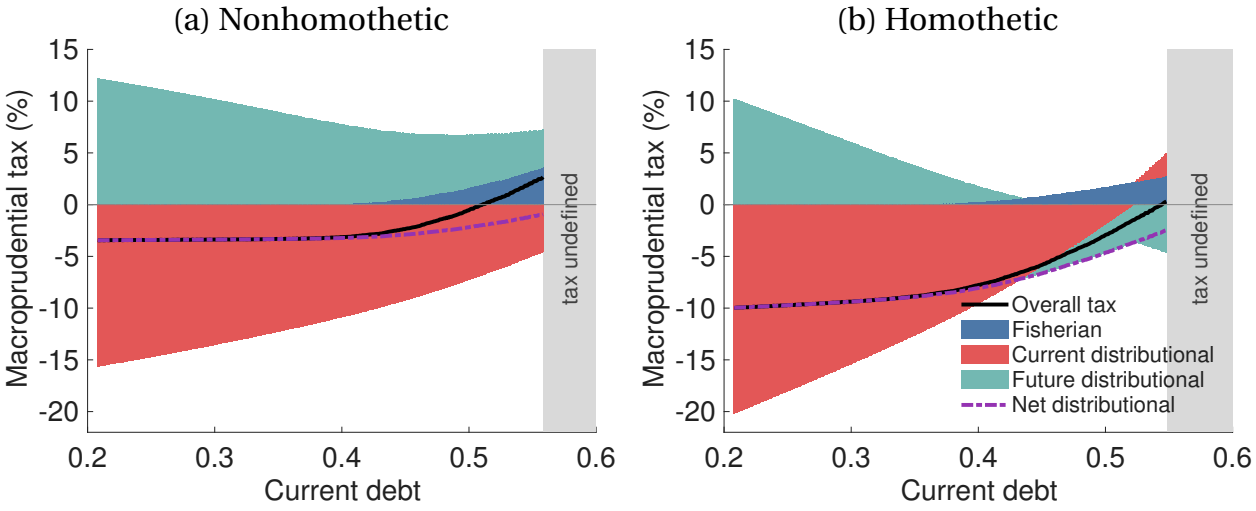


Figure 4: Optimal tax decomposition

Note: The figure decomposes the optimal borrowing tax into the Fisherian, current distributional, and future distributional components defined in equation (16). The shaded area marks debt levels at which the planner's collateral constraint binds and the tax is undefined.

Under homothetic preferences in Panel (b), the current distributional subsidy is larger at low debt, while the positive future distributional component is smaller than in

the baseline. Both differences strengthen the net borrowing subsidy. As debt rises, both channels attenuate rapidly and then change signs. The future distributional component turns negative, and the current component subsequently turns positive. Despite these reversals, their combined contribution remains negative over the entire debt range and below its nonhomothetic counterpart. Differences in this net distributional contribution account for most of the gap between the two tax schedules, while the differences in the Fisherian channel explain the rest. Nonhomotheticity therefore raises borrowing taxes primarily by weakening the net distributional subsidy.

Quantitative importance of each channel To explain these differences, we recall how each term enters the tax decomposition (16):

$$\tau = \underbrace{\frac{\mathbb{E}\left[\mu^{SP\prime}\Psi^{F\prime}\right]}{\mathbb{E}\left[U_T^{H\prime}\right]}}_{\text{Fisherian}} - \underbrace{\frac{Q}{\beta}\frac{\Psi^D}{\mathbb{E}\left[U_T^{H\prime}\right]}}_{\text{current distributional}} + \underbrace{\frac{\mathbb{E}\left[\Psi^{D\prime}\right]}{\mathbb{E}\left[U_T^{H\prime}\right]}}_{\text{future distributional}} .$$

Figure 5 compares the underlying Fisherian and distributional terms. Panel (a) shows that the Fisherian term is larger in the nonhomothetic baseline for values of debt sufficiently close to the constraint. Panel (b) shows the distributional terms. In our baseline nonhomothetic economy, the current distributional term remains negative and increasing in the initial level of debt, while the future distributional term is positive and decreasing. With homothetic preferences the terms follow the same monotonicity, albeit more steeply, and thus switch signs at different levels of initial debt.

In our baseline model the dynamic real-exchange-rate distributional terms always keep the same sign, although their effects attenuate as debt approaches the credit constraint. The current term captures the distributional benefit of an additional unit of borrowing: borrowers increase their demand for nontradable goods. This simultaneously improves the terms of trade of the poor hand-to-mouth households and increases the quantities of nontradables they sell, and thus reduces inequality. As the borrowers become more credit constrained, their demand for nontradables falls and with it the relative price of nontradables. Thus each additional unit of borrowing is less effective at reducing inequality as the hand-to-mouth are less willing to sell their nontradables at these prices, as they obtain fewer tradables in return. The future term captures the impact of additional borrowing today on next period's inequality. It operates in the opposite direction, since current borrowing must be repaid next period.

The net effect is almost always negative because, in the ergodic distribution, the economy is usually accumulating debt when the credit constraint is slack (in 82 percent

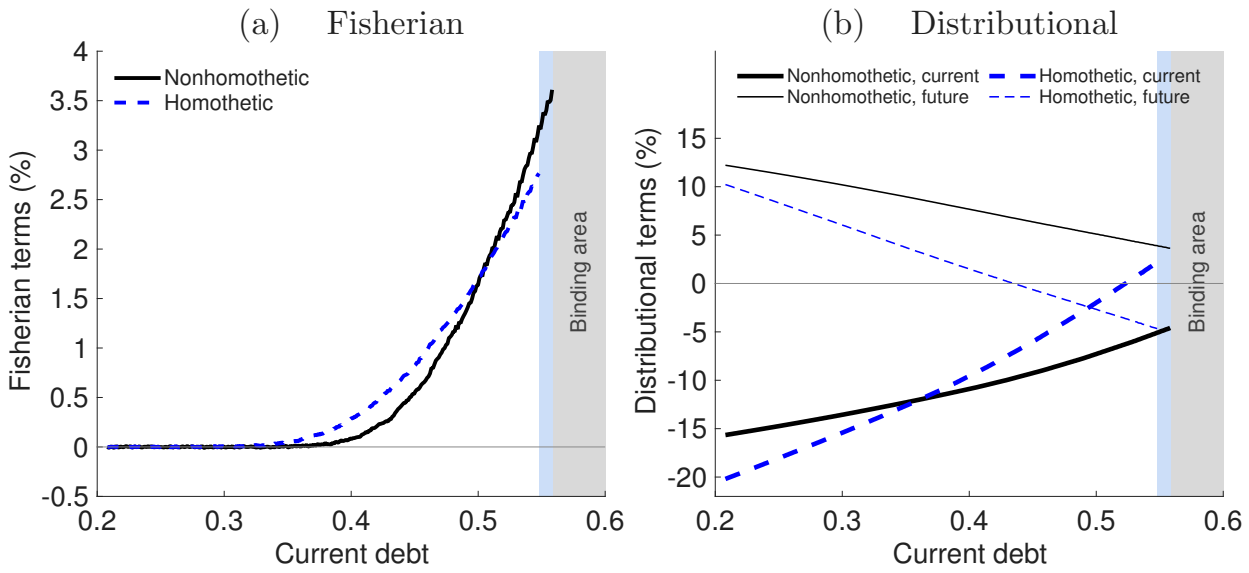


Figure 5: Fisherian and distributional terms of the optimal tax in heterogeneous-agent models

Note: Terms of equation (16) at the median income shock. Panel (b): current (thick) and future (thin) distributional terms. Shading marks debt levels at which the planner's constraint binds in both models (gray) or only in the homothetic one (light blue).

of slack periods in the baseline). In these cases, the hand-to-mouth households sell more nontradables in the current period than in the future period. Thus, a gain in the price today outweighs the loss from a lower price tomorrow. We can see this in Figure 6: panel (a) shows the quantities of nontradables sold by the hand-to-mouth households in both the decentralized and constrained-efficient economies, while panel (b) shows the relative price of nontradables. The planner manipulates the terms of trade so that hand-to-mouth households sell at a higher price when demand is high (low debt), even if tomorrow's price will be lower (higher debt), because the quantities traded next period will be smaller.

This figure also shows how the distributional channel weakens as debt approaches the binding region. When borrowers are deleveraging, hand-to-mouth households sell fewer nontradables, so a higher price raises their purchasing power by less. The planner still wants to maintain a small subsidy for distributional reasons, though, because of its interaction with the probability of a binding constraint next period, which is high. While both the quantities of nontradables sold and the relative price of nontradables are always decreasing in initial debt, they also exhibit a kink when the constraint binds (Figure 6). Thus, the expected distributional cost of a unit of borrowing in the current period declines faster when that borrowing also increases the odds of a binding constraint next period.

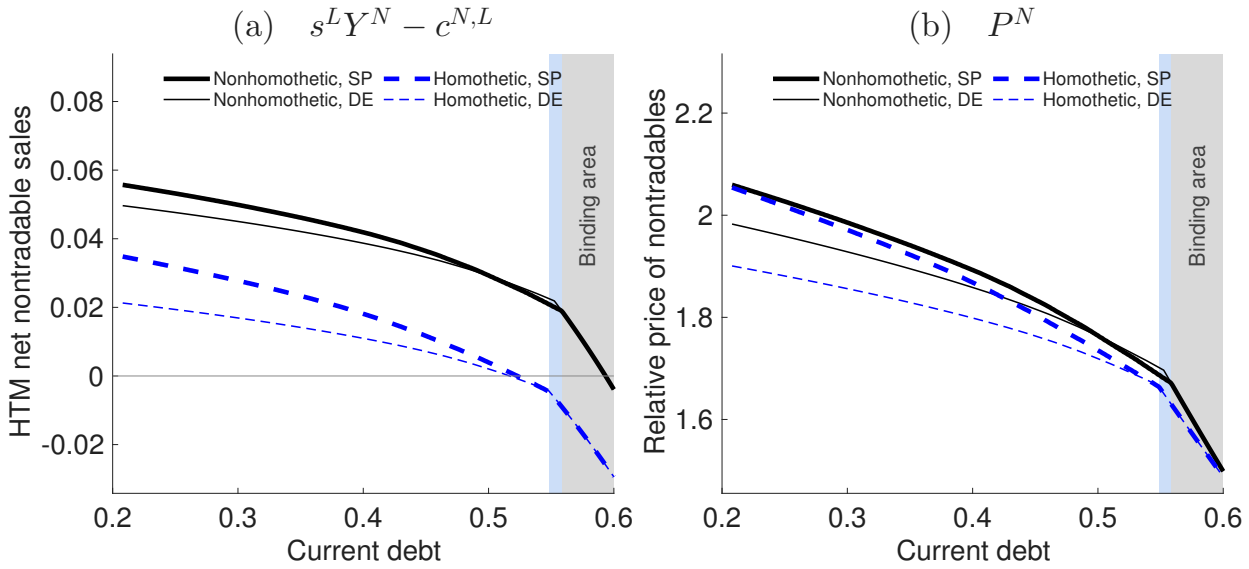


Figure 6: Net nontradable sales of hand-to-mouth households and the relative price of nontradables

Note: Hand-to-mouth net sales of nontradables (panel (a)) and the relative price of nontradables (panel (b)) at the median income shock. Thick lines: constrained efficiency; thin lines: decentralized equilibrium; black: nonhomothetic; blue dashed: homothetic. Shading marks debt levels at which the planner's constraint binds in both models (gray) or only in the homothetic one (light blue).

The homothetic case The dynamic real-exchange-rate distributional externality operates in the same direction when preferences are homothetic. Nevertheless, some effects switch signs and others are strengthened, because hand-to-mouth households turn into net *buyers* of nontradables at lower levels of initial debt.

At low levels of initial debt, hand-to-mouth households are net sellers of nontradables and the mechanism works in the same way. The implied net subsidy is larger than under nonhomothetic preferences, however. With homothetic preferences, hand-to-mouth households sell nontradables only when the country borrows on net from abroad, so their sales are smaller and fall proportionally much more by the next period, and the future distributional term offsets less of the current subsidy. This can be seen in the dashed blue lines in panel (a) of Figure 6, which remain well below their black solid counterparts, and in the steeper slopes of the dashed blue lines in panel (b) of Figure 5.

At high levels of initial debt, the borrowers start deleveraging while the constraint is still slack ($Qb' < b$). At exactly this point the hand-to-mouth households become net buyers of nontradables and the current distributional term turns positive, because increasing the relative price of nontradables *worsens* the current terms of trade of the poor. The flip side is that more borrowing now improves the expected distributional state in the future, because more constrained borrowers that are deleveraging will offer

favorable terms to the poor for the tradables they sell.

This force exerts downward pressure on the future distributional term, but it is not the only one at work. While both the future and current distributional terms switch signs, the future term does so at a lower level of initial debt (panel (b) of Figure 5). The reason is the interaction between the distributional term and the probability of a binding credit constraint in the future, described in the baseline case. If the constraint binds next period, borrowers deleverage sharply, the relative price of nontradables falls with a kink, and hand-to-mouth households sell more tradables to borrowers on these favorable terms.

3.4 Long-run moments and welfare implications

We now examine the implications for long-run debt, sudden stops, and welfare. Table 2 compares decentralized and constrained-efficient allocations across the four model specifications. The dampened policy response in the heterogeneous-agent economies is accompanied by substantially smaller stabilization and aggregate welfare gains than in the representative-agent benchmarks.

A sudden stop is defined as a period in which the current account increases by more than two standard deviations and the credit constraint binds under the decentralized equilibrium. Welfare gains are reported as expenditure-equivalent variations, defined as the permanent percentage change in expenditure, evaluated at decentralized-equilibrium prices, required to attain the lifetime utility of the constrained-efficient allocation.[6] F

Debt and sudden stops The heterogeneous-agent economies sustain substantially lower average debt than the representative-agent benchmarks under both decentralized equilibrium and constrained efficiency (Table 2). The planner reduces average debt only slightly in all four economies, with smaller reductions in the heterogeneous-agent models. Household heterogeneity also weakens the stabilizing effect of intervention. In the representative-agent economies, the planner substantially reduces sudden-stop frequency and moderates the associated real exchange rate depreciation and decline in tradable consumption. In the heterogeneous-agent baseline, these improvements are modest. Despite lower average debt, sudden-stop frequencies are similar under

[6]Following Lewis et al. (2022), we use expenditure-equivalent variations because the composite consumption index does not scale with resources under nonhomothetic preferences; under homothetic preferences the measure coincides with the consumption-equivalent variation

Table 2: Long-run moments and welfare

	Baseline		**Heterogeneous-Homothetic**		**Representative-Nonhomothetic** Rojas and Saffie (2022)		**Representative-Homothetic** Bianchi (2011)	
	DE	SP	DE	SP	DE	SP	DE	SP
Average (%)								
Debt/income	20.1	19.9	20.1	20.0	32.6	31.9	32.8	32.1
Prob. of sudden stop	5.1	3.8	5.4	5.9	4.7	1.2	5.1	1.5
Macroprudential tax	–	0.9	–	-0.4	–	3.0	–	2.8
Change in sudden stop (%)								
Real exchange rate	-18.8	-17.7	-16.1	-16.2	-29.8	-18.2	-25.1	-16.3
Tradable consumption	-14.6	-13.7	-13.5	-13.6	-23.8	-14.3	-21.3	-13.8
Welfare gain (%)	–	0.0005	–	0.0002	–	0.0333	–	0.0247
High type	–	0.0060	–	-0.0042	–	–	–	–
Low type	–	-0.0025	–	0.0015	–	–	–	–

Note: DE: decentralized equilibrium; SP: constrained efficiency. Welfare gains are expenditure-equivalent variations. The baseline features heterogeneous agents and nonhomothetic preferences. A sudden stop is defined as a period in which the current account increases by more than two standard deviations and the credit constraint binds under the decentralized equilibrium. Welfare gains are reported as expenditure-equivalent variations.

decentralized equilibrium and remain higher in the heterogeneous-agent economies under constrained efficiency.

The homothetic and nonhomothetic specifications have similar average debt within each model class, but differ in their crisis outcomes. Nonhomotheticity amplifies crisis depreciations and consumption declines in the representative-agent economies under decentralized equilibrium. The planner consequently achieves larger reductions in crisis severity, consistent with the amplification of the Fisherian externality in Rojas and Saffie (2022). With heterogeneous households, nonhomotheticity also weakens the net distributional incentive to subsidize borrowing documented in Section 3.3. Constrained efficiency increases sudden-stop frequency under homothetic preferences, with little change in severity, but reduces both frequency and severity in the nonhomothetic baseline.

Welfare Aggregate welfare gains are substantially smaller in the heterogeneous-agent economies than in the representative-agent benchmarks, where constrained efficiency delivers stronger crisis stabilization. Nonhomotheticity increases the gains in both settings. In representative-agent economies, this pattern is consistent with a stronger Fisherian externality. With heterogeneous households, it accompanies the weaker net dis-

tributional incentive to expand credit and the improved stabilization described above, although aggregate gains remain small.

Nonhomotheticity also reverses the incidence of welfare gains across household types. In the baseline, high-income borrowers benefit from milder crises and better consumption smoothing, while low-income hand-to-mouth households lose. Their forgone appreciation benefits in states where the planner restrains borrowing outweigh the gains from crisis stabilization. Under homothetic preferences, stronger credit expansions instead benefit hand-to-mouth households, while borrowers bear the costs of more frequent crises.

4 Roles of Heterogeneity, Inequality, and Nonhomotheticity

We examine how the trade-off between the Fisherian and distributional motives depends on household composition, income inequality, and nonhomotheticity, reporting the average optimal tax, its components, and welfare gains.[7]

4.1 Household heterogeneity

A larger hand-to-mouth population concentrates borrowing among a smaller group of high-income households. Their borrowing decisions consequently affect the purchasing power of a larger population outside credit markets, increasing the importance of distributional considerations for optimal policy.

Figure 7 shows that the average borrowing tax declines as the hand-to-mouth share increases and eventually becomes a subsidy. This decline occurs despite a broadly stable and subsequently increasing Fisherian component. The increase in the Fisherian component partly reflects a stronger relative-price response, which strengthens the effect of borrowing on collateral values and borrowing capacity.

The net distributional component falls more sharply and dominates this Fisherian force. As more households depend on current income, the planner places greater weight on their purchasing-power gains from appreciation during credit expansions. The net distributional benefit of accommodating borrowing therefore rises, shifting policy toward a subsidy even as the financial-stability motive for taxation strengthens.

[7] Appendix C.3 reports the corresponding results for average debt and crisis frequency.

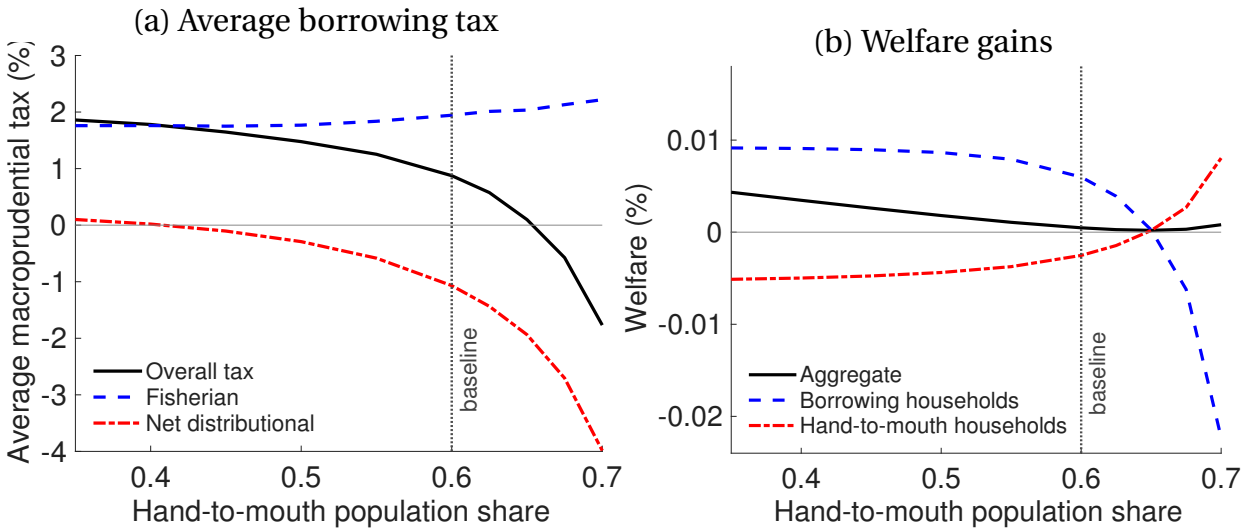


Figure 7: Household heterogeneity, optimal borrowing tax, and welfare

Note: Left panels: average optimal borrowing tax and its Fisherian and net distributional components. Right panels: welfare gains from constrained efficiency (expenditure-equivalent).

Welfare incidence shifts accordingly. As the hand-to-mouth share increases, borrowers' gains diminish and hand-to-mouth households' losses narrow, eventually reversing sign for both groups. Aggregate gains remain small. These changes accompany little movement in average debt or sudden-stop frequency, as documented in Appendix C.3. Household composition can therefore substantially alter optimal policy through its distributional consequences even when aggregate financial outcomes change little.

4.2 Income inequality

Holding household composition fixed, income inequality changes the same trade-off by reallocating resources across household types. As income shifts toward high-income households, the marginal value of consumption rises among hand-to-mouth households. The planner consequently places greater value on the purchasing-power gains these households receive during credit expansions.

Figure 8 shows that greater inequality strengthens both the Fisherian motive for taxation and the opposing distributional motive. The Fisherian component increases because borrowing households hold a larger share of income, and hence of collateral, and carry more debt. The net distributional component, however, becomes more negative by a larger amount. Supporting purchasing power among increasingly resource-poor hand-to-mouth households becomes more valuable, outweighing the stronger Fisherian incentive to restrain borrowing. The average tax therefore declines and eventually

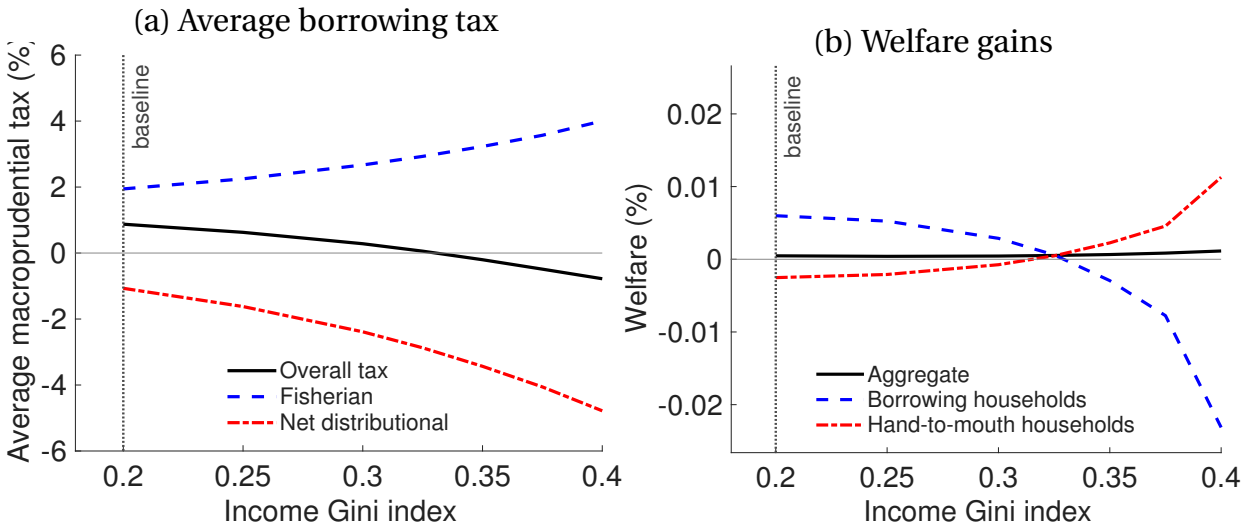


Figure 8: Income inequality, optimal borrowing policy, and welfare

Note: Left panels: average optimal borrowing tax and its Fisherian and net distributional components. Right panels: welfare gains from constrained efficiency (expenditure-equivalent). The income Gini equals $(1-\pi)(s^H-1)$.

becomes a subsidy.

As in the household-composition exercise, welfare gains shift from borrowers toward hand-to-mouth households. Here, however, the declining tax accompanies higher average debt, as reported in Appendix C.3. Greater inequality thus leads the planner to accommodate more borrowing despite its stronger Fisherian consequences.

4.3 Nonhomotheticity

Whereas household composition and inequality change the weight placed on distributional effects, nonhomotheticity changes households' exposure to relative prices. As ϵ_N increases, hand-to-mouth households devote a larger expenditure share to tradables. This magnifies both their purchasing-power gains from appreciation during credit expansions and their losses from depreciation during repayment and sudden stops.

Figure 9 shows that stronger nonhomotheticity raises the average borrowing tax, reversing the pattern of the preceding exercises. The Fisherian component initially increases through the relative-price response and then remains broadly stable. Meanwhile, the net distributional component becomes less negative, weakening the incentive to accommodate borrowing.

This change reflects the intertemporal trade-off of the distributional channel. Greater exposure to relative prices makes appreciation during an expansion more

beneficial, but also makes the subsequent depreciation more costly for hand-to-mouth households. The latter dominates, leaving the net distributional component less negative. Together with the stronger Fisherian component, this shifts optimal policy from an average subsidy toward taxation.

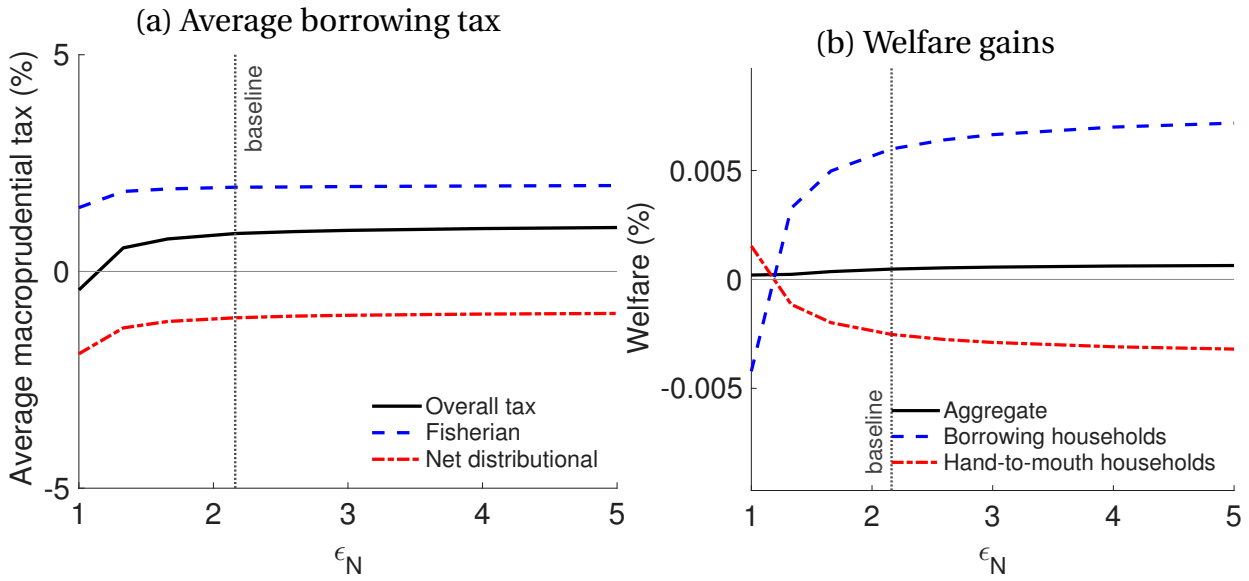


Figure 9: Nonhomotheticity, optimal borrowing policy, and welfare

Note: Left panels: average optimal borrowing tax and its Fisherian and net distributional components. Right panels: welfare gains from constrained efficiency (expenditure-equivalent).

Welfare gains consequently shift toward borrowing households and away from hand-to-mouth households. Greater sensitivity to relative prices therefore need not make intervention more beneficial for hand-to-mouth households. Its welfare implications depend on how policy changes purchasing power over the borrowing and repayment cycle.

Across these exercises, a stronger Fisherian externality does not necessarily warrant a higher borrowing tax. A larger hand-to-mouth population and greater inequality strengthen the opposing distributional motive, while stronger nonhomotheticity weakens it on net. These differences produce substantial changes in optimal policy and welfare incidence despite small aggregate welfare gains.

5 Production economies

We extend the endowment economy to allow for production in the tradable and nontradable sectors. Competitive firms use labor as the only production input, and

households supply labor inelastically. We retain household heterogeneity, nonhomothetic preferences, and the financial restrictions of the baseline model. We consider two economies. In the *production economy with flexible wages*, sectoral output adjusts to the changes in demand and relative prices associated with external borrowing. In the *production economy with downward wage rigidity*, nominal wages are downwardly rigid and the exchange rate is fixed, as in Schmitt-Grohé and Uribe (2016); external borrowing then also moves employment, and the planner internalizes a labor externality in addition to the Fisherian and distributional ones.

5.1 Environment and equilibrium

Each household has one unit of labor that can be allocated across the two sectors. Let $l_t^{j,i}$ denote the hours supplied by household $i \in \{L, H\}$ to sector $j \in \{T, N\}$, with $l_t^{T,i} + l_t^{N,i} = 1$. Labor productivity is s^i in either sector, where $s^H > s^L$ and $\pi s^L + (1-\pi)s^H = 1$. Labor employed in each sector, measured in efficiency units, is

$$L_t^j = \pi s^L l_t^{j,L} + (1-\pi) s^H l_t^{j,H}, \qquad j \in \{T, N\}, \qquad L_t^T + L_t^N = 1. \tag{17}$$

A representative competitive firm in each sector produces

$$Y_t^T = z_t^T (L_t^T)^\alpha, \qquad Y_t^N = z^N (L_t^N)^\alpha, \qquad 0 < \alpha < 1. \tag{18}$$

Tradable productivity z_t^T follows a stationary first-order Markov process, while nontradable productivity is constant and normalized to $z^N = 1$. Labor mobility equalizes the wage per efficiency unit across sectors. Profit maximization implies

$$w_t = \alpha z_t^T (L_t^T)^{\alpha-1} = P_t^N \alpha z^N (L_t^N)^{\alpha-1}. \tag{19}$$

An increase in the relative price of nontradables shifts labor toward the nontradable sector.

Households hold fixed ownership claims in both sectors with per-household weights s^i. The groups' aggregate ownership fractions are πs^L and $(1-\pi)s^H$. Equalizing ownership weights to labor productivity implies that household i receives $s^i(Y_t^T + P_t^N Y_t^N)$ from wages and profits. As before, hand-to-mouth households consume current income, and borrowing households can pledge a fraction κ of their income as collateral.

Downward wage rigidity In the production economy with downward wage rigidity, nominal wages cannot fall by more than a fraction $1-\gamma$ per period, and the nominal exchange rate is fixed. With the tradable good as numeraire, the real wage satisfies

$$a_{t+1} = w_t, \qquad w_t \geq \gamma a_t, \qquad n_t \leq 1, \qquad (w_t - \gamma a_t)(1 - n_t) = 0, \tag{20}$$

where a_t is the inherited wage and n_t is employment, so $L_t^T + L_t^N = n_t$ and the unemployment rate is $1 - n_t$. When the market-clearing wage falls below the floor, firms hire less and employment is rationed at the same rate across households, which leaves income shares $s^i(Y_t^T + P_t^N Y_t^N)$ unchanged. The aggregate state becomes (B_t, z_t^T, a_t): because today's wage sets tomorrow's floor, a credit expansion that raises wages today raises the risk of unemployment tomorrow. The production economy with flexible wages is the case $\gamma = 0$.

Following Arce et al. (2025), we focus on ex-ante macroprudential policy and assume that the planner has no ex-post policy instrument. The planner chooses external borrowing subject to household budgets, the borrowing constraint, and competitive goods and labor markets. Its allocations must therefore satisfy the implementability conditions (19), ruling out reallocation of labor across sectors by the planner. With wage rigidity, the planner also takes the wage floor (20) as given. Appendix D states the equilibrium conditions and the planner's problems.

5.2 Optimal macroprudential policy

The optimal tax retains the Fisherian and distributional components of Section 2. With production, the relevant price response is measured with respect to aggregate net external funds,

$$X_t \equiv QB_{t+1} - B_t, \qquad C_t^T = Y_t^T + X_t. \tag{21}$$

The derivative $\partial P_t^N / \partial X_t$ holds productivity fixed and allows consumption, labor allocation, and output to adjust through competitive market clearing.

The Fisherian and distributional wedges can be written as

$$\Psi_{\mathrm{P}}^F = (1-\pi)\kappa s^H Y^N \frac{\partial P^N}{\partial X}, \tag{22}$$

$$\Psi_{\mathrm{P}}^D = \pi(U_T^L - U_T^H)(s^L Y^N - c^{N,L}) \frac{\partial P^N}{\partial X}. \tag{23}$$

The first wedge measures the response of aggregate collateral to additional external funds. The second measures the associated distributional effect through the marginal-

utility gap and the hand-to-mouth households' net nontradable position. The production response enters both wedges through equilibrium output and the price derivative.

Let μ^{SP} denote the multiplier on the aggregate borrowing constraint. The following corollary extends Proposition 2.1 to the production economy.

Corollary 5.1 (Optimal macroprudential policy with flexible wages)**.** *Consider a social planner that chooses borrowing subject to competitive goods and labor markets. At a state where the current collateral constraint is slack, the optimal macroprudential tax that decentralizes the social planner's allocation can be decomposed as*

$$\tau = \underbrace{\frac{\mathbb{E}[\mu^{SP'}\Psi_{\mathrm{P}}^{F'}]}{\mathbb{E}[U_T^{H'}]}}_{\textit{Fisherian}} - \underbrace{\frac{Q}{\beta}\frac{\Psi_{\mathrm{P}}^{D}}{\mathbb{E}[U_T^{H'}]}}_{\textit{current distributional}} + \underbrace{\frac{\mathbb{E}[\Psi_{\mathrm{P}}^{D'}]}{\mathbb{E}[U_T^{H'}]}}_{\textit{future distributional}}. \tag{24}$$

Proof. See Appendix D.1.3. □

The tax decomposition formula is preserved in the production economy with flexible wages, with both externalities depending on the relative price response to X. As in the endowment economy, a positive distributional wedge lowers the tax through the current component and raises it through the expected future component. The Fisherian component is positive when the future collateral constraint binds with positive probability.

With downward wage rigidity, external funds affect welfare through two additional margins. When the wage floor binds, additional borrowing raises the demand for nontradables, the market-clearing wage, and therefore employment, $\partial n/\partial X > 0$; the extra income is valued at the marginal utilities of both household types. When the floor is slack, employment is full, but a higher current wage raises tomorrow's floor, $a' = w$, and this is costly whenever unemployment may arise next period, $\mathbb{E}[V_a^{SP'}] < 0$. The two margins define an employment wedge and a wage-floor wedge,

$$\Psi_{\mathrm{P}}^{n} = \left[\pi s^L U_T^L + (1-\pi)s^H U_T^H\right] w\frac{\partial n}{\partial X}, \qquad \Psi_{\mathrm{P}}^{a} = \beta\,\mathbb{E}[V_a^{SP'}]\frac{\partial w}{\partial X}, \tag{25}$$

and the optimal tax adds two terms to equation (24). Appendix D.2 states the planner's problem and derives the result.

Corollary 5.2 (Optimal macroprudential policy with downward wage rigidity)**.** *Consider a social planner that chooses borrowing subject to competitive goods markets and the wage floor* (20)*. At a state where the current collateral constraint is slack, the optimal macroprudential tax that decentralizes the social planner's allocation can be decomposed as*

$$\tau = \underbrace{\frac{\mathbb{E}[\mu^{SP'}\Psi_{\mathrm{P}}^{F'}]}{\mathbb{E}[U_T^{H'}]}}_{\textit{Fisherian}} - \underbrace{\frac{Q}{\beta}\frac{\Psi_{\mathrm{P}}^{D}}{\mathbb{E}[U_T^{H'}]}}_{\textit{current distributional}} + \underbrace{\frac{\mathbb{E}[\Psi_{\mathrm{P}}^{D'}]}{\mathbb{E}[U_T^{H'}]}}_{\textit{future distributional}} - \underbrace{\frac{Q}{\beta}\frac{\Psi_{\mathrm{P}}^{n}}{\mathbb{E}[U_T^{H'}]}}_{\textit{current labor}} + \underbrace{\frac{\mathbb{E}[\Psi_{\mathrm{P}}^{n'} + \Psi_{\mathrm{P}}^{a'}] - \frac{Q}{\beta}\Psi_{\mathrm{P}}^{a}}{\mathbb{E}[U_T^{H'}]}}_{\textit{future labor}}, \tag{26}$$

where Ψ_{P}^{D} *is given by equation* (23)*,* Ψ_{P}^{n} *and* Ψ_{P}^{a} *by equation* (25)*, and* $\Psi_{\mathrm{P}}^{F} = \kappa(1-\pi)s^{H}\left(Y^{N}\,\partial P^{N}/\partial X + w\,\partial n/\partial X\right)$ *adds the employment response of collateral income to equation* (22)*.*

Proof. See Appendix D.2. □

The labor terms are grouped by when their effects materialize. The current labor term is a subsidy that is active only when the wage floor binds today, so that additional borrowing creates employment today. The future labor term collects everything that operates through next period's labor market: the wage-floor wedge, because today's wage becomes tomorrow's floor and additional borrowing raises it, and the expected labor wedge of next period, because borrowing that must be repaid lowers next period's demand and wages, which destroys jobs if the floor binds then but relaxes the floor inherited the period after.

5.3 Quantitative results

Parameterization and values Tables D.1 and D.2 in Appendix D.1.4 report the parameter values for the two heterogeneous-agent nonhomothetic production economies. We set $\alpha = 0.2$, following Rojas and Saffie (2022), who adopt the production-curvature calibration of Durdu et al. (2009). Tradable productivity follows

$$\log z_t^T = \rho_z \log z_{t-1}^T + \epsilon_t^z, \qquad \epsilon_t^z \sim \mathcal{N}\left(0, (1-\rho_z^2)\sigma_z^2\right), \tag{27}$$

where σ_z denotes the standard deviation of tradable productivity. We set $\rho_z = 0.592$ and calibrate σ_z to target a standard deviation of tradable output of 0.048. The productivity process is discretized using Tauchen's method with 20 equally spaced nodes. Nontradable productivity is normalized at $z^N = 1$. In the economy with wage rigidity, $\gamma = 0.96$

follows Schmitt-Grohé and Uribe (2016), and β, κ, σ_z, and ω are recalibrated to the same four targets.[8]

Optimal taxes with flexible wages Figure 10 reports the optimal tax decomposition in the heterogeneous-agent production economies with flexible wages. In the nonhomothetic case, the negative current distributional component still exceeds the positive future distributional and Fisherian components at low debt, making a borrowing subsidy optimal. As debt rises, the net distributional contribution becomes less negative and the Fisherian component increases. The overall tax becomes positive at high debt. Under homothetic preferences, the net distributional contribution remains sufficiently negative to sustain a subsidy throughout the plotted range. The dampening effect of the dynamic real-exchange-rate distributional externality therefore remains present with production.

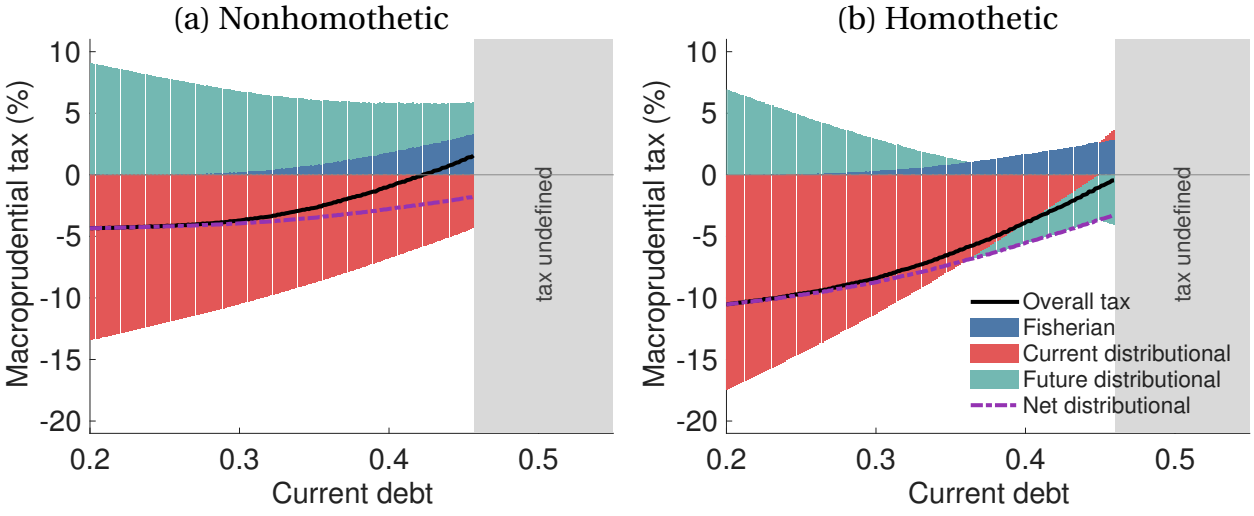


Figure 10: Optimal tax decomposition in production economy with flexible wages

Note: The figure decomposes the optimal borrowing tax into the Fisherian, current distributional, and future distributional components defined in equation (24). The shaded area marks debt levels at which the planner's collateral constraint binds and the tax is undefined.

Optimal taxes with downward wage rigidity Figure 11 reports the five-term decomposition of equation (26) in the heterogeneous-agent production economies with downward wage rigidity, at the median productivity shock and the median inherited wage. Where the wage floor is slack, the current labor term is zero and the labor

[8]The decentralized equilibrium has an average unemployment rate of 2.6%. Appendix E reports the long-run moments and welfare gains of the production economies (Tables E.1 and E.2).

externality is entirely forward-looking. The future labor term is large and positive. Its value is driven by the wage-floor wedge: additional borrowing raises today's wage and therefore tomorrow's floor. Our distributional externality is smaller by comparison and the Fisherian term is small away from the constraint. The net distributional term can turn positive as the planner deleverages to avoid future unemployment. The overall tax is positive at every debt level because the labor externality dominates the distributional motive for credit expansion.

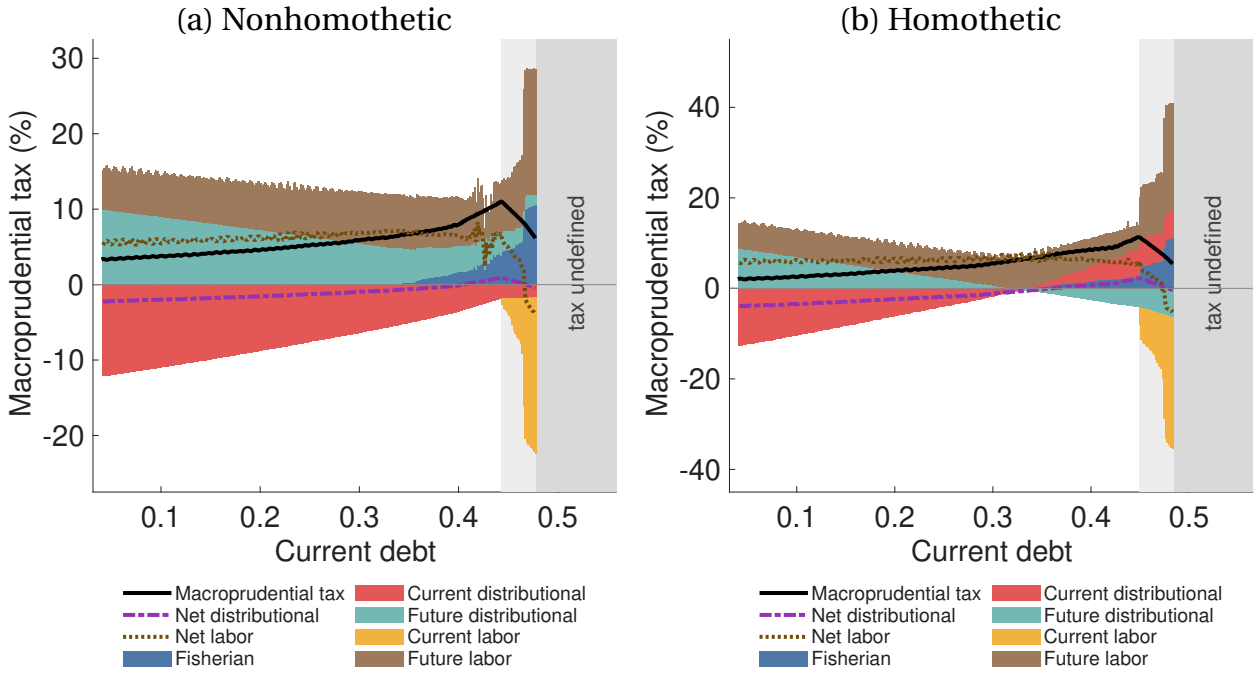


Figure 11: Optimal tax decomposition in production economy with downward wage rigidity

Note: The figure plots the terms of equation (26) at the median productivity shock and inherited wage. Light shading: the planner keeps the wage at the floor with full employment. Dark shading: the planner's collateral constraint binds.

In the light-shaded area, the planner keeps the wage at the floor with full employment: less borrowing would create unemployment and more would raise the wage. The current labor term is active here, as the planner's borrowing supports employment and offsets a growing share of the future labor term. Household heterogeneity amplifies both labor terms: job losses are shared evenly, but the poor have a higher marginal utility of consumption. The net distributional term is small by comparison, but trends toward a subsidy as the planner rolls over debt to support employment.

6 Conclusion

This paper studies optimal macroprudential policy when lower-income households are excluded from credit markets. In a small open economy with nonhomothetic preferences, high-income households borrow internationally subject to collateral constraints, while hand-to-mouth households consume their income. Real exchange rate movements then affect households differently, and the planner trades off financial stability against redistribution.

We emphasize a novel dynamic real-exchange-rate distributional externality that operates alongside the standard Fisherian debt-deflation externality, and decompose the optimal borrowing tax into a Fisherian component and current and future distributional components. A credit-driven appreciation improves the terms of trade of the poorest households today. This benefit usually outweighs the deterioration it induces next period, because hand-to-mouth households sell fewer nontradables as the credit cycle advances. Late in the cycle, the Fisherian component activates and the planner taxes borrowing, though less than in representative-agent economies. The pattern survives with production and flexible wages. With downward wage rigidity, avoiding unemployment realigns financial stability and distributional considerations.

Nonhomotheticity partly offsets this dampening. By tilting hand-to-mouth spending toward tradables, it magnifies both the gains from appreciation during expansions and the losses from depreciation during repayment, and the latter rise relative to the former, weakening the net distributional subsidy. Its effect on the optimal tax runs mainly through the distributional rather than the Fisherian externality.

A larger hand-to-mouth share and greater income inequality strengthen the distributional incentive to accommodate borrowing, lowering the average tax despite a stronger Fisherian motive for taxation, and shift welfare gains toward hand-to-mouth households; stronger nonhomotheticity shifts them toward borrowers. Aggregate gains remain small throughout because much of the intervention redistributes welfare between the two groups.

Our results suggest that the distributional incidence of real exchange rate movements could partly explain why emerging economies with high inequality and financial exclusion may be reluctant to adopt strict macroprudential policies: policies that reduce financial vulnerability can increase inequality relative to laissez-faire. Future research could study how macroprudential policy should be coordinated with social insurance and financial inclusion policies in emerging market economies.

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Appendix

A Data

A.1 World Inequality Database (WID)

Income share data are drawn from the World Inequality Database, maintained by the World Inequality Lab, which combines national accounts, household surveys, and administrative tax records into distributional national accounts designed to be comparable across countries and over time. We use the pre-tax national income share accruing to the bottom 50 percent of the adult population.

A.2 Capital Control Measures

Capital control data are from Fernández et al. (2016): "Capital Control Measures: A New Dataset". The dataset translates the narrative restrictions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions into binary indicators of whether a restriction is in place, separately by asset category and by direction of the transaction. Averaging these indicators yields continuous indices bounded between zero and one, where higher values denote more restricted capital accounts. We use the overall restrictions index (ka), covering 100 countries annually from 1995 to 2019.

A.3 Peruvian National Household Survey ENAHO

The Peruvian National Household Survey (Encuesta Nacional de Hogares, ENAHO), conducted annually by the National Institute of Statistics and Informatics (INEI), is a nationally representative survey designed to monitor living conditions and socioeconomic outcomes in Peru. ENAHO collects detailed information on demographics, labor markets, education, health, housing, income, and expenditures. In this paper, we rely specifically on the income and consumption modules. The income module provides granular information on labor earnings, self-employment income, transfers, and other revenue sources, which we use to construct the income distribution and measure inequality between the top 40 percent and bottom 60 percent of households. The consumption module reports detailed household expenditures across a wide range of goods and services, allowing us to aggregate spending into tradable and nontradable categories.

A.4 List of countries

Figure 1 uses the 100 countries covered by the capital control dataset of Fernández et al. (2016). Advanced economies follow the IMF classification, and all other countries form the emerging-market sample.

Advanced economies (31, panel (b)) Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

Emerging market and developing economies (69, panel (a)) Algeria, Angola, Argentina, Bahrain, Bangladesh, Bolivia, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Eswatini, Ethiopia, Georgia, Ghana, Guatemala, Hungary, India, Indonesia, Iran, Jamaica, Kazakhstan, Kenya, Kuwait, Kyrgyz Republic, Lebanon, Malaysia, Mauritius, Mexico, Moldova, Morocco, Myanmar, Nicaragua, Nigeria, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Qatar, Romania, Russia, Saudi Arabia, South Africa, Sri Lanka, Tanzania, Thailand, Togo, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, Uruguay, Uzbekistan, Venezuela, Vietnam, Yemen, Zambia.

B Equilibrium Derivations and Proof

This appendix characterizes the equilibrium allocation and relative price, the social marginal value of aggregate tradable consumption, and provides the proof of the tax decomposition.

B.1 Hicksian Demands

For household type $i \in \{L, H\}$, let $E^i \equiv c^{T,i} + P^N c^{N,i}$ denote expenditure. For a given composite consumption level c^i and relative price P^N, expenditure minimization im-

plies the Hicksian demands

$$\begin{aligned} c^{T,i} &= \omega^{\frac{1}{1+\eta}} (E^i)^{\frac{1}{1+\eta}} (c^i)^{\epsilon_T - \frac{1}{1+\eta}}, \\ c^{N,i} &= (1-\omega)^{\frac{1}{1+\eta}} \left(\frac{E^i}{P^N}\right)^{\frac{1}{1+\eta}} (c^i)^{\epsilon_N - \frac{1}{1+\eta}}. \end{aligned} \tag{B.1}$$

Substituting these demands into the expenditure identity and solving for E^i gives the expenditure function

$$\begin{aligned} E^i &= E(c^i, P^N) \\ &= \left[\omega^{\frac{1}{1+\eta}} (c^i)^{\epsilon_T - \frac{1}{1+\eta}} + (1-\omega)^{\frac{1}{1+\eta}} (P^N)^{\frac{\eta}{1+\eta}} (c^i)^{\epsilon_N - \frac{1}{1+\eta}}\right]^{\frac{1+\eta}{\eta}}. \end{aligned} \tag{B.2}$$

Market clearing requires

$$\pi c^{T,L} + (1-\pi) c^{T,H} = C^T, \qquad \pi c^{N,L} + (1-\pi) c^{N,H} = 1. \tag{B.3}$$

Substituting nontradable demand into the second condition and rearranging yields

$$P^N = (1-\omega)\left[\pi (E^L)^{\frac{1}{1+\eta}} (c^L)^{\epsilon_N - \frac{1}{1+\eta}} + (1-\pi)(E^H)^{\frac{1}{1+\eta}} (c^H)^{\epsilon_N - \frac{1}{1+\eta}}\right]^{1+\eta}. \tag{B.4}$$

The hand-to-mouth budget constraint and aggregate expenditure identity are

$$E^L = s^L (Y^T + P^N Y^N), \tag{B.5}$$

$$\pi E^L + (1-\pi) E^H = C^T + P^N Y^N. \tag{B.6}$$

Using the normalization of endowment shares, high-income household expenditure can therefore be written as

$$E^H = s^H (Y^T + P^N Y^N) + \frac{C^T - Y^T}{1-\pi}. \tag{B.7}$$

Together with the expenditure function and household demands, these conditions characterize the equilibrium for given (Y^T, Y^N).

B.2 Social Marginal Value of Aggregate Tradable Consumption

We next derive Λ. By Shephard's lemma, $\partial E(c^i, P^N)/\partial P^N = c^{N,i}$. Applying the chain rule to equilibrium expenditure gives

$$\frac{\partial E^i}{\partial C^T} = \frac{\partial E(c^i, P^N)}{\partial c^i}\frac{\partial c^i}{\partial C^T} + c^{N,i}\frac{\partial P^N}{\partial C^T}. \tag{B.8}$$

Rearranging and using $U_T^i = u'(c^i)/(\frac{\partial E(c^i,P^N)}{\partial c^i})$, the marginal utility of tradable consumption, yields

$$\frac{\partial u(c^i)}{\partial C^T} = u'(c^i)\frac{\partial c^i}{\partial C^T} = U_T^i\left(\frac{\partial E^i}{\partial C^T} - c^{N,i}\frac{\partial P^N}{\partial C^T}\right). \tag{B.9}$$

Differentiating (B.5) and (B.7) with respect to C^T gives

$$\frac{\partial E^L}{\partial C^T} = s^L Y^N \frac{\partial P^N}{\partial C^T}, \qquad \frac{\partial E^H}{\partial C^T} = \frac{1}{1-\pi} + s^H Y^N \frac{\partial P^N}{\partial C^T}. \tag{B.10}$$

Using (B.9) and aggregating across household types, the welfare derivative is

$$\begin{aligned}\Lambda &= \pi U_T^L\left(\frac{\partial E^L}{\partial C^T} - c^{N,L}\frac{\partial P^N}{\partial C^T}\right) + (1-\pi)U_T^H\left(\frac{\partial E^H}{\partial C^T} - c^{N,H}\frac{\partial P^N}{\partial C^T}\right)\\ &= U_T^H + \left[\pi U_T^L(s^L Y^N - c^{N,L}) + (1-\pi)U_T^H(s^H Y^N - c^{N,H})\right]\frac{\partial P^N}{\partial C^T}.\end{aligned} \tag{B.11}$$

Nontradable market clearing implies

$$\pi(s^L Y^N - c^{N,L}) + (1-\pi)(s^H Y^N - c^{N,H}) = 0. \tag{B.12}$$

Substituting into (B.11) gives

$$\Lambda = U_T^H + \pi(s^L Y^N - c^{N,L})\left(U_T^L - U_T^H\right)\frac{\partial P^N}{\partial C^T}. \tag{B.13}$$

B.3 Proof of Proposition 2.1

Proof. When the current borrowing constraint is slack, $\mu^{SP} = 0$, and the planner's Euler equation is

$$\Lambda = \frac{\beta}{Q}\mathbb{E}\left[\Lambda' + \mu^{SP'}\Psi^{F\prime}\right]. \tag{B.14}$$

Using $\Lambda = U_T^H + \Psi^D$, this condition can be written as

$$U_T^H + \Psi^D = \frac{\beta}{Q}\mathbb{E}\left[U_T^{H\prime} + \Psi^{D\prime} + \mu^{SP'}\Psi^{F\prime}\right]. \tag{B.15}$$

Rearranging gives

$$U_T^H = \frac{\beta}{Q}\mathbb{E}\left[U_T^{H\prime}\right] + \frac{\beta}{Q}\mathbb{E}\left[\Psi^{D\prime}\right] + \frac{\beta}{Q}\mathbb{E}\left[\mu^{SP'}\Psi^{F\prime}\right] - \Psi^D. \tag{B.16}$$

The Euler equation of a high-income household facing the macroprudential tax is

$$U_T^H = \frac{\beta}{Q}(1+\tau)\mathbb{E}\left[U_T^{H\prime}\right], \tag{B.17}$$

where the lump-sum rebate of tax revenues is taken as given by the household. Combining equations (B.16) and (B.17) yields

$$\frac{\beta}{Q}\tau\mathbb{E}\left[U_T^{H\prime}\right] = \frac{\beta}{Q}\mathbb{E}\left[\mu^{SP'}\Psi^{F\prime}\right] + \frac{\beta}{Q}\mathbb{E}\left[\Psi^{D\prime}\right] - \Psi^D. \tag{B.18}$$

Dividing by $(\beta/Q)\mathbb{E}[U_T^{H\prime}]$ gives

$$\tau = \frac{\mathbb{E}\left[\mu^{SP'}\Psi^{F\prime}\right]}{\mathbb{E}\left[U_T^{H\prime}\right]} + \frac{\mathbb{E}\left[\Psi^{D\prime}\right]}{\mathbb{E}\left[U_T^{H\prime}\right]} - \frac{Q}{\beta}\frac{\Psi^D}{\mathbb{E}\left[U_T^{H\prime}\right]}, \tag{B.19}$$

which establishes the decomposition in equation (16). □

C Quantitative Appendix

C.1 Consumption Dynamics Around Sudden Stops

We provide evidence on household consumption dynamics around sudden stops. Figure C.1 reports tradable and nontradable consumption for high-income and hand-to-mouth households around sudden stops. Tradable consumption falls sharply for both household types when the crisis occurs. High-income borrowers also reduce nontradable consumption as deleveraging contracts their available resources. Hand-to-mouth households, in contrast, increase nontradable consumption as the real exchange rate depreciates and they substitute away from relatively more expensive tradables.

The different responses reflect the distinct channels through which the crisis affects the two household types. High-income households are directly exposed to delever-

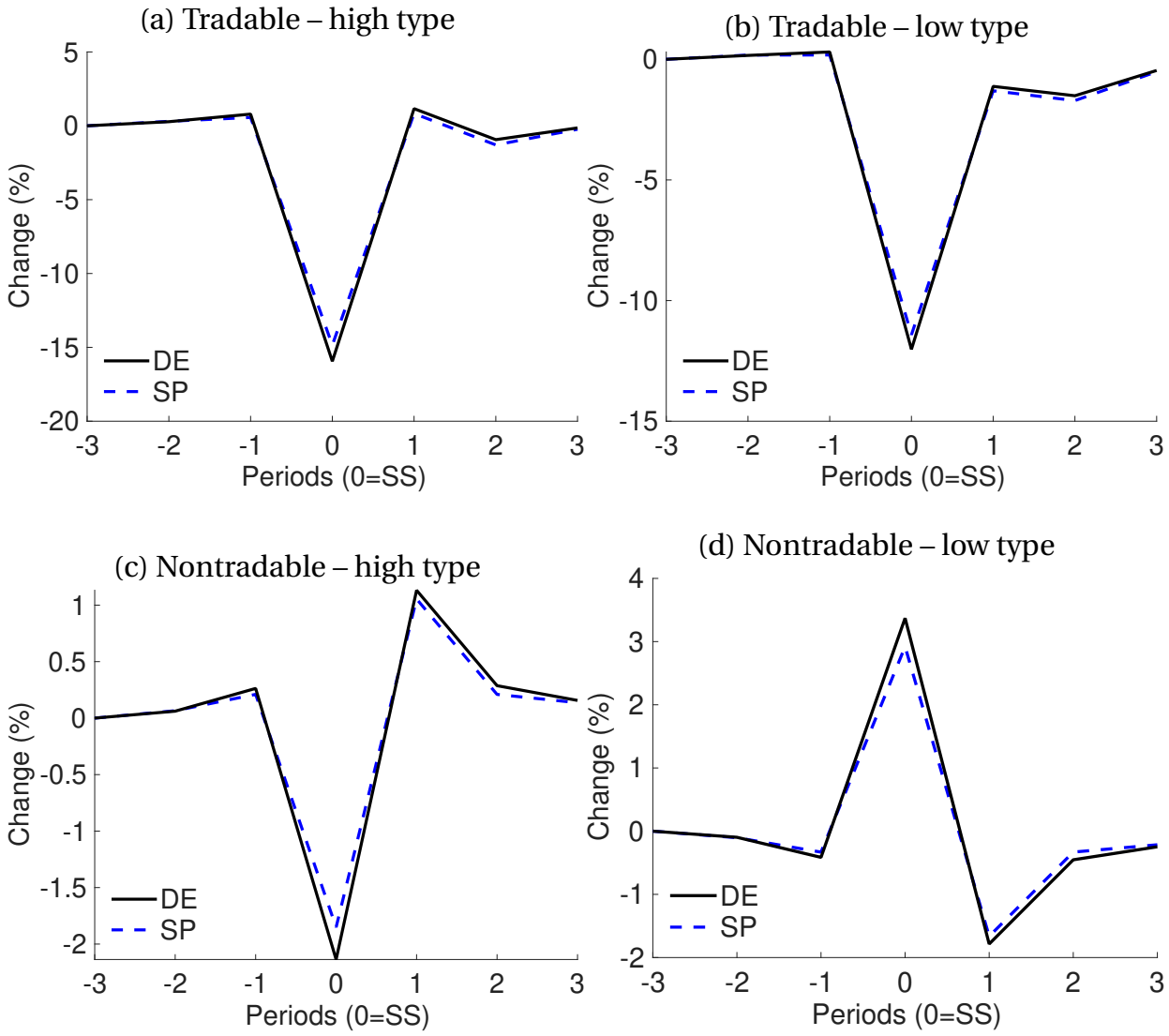


Figure C.1: Consumption around sudden stops in the baseline model

Note: Figure C.1 plots tradable and nontradable consumption around a sudden stop under the decentralized equilibrium (DE) and constrained efficiency (SP) in simulations of the baseline model. A sudden stop (SS) is defined as a period in which the current account increases by more than two standard deviations and the borrowing constraint binds under the decentralized equilibrium.

aging, while hand-to-mouth households adjust primarily through relative prices. Although substitution toward nontradables cushions their consumption adjustment, nonhomothetic preferences make the accompanying depreciation particularly costly because hand-to-mouth households devote a larger expenditure share to tradables.

Constrained efficiency modestly attenuates these adjustments. The smaller real exchange rate depreciation reduces deleveraging by high-income borrowers and the decline in tradable consumption of hand-to-mouth households, while also limiting their

substitution toward nontradables. These consumption dynamics are consistent with the modest reduction in crisis severity in the baseline model.

We next show how consumption inequality evolves around sudden stops. Figure C.2 reports tradable and nontradable consumption inequality, measured as the ratio of consumption of high-income households to that of low-income households. Both measures fall sharply during sudden stops and rebound thereafter. The fluctuations are larger for nontradable consumption inequality, reflecting the sharper contraction in nontradable consumption of high-income borrowers as they deleverage, while hand-to-mouth households substitute toward relatively cheaper nontradables as the real exchange rate depreciates.

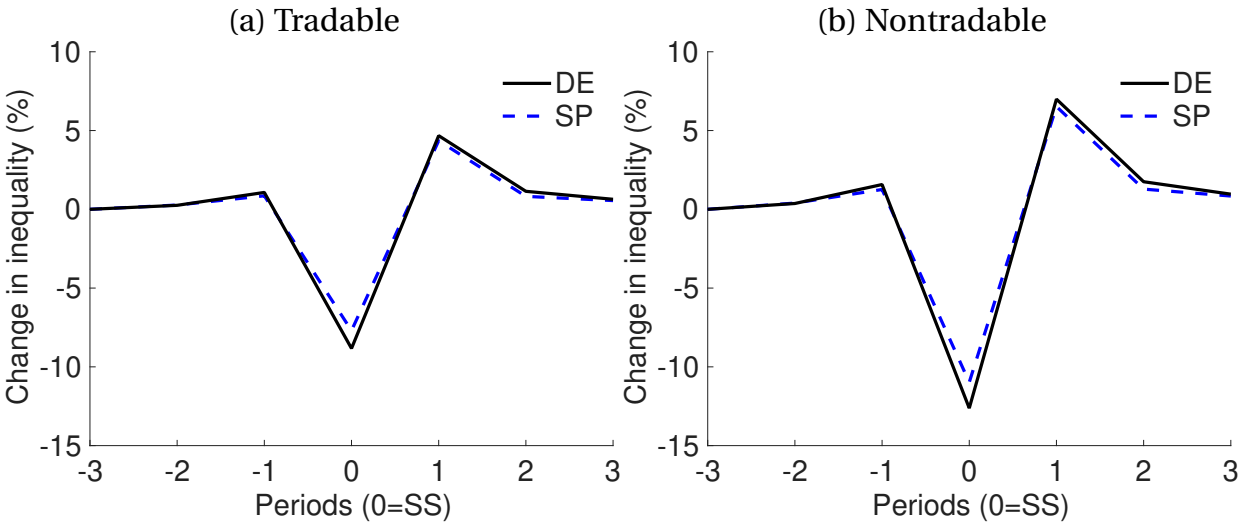


Figure C.2: Consumption inequality around sudden stops

Note: Figure C.2 plots consumption inequality around a sudden stop under the decentralized equilibrium (DE) and constrained efficiency (SP) in simulations of the baseline model. Consumption inequality is measured as the ratio of consumption of high-income households to that of low-income households. A sudden stop (SS) is defined as a period in which the current account increases by more than two standard deviations and the credit constraint binds under the decentralized equilibrium.

Under constrained efficiency, these fluctuations are somewhat attenuated. By limiting pre-crisis borrowing, the social planner reduces subsequent deleveraging and real exchange rate depreciation, moderating both the decline in consumption inequality during the sudden stop and its rebound afterward.

C.2 Marginal values and tax normalization

In this subsection we revisit the different terms that enter the distributional and Fisherian externalities. Recall that the relevant terms for equation (16) are $\mathbb{E}_t[U_T^{H\prime}]$, and:

$$\begin{aligned}\Psi^D &= \pi\left(U_T^L - U_T^H\right)\left(s^L Y^N - c^{N,L}\right)\frac{\partial P^N}{\partial C^T},\\ \Psi^F &= (1-\pi)\kappa s^H Y^N \frac{\partial P^N}{\partial C^T}.\end{aligned} \tag{C.1}$$

Figure C.3 reports the marginal-value terms entering the optimal tax decomposition. Panel (a) explains the sign changes in the distributional wedge. Since the marginal-value gap and the relative-price response remain positive in both economies over the plotted debt range, the sign of the distributional wedge follows hand-to-mouth households' net nontradable position. These households are net sellers of nontradables at low debt, so an appreciation raises their purchasing power. Their net sales decline as debt rises and eventually become negative, reversing this effect.

Panel (b) shows a stronger response of the relative price of nontradables to aggregate tradable consumption in the baseline. Holding the other determinants fixed, this response strengthens the collateral-price channel and magnifies the distributional effects of changes in tradable consumption. These price and quantity responses, however, do not alone determine the relative magnitudes of optimal taxes, which also depend on current and expected future marginal valuations. Panels (c) and (d) report the marginal-value terms.

Panel (c) displays the gap $U_T^L - U_T^H$, which weights price-mediated redistribution toward hand-to-mouth households. This gap remains positive in both economies over the plotted debt range, supporting the sign interpretation in the main text. Panel (d) displays borrowing households' expected future marginal value of tradable consumption, $\mathbb{E}_t[U_T^{H\prime}]$, which converts the utility-valued numerators into tax rates. The levels of these quantities depend on the utility representation and are therefore not directly comparable across the nonhomothetic and homothetic specifications.

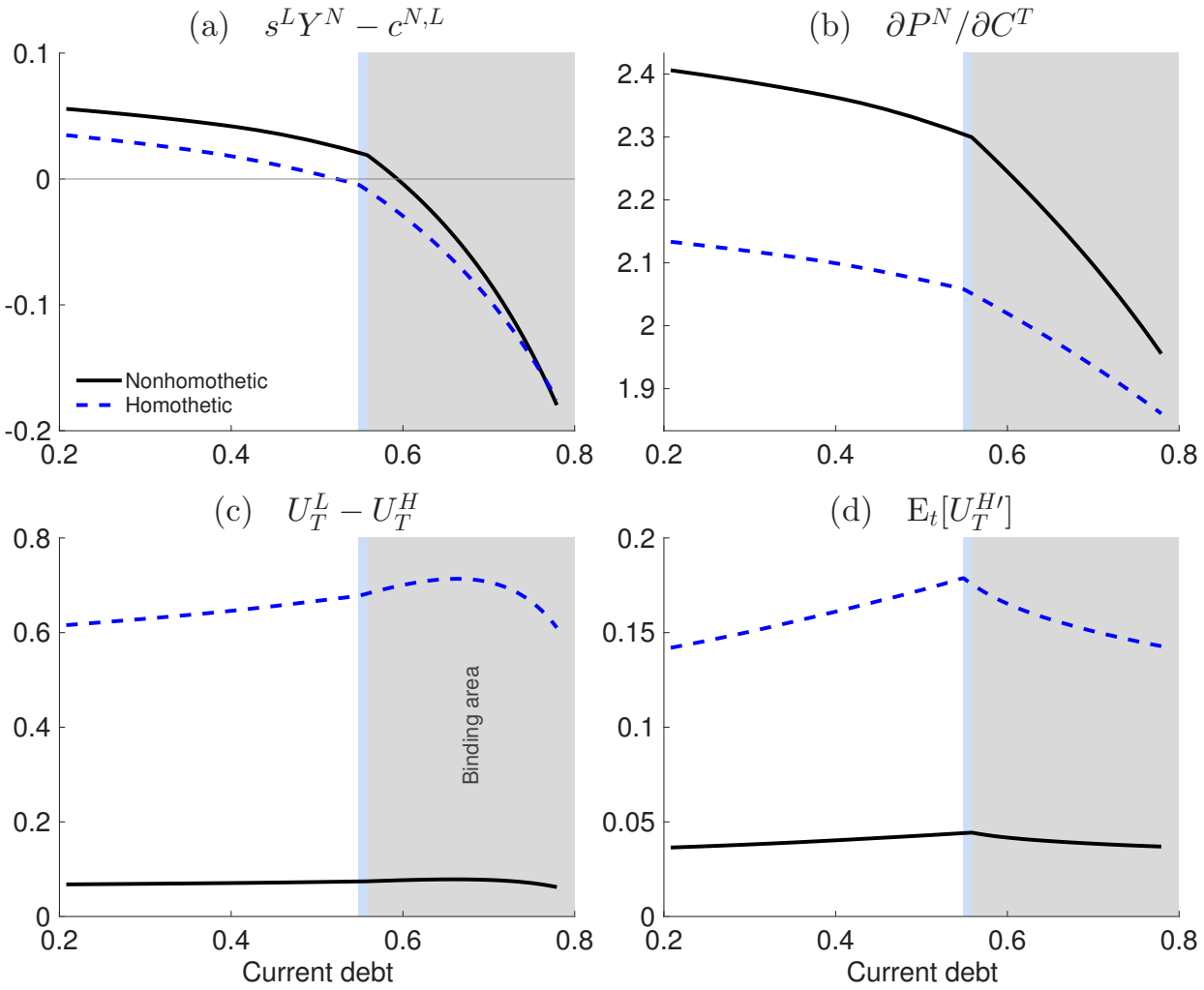


Figure C.3: Marginal values and tax normalization in heterogeneous-agent models

Note: The figure reports the terms entering the optimal tax decomposition in the heterogeneous-agent economies at the median income shock. Panel (a) reports hand-to-mouth households' net nontradable position, $s^L Y^N - c^{N,L}$. Panel (b) reports the relative-price response, $\partial P^N / \partial C^T$. Panel (c) reports the marginal-value gap, $U_T^L - U_T^H$. Panel (d) reports borrowing households' expected future marginal value of tradable consumption, $\mathbb{E}_t[U_T^{H\prime}]$. These quantities are expressed in utility units under each specification's normalization; their levels are not directly comparable across specifications. The shaded areas indicate the debt levels at which the planner's collateral constraint binds: in both models (gray) and only in the homothetic model (light blue).

C.3 Additional Sensitivity Analysis

We complement Section 4 by reporting the effects of household composition, income inequality, and nonhomotheticity on average debt and sudden-stop frequency. Average debt increases with inequality but changes little in the other exercises. Changes in sudden-stop frequency are modest throughout.

Household heterogeneity Figure C.4 varies the population share of hand-to-mouth households. Average debt changes little, and sudden-stop frequency is essentially constant, between 5.05 and 5.09 percent. Household composition therefore has limited effects on aggregate leverage and crisis frequency.

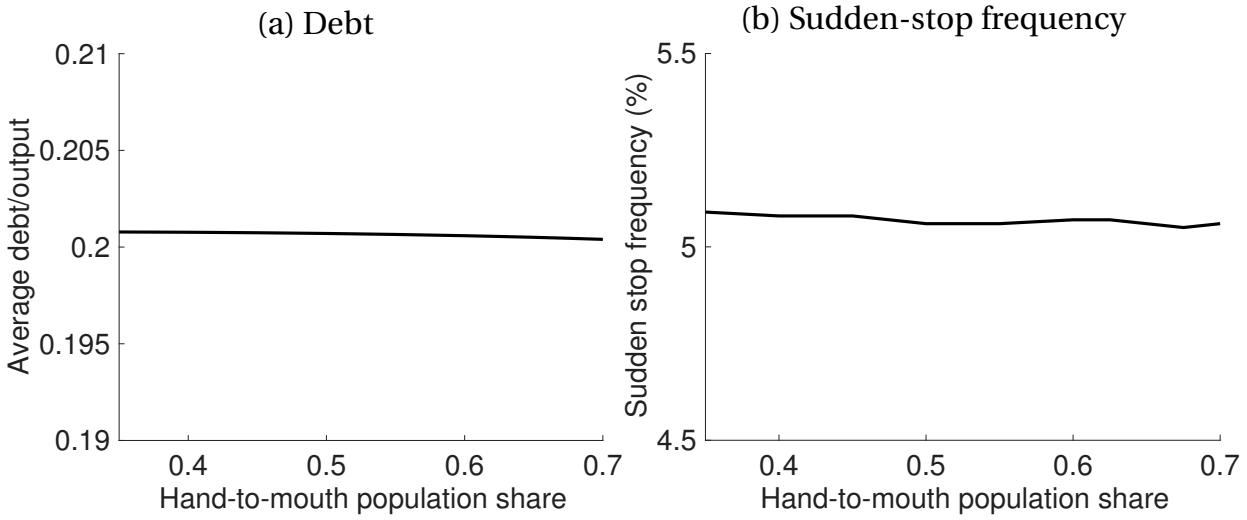


Figure C.4: Effects of the hand-to-mouth share on debt and sudden-stop frequency

Note: The figure reports equilibrium outcomes as functions of the population share of hand-to-mouth households. Panel (a) shows average debt relative to output, and panel (b) shows sudden-stop frequency.

Income inequality Figure C.5 varies the income share of high-income households. Greater inequality increases average debt as more income accrues to households with access to external borrowing. Sudden-stop frequency, however, rises only modestly, from 5.1 to 5.4 percent. Higher average leverage therefore translates into only slightly more frequent crises.

Nonhomotheticity Figure C.6 varies ϵ_N, which governs nonhomotheticity. Average debt remains within a narrow range, while sudden-stop frequency fluctuates modestly and nonmonotonically. Stronger nonhomotheticity thus produces little systematic change in aggregate leverage or crisis frequency over the range considered.

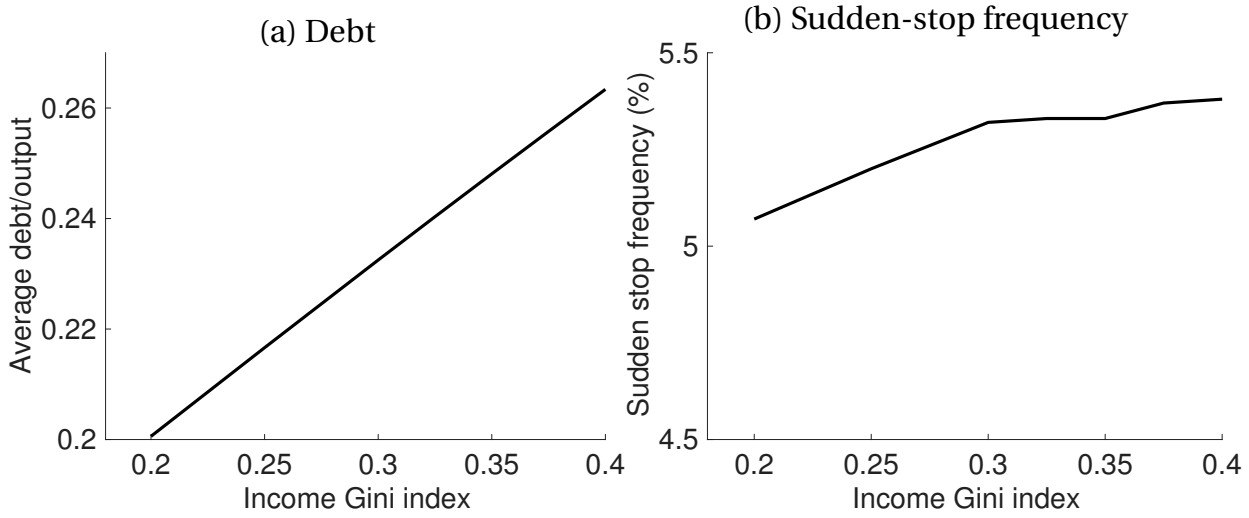


Figure C.5: Effects of income inequality on debt and sudden-stop frequency

Note: The figure reports equilibrium outcomes as functions of the income Gini index of the endowment distribution, $(1-\pi)(s^H-1)$. Panel (a) shows average debt relative to output, and panel (b) shows sudden-stop frequency.

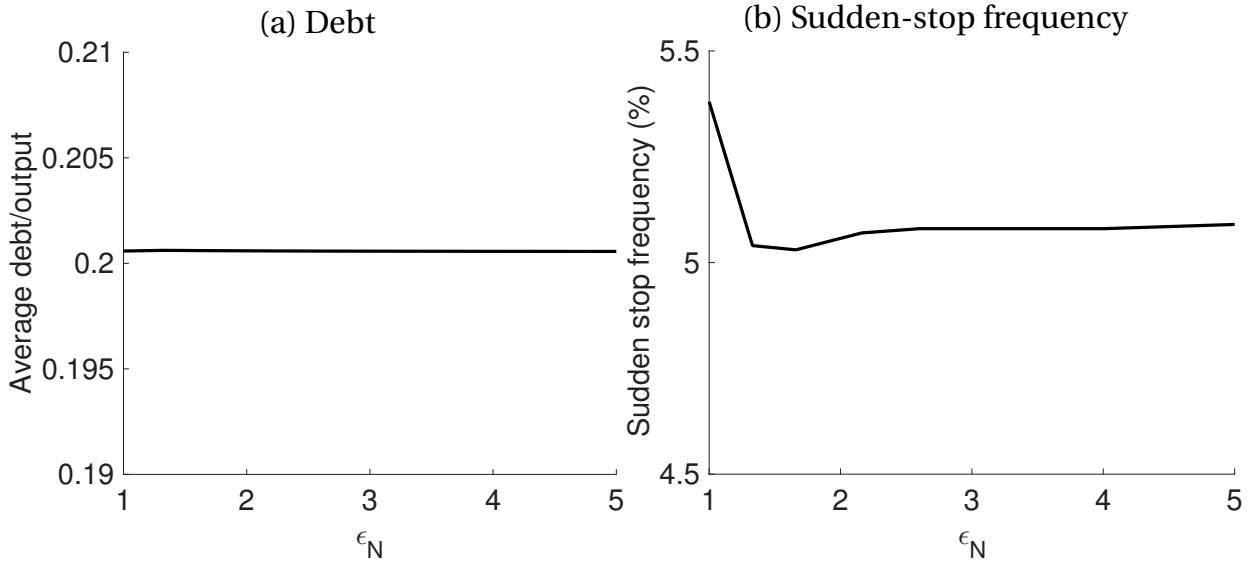


Figure C.6: Effects of nonhomotheticity on debt and sudden-stop frequency

Note: The figure reports equilibrium outcomes as functions of ϵ_N, which governs nonhomotheticity. Panel (a) shows average debt relative to output, and panel (b) shows sudden-stop frequency.

D The production economies

This appendix defines competitive equilibrium and constrained efficiency in the production economy with flexible wages and in the production economy with downward wage rigidity, proves the two tax decompositions, and reports both calibrations.

D.1 Production economy with flexible wages

D.1.1 Competitive equilibrium

Preferences and the productivity process are as specified in the main text. Each household supplies one unit of labor, with efficiency s^i in either sector, where $\pi s^L + (1-\pi)s^H = 1$. Let Π denote total firm profits in units of tradables. Household i has ownership weight s^i, so the groups' ownership fractions are πs^L and $(1-\pi)s^H$. Households take prices, profits, and the aggregate debt law $B' = G(B, z^T)$ as given.

Borrowing households The recursive problem of a borrowing household is

$$\begin{aligned} V^H(b, B, z^T) = \max_{\substack{c^{T,H}, c^{N,H}, b' \\ l^{T,H}, l^{N,H}}} \quad & \frac{c(c^{T,H}, c^{N,H})^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^H(b', B', z^{T'}) \\ \text{subject to} \quad & c^{T,H} + P^N c^{N,H} + b = s^H w(l^{T,H} + l^{N,H}) + s^H \Pi + Qb', \\ & Qb' \leq \kappa \left[s^H w(l^{T,H} + l^{N,H}) + s^H \Pi \right], \\ & l^{T,H} + l^{N,H} = 1, \qquad l^{j,H} \geq 0, \quad j \in \{T, N\}, \\ & B' = G(B, z^T). \end{aligned} \tag{D.2}$$

Prices and profits are evaluated at (B, z^T), while individual debt b is a separate state in the household's problem.

Hand-to-mouth households The recursive problem of a hand-to-mouth household is

$$\begin{aligned} V^L(B, z^T) = \max_{\substack{c^{T,L}, c^{N,L} \\ l^{T,L}, l^{N,L}}} \quad & \frac{c(c^{T,L}, c^{N,L})^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^L(B', z^{T'}) \\ \text{subject to} \quad & c^{T,L} + P^N c^{N,L} = s^L w(l^{T,L} + l^{N,L}) + s^L \Pi, \\ & l^{T,L} + l^{N,L} = 1, \qquad l^{j,L} \geq 0, \quad j \in \{T, N\}, \\ & B' = G(B, z^T). \end{aligned} \tag{D.3}$$

Firms A representative competitive firm in each sector chooses efficiency-unit labor to maximize profits:

$$\max_{L^T \geq 0} \{ z^T (L^T)^\alpha - w L^T \}, \qquad \max_{L^N \geq 0} \{ P^N z^N (L^N)^\alpha - w L^N \}. \tag{D.4}$$

Sectoral output is

$$Y^T = z^T (L^T)^\alpha, \qquad Y^N = z^N (L^N)^\alpha, \qquad 0 < \alpha < 1. \tag{D.5}$$

Market clearing Goods and labor markets require

$$\begin{aligned} C^T + B &= Y^T + QB', \\ C^N &= Y^N, \\ L^j &= \pi s^L l^{j,L} + (1-\pi) s^H l^{j,H}, \qquad j \in \{T, N\} \end{aligned} \tag{D.6}$$

Definition D.1 (Competitive equilibrium with production)**.** A *recursive competitive equilibrium* consists of household policies and value functions, aggregate allocations, prices P^N, w, profits Π, and a debt law $B' = G(B, z^T)$ such that:

- Household optimization: given prices, profits, and G, household policies solve the borrowing and hand-to-mouth problems above.
- Firm optimization: sectoral labor demand solves the firms' problems, and Π equals total firm profits.
- Aggregation: $C^j = \pi c^{j,L} + (1-\pi) c^{j,H}$ for $j \in \{T, N\}$, $B = (1-\pi)b$, and $G(B, z^T) = (1-\pi)b'(B/(1-\pi), B, z^T)$.
- Market clearing: goods and labor market conditions hold.

Equilibrium characterization Firm optimization gives

$$w = \alpha z^T (L^T)^{\alpha-1} = P^N \alpha z^N (L^N)^{\alpha-1}, \tag{D.7}$$

$$P^N = \frac{z^T}{z^N} \left(\frac{L^T}{L^N} \right)^{\alpha-1}. \tag{D.8}$$

which gives the labor-market implementability constraint imposed on the planner.

Unit labor endowments and the productivity normalization imply $L^T + L^N = 1$. Total profits and household income therefore satisfy

$$\begin{aligned} \Pi &= Y^T + P^N Y^N - w(L^T + L^N) = (1-\alpha)(Y^T + P^N Y^N), \\ s^i w(l^{T,i} + l^{N,i}) + s^i \Pi &= s^i (w + \Pi) = s^i (Y^T + P^N Y^N). \end{aligned} \tag{D.9}$$

Combining labor-market clearing with firm optimality gives

$$\begin{aligned} L^T &= \left(\frac{\alpha z^T}{w} \right)^{\frac{1}{1-\alpha}}, \qquad & L^N &= \left(\frac{\alpha P^N z^N}{w} \right)^{\frac{1}{1-\alpha}}, \\ w &= \alpha \left[(z^T)^{\frac{1}{1-\alpha}} + (P^N z^N)^{\frac{1}{1-\alpha}} \right]^{1-\alpha}. \end{aligned} \tag{D.10}$$

D.1.2 Constrained efficiency

The planner puts equal welfare weights on households and chooses external borrowing while respecting competitive goods and labor markets. It cannot transfer resources directly across household types.

The planner chooses B', $c^{T,i}, c^{N,i}$, $l^{T,i}, l^{N,i}$, P^N, and Y^j, L^j, for $i \in \{L, H\}$ and $j \in \{T, N\}$ to solve the following recursive problem

$$V^{SP}(B, z^T) = \max \left\{ \pi \frac{c(c^{T,L}, c^{N,L})^{1-\sigma}}{1-\sigma} + (1-\pi) \frac{c(c^{T,H}, c^{N,H})^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^{SP}(B', z^{T'}) \right\}$$

subject to

$$\begin{aligned}
c^{T,H} + P^N c^{N,H} + \frac{B}{1-\pi} &= s^H (Y^T + P^N Y^N) + \frac{QB'}{1-\pi}, \\
c^{T,L} + P^N c^{N,L} &= s^L (Y^T + P^N Y^N), \\
QB' &\leq (1-\pi)\kappa s^H (Y^T + P^N Y^N), \\
P^N &= \frac{1-\omega}{\omega} \left(\frac{c^{T,i}}{c^{N,i}} \right)^{1+\eta} (c^i)^{(\epsilon_N - \epsilon_T)(1+\eta)}, \quad i \in \{L, H\}, \\
\pi c^{T,L} + (1-\pi) c^{T,H} + B &= Y^T + QB', \\
\pi c^{N,L} + (1-\pi) c^{N,H} &= Y^N, \\
Y^T &= z^T (L^T)^\alpha, \qquad Y^N = z^N (L^N)^\alpha, \\
P^N &= \frac{z^T}{z^N} \left(\frac{L^T}{L^N} \right)^{\alpha-1}, \\
L^T &= \pi s^L l^{T,L} + (1-\pi) s^H l^{T,H}, \\
L^N &= \pi s^L l^{N,L} + (1-\pi) s^H l^{N,H}, \\
l^{T,i} + l^{N,i} &= 1, \quad i \in \{L, H\}.
\end{aligned} \tag{D.11}$$

Definition D.2 (Constrained efficiency with production)**.** A *recursive constrained-efficient allocation* consists of the value function $V^{SP}(B, z^T)$ and policy rules that solve the planner's problem above at every feasible state (B, z^T).

D.1.3 Proof of Corollary 5.1

Proof. Aggregate net external funds satisfy $X = C^T - Y^T$, which implies that

$$\frac{\partial P^N}{\partial X} = \left[\frac{\partial C^T}{\partial P^N} - \frac{\partial Y^T}{\partial P^N} \right]^{-1}. \tag{D.12}$$

Both derivatives on the right-hand side account for the equilibrium adjustment of labor and household demand. Since $X = QB' - B$ and $B' = (1-\pi)b'$, the price response also satisfies

$$\frac{\partial P^N}{\partial X} = \frac{1}{Q}\frac{\partial P^N}{\partial B'} = \frac{1}{Q(1-\pi)}\frac{\partial P^N}{\partial b'}. \tag{D.13}$$

Competitive labor allocation implies $\partial(Y^T + P^N Y^N)/\partial P^N = Y^N$. Differentiating household budgets with respect to X therefore gives

$$\frac{\partial E^L}{\partial X} = s^L Y^N \frac{\partial P^N}{\partial X}, \qquad \frac{\partial E^H}{\partial X} = s^H Y^N \frac{\partial P^N}{\partial X} + \frac{1}{1-\pi}. \tag{D.14}$$

Let $U_T^i = (c^i)^{-\sigma}\partial c^i/\partial c^{T,i}$. Intratemporal optimality and the household budget imply

$$\frac{\partial u(c^i)}{\partial X} = U_T^i\left(\frac{\partial E^i}{\partial X} - c^{N,i}\frac{\partial P^N}{\partial X}\right).$$

Aggregating across households and using $\pi s^L + (1-\pi)s^H = 1$ and nontradable market clearing yields

$$\begin{aligned}\frac{\partial[\pi u(c^L) + (1-\pi)u(c^H)]}{\partial X} &= U_T^H + \pi(U_T^L - U_T^H)(s^L Y^N - c^{N,L})\frac{\partial P^N}{\partial X} \\ &\equiv \Lambda_{\mathrm{P}} = U_T^H + \Psi_{\mathrm{P}}^D.\end{aligned} \tag{D.15}$$

Differentiating the right-hand side of the aggregate collateral constraint with respect to X gives Ψ_{P}^F in equation (22).

Since $X = QB' - B$, the planner's envelope condition and borrowing first-order condition imply

$$\Lambda_{\mathrm{P}} + \mu^{SP}\Psi_{\mathrm{P}}^F = \frac{\beta}{Q}\mathbb{E}[\Lambda_{\mathrm{P}}' + \mu^{SP'}\Psi_{\mathrm{P}}^{F'}] + \mu^{SP}. \tag{D.16}$$

When the current borrowing constraint is slack, $\mu^{SP} = 0$ and $\Lambda_{\mathrm{P}} = U_T^H + \Psi_{\mathrm{P}}^D$. Competitive equilibrium conditions imply

$$U_T^H = \frac{\beta}{Q}(1+\tau)\mathbb{E}[U_T^{H'}]. \tag{D.17}$$

Combining equations (D.16) and (D.17) gives equation (24). □

D.1.4 Calibration

Table D.1: Parameters and Values: Production Economy with Flexible Wages

Parameter	Description	Value	Target
r^*	Risk-free rate	0.04	Standard literature value
σ	Risk aversion	2	Standard literature value
η	Substitution parameter	0.205	Elasticity of substitution T-NT $= 0.83$
ϵ_T	Tradable nonhomotheticity	1	Normalized
ϵ_N	Nontradable nonhomotheticity	2.162	GMM estimate, ENAHO
ω	Preference weight of tradables	0.355	Tradable output share $= 37\%$
ρ_z	Tradable productivity persistence	0.592	Baseline persistence
σ_z	Std. dev. of log productivity	0.0619	Std. dev. of tradable output $= 0.048$
π	Share of hand-to-mouth households	0.6	Share of adults borrowing $= 40\%$
s^H/s^L	Relative labor productivity	2.25	Top 40%/bottom 60% income $= 1.5$
β	Discount factor	0.905	NFA of private sector $= -20\%$
κ	Credit constraint coefficient	0.339	Sudden-stop probability $= 5.1\%$
α	Production elasticity	0.2	Rojas and Saffie (2022)

Note: This table reports the parameter values and targets for the production economy with flexible wages. Preference and household-income targets follow Table 1.

D.2 Production economy with downward wage rigidity

D.2.1 Competitive equilibrium

Preferences, technologies, ownership weights, and the productivity process are unchanged. Let a denote the previous period's wage in units of tradables. Under a fixed exchange rate, downward nominal wage rigidity requires

$$w \geq \gamma a, \qquad n \leq 1, \qquad (w - \gamma a)(1 - n) = 0, \qquad a' = w, \tag{D.18}$$

where n is the common employment rate and $1 - n$ is unemployment. Both household types take employment as given. Their labor assignments and aggregate employment satisfy

$$l^{T,i} + l^{N,i} = n, \quad i \in \{L, H\}, \qquad L^T + L^N = n. \tag{D.19}$$

The household problems are those in (D.2) and (D.3), with the employment equations replaced by (D.19). The inherited wage a is added to each value function and policy rule, and the aggregate laws are

$$B' = G(B, z^T, a), \qquad a' = w(B, z^T, a). \tag{D.20}$$

As before, individual debt is a separate state in the borrower's problem. Households take aggregate debt, wages, employment, and profits as given.

Firms and household income Firms solve the same problems as under flexible wages. For a candidate relative price P^N, their first-order conditions imply

$$\begin{aligned} w^{FE} &= \alpha \left[(z^T)^{\frac{1}{1-\alpha}} + (P^N z^N)^{\frac{1}{1-\alpha}} \right]^{1-\alpha}, \qquad w = \max\{w^{FE}, \gamma a\}, \\ L^T &= \left(\frac{\alpha z^T}{w} \right)^{\frac{1}{1-\alpha}}, \qquad\qquad L^N = \left(\frac{\alpha P^N z^N}{w} \right)^{\frac{1}{1-\alpha}}. \end{aligned} \tag{D.21}$$

The wage w^{FE} clears the labor market at full employment. If $w^{FE} < \gamma a$, the wage floor binds and employment is below one.

The household budgets and collateral constraint retain the same form in terms of output, even when the wage floor binds. Goods-market clearing and the aggregation of sectoral labor are unchanged.

Definition D.3 (Competitive equilibrium with wage rigidity)**.** A *recursive competitive equilibrium* consists of household policies and value functions, aggregate allocations, employment n, prices P^N, w, profits Π, and a debt law $B' = G(B, z^T, a)$ such that:

- Household optimization: household policies solve the borrowing and hand-to-mouth problems with employment taken as given and aggregate transitions satisfying (D.20).
- Firm optimization: sectoral labor demand solves the firms' problems, and Π equals total firm profits.
- Aggregation: $C^j = \pi c^{j,L} + (1-\pi)c^{j,H}$ for $j \in \{T, N\}$, $B = (1-\pi)b$, and $G(B, z^T, a) = (1-\pi)b'(B/(1-\pi), B, z^T, a)$.
- Market clearing: goods markets clear, sectoral labor satisfies (D.6), and wages and employment satisfy (D.18)–(D.19).

D.2.2 Constrained efficiency

The planner chooses the current allocation and B' to solve

$$V^{SP}(B, z^T, a) = \max \left\{ \pi \frac{(c^L)^{1-\sigma}}{1-\sigma} + (1-\pi)\frac{(c^H)^{1-\sigma}}{1-\sigma} + \beta \mathbb{E} V^{SP}(B', z^{T'}, w) \right\}. \tag{D.22}$$

The household budgets, collateral constraint, intratemporal optimality, technologies, and goods-market clearing conditions are those of the flexible-wage planner. Firm optimality continues to require (D.7). The employment equations are replaced by (D.19), and the planner also respects (D.18).

Definition D.4 (Constrained efficiency with wage rigidity)**.** A *recursive constrained-efficient allocation* consists of the value function $V^{SP}(B, z^T, a)$ and policy rules that solve the planner's problem above at every feasible state (B, z^T, a).

D.2.3 Proof of Corollary 5.2

Proof. As under flexible wages, net external funds are $X = QB' - B = C^T - Y^T$. Derivatives of the static allocation with respect to X hold (z^T, a) fixed and are evaluated along a differentiable competitive-equilibrium branch. The price response is therefore given by (D.12), with labor and household demand now adjusting subject to the wage floor.

Firm optimality gives

$$\frac{\partial(Y^T + P^N Y^N)}{\partial X} = Y^N \frac{\partial P^N}{\partial X} + w\frac{\partial n}{\partial X}. \tag{D.23}$$

Differentiating household budgets consequently yields

$$\begin{aligned} \frac{\partial E^L}{\partial X} &= s^L \left(Y^N \frac{\partial P^N}{\partial X} + w\frac{\partial n}{\partial X} \right), \\ \frac{\partial E^H}{\partial X} &= s^H \left(Y^N \frac{\partial P^N}{\partial X} + w\frac{\partial n}{\partial X} \right) + \frac{1}{1-\pi}. \end{aligned} \tag{D.24}$$

Using intratemporal optimality and nontradable market clearing as in the flexible-wage proof, the marginal welfare of external funds is

$$\begin{aligned} \frac{\partial[\pi u(c^L) + (1-\pi)u(c^H)]}{\partial X} &= U_T^H + \pi(U_T^L - U_T^H)(s^L Y^N - c^{N,L})\frac{\partial P^N}{\partial X} \\ &\quad + \left[\pi s^L U_T^L + (1-\pi)s^H U_T^H\right] w\frac{\partial n}{\partial X} \\ &= U_T^H + \Psi_{\mathrm{P}}^D + \Psi_{\mathrm{P}}^n. \end{aligned} \tag{D.25}$$

The distributional wedge retains its flexible-wage form. The additional term Ψ_{P}^n is the welfare effect of employment.

The response of aggregate collateral and the continuation effect of the current wage are, respectively,

$$\Psi_{\mathrm{P}}^F = \kappa(1-\pi)s^H \left(Y^N \frac{\partial P^N}{\partial X} + w\frac{\partial n}{\partial X} \right), \tag{D.26}$$

$$\Psi_{\mathrm{P}}^a = \beta \mathbb{E}[V_a^{SP'}]\frac{\partial w}{\partial X}. \tag{D.27}$$

Here $V_a^{SP'}$ is the derivative of next period's planner value with respect to its inherited wage, evaluated at $(B', z^{T'}, a' = w)$.

Let μ^{SP} be the multiplier on $\kappa(1-\pi)s^H(Y^T + P^N Y^N) - QB' \geq 0$. Since $X_B = -1$, the debt envelope condition is

$$V_B^{SP} = -U_T^H - \Psi_{\mathrm{P}}^D - \Psi_{\mathrm{P}}^n - \Psi_{\mathrm{P}}^a - \mu^{SP}\Psi_{\mathrm{P}}^F. \tag{D.28}$$

The first-order condition for borrowing, using $X_{B'} = Q$, is

$$0 = Q\left(U_T^H + \Psi_{\mathrm{P}}^D + \Psi_{\mathrm{P}}^n + \Psi_{\mathrm{P}}^a\right) + \beta\mathbb{E}[V_B^{SP'}] + Q\mu^{SP}(\Psi_{\mathrm{P}}^F - 1). \tag{D.29}$$

Substituting next period's envelope condition gives

$$U_T^H + \Psi_{\mathrm{P}}^D + \Psi_{\mathrm{P}}^n + \Psi_{\mathrm{P}}^a + \mu^{SP}\Psi_{\mathrm{P}}^F = \frac{\beta}{Q}\mathbb{E}\left[U_T^{H'} + \Psi_{\mathrm{P}}^{D'} + \Psi_{\mathrm{P}}^{n'} + \Psi_{\mathrm{P}}^{a'} + \mu^{SP'}\Psi_{\mathrm{P}}^{F'}\right] + \mu^{SP}. \tag{D.30}$$

The effect of next period's wage on the subsequent inherited wage shows up in $\Psi_{\mathrm{P}}^{a'}$.

When the current collateral constraint is slack, $\mu^{SP} = 0$ and the private Euler equation is (D.17). Subtracting that equation from (D.30) and rearranging gives

$$\begin{aligned}\tau = {} & \underbrace{\frac{\mathbb{E}[\mu^{SP'}\Psi_{\mathrm{P}}^{F'}]}{\mathbb{E}[U_T^{H'}]}}_{\text{Fisherian}} - \underbrace{\frac{Q}{\beta}\frac{\Psi_{\mathrm{P}}^D}{\mathbb{E}[U_T^{H'}]}}_{\substack{\text{Current}\\ \text{distributional}}} + \underbrace{\frac{\mathbb{E}[\Psi_{\mathrm{P}}^{D'}]}{\mathbb{E}[U_T^{H'}]}}_{\substack{\text{Future}\\ \text{distributional}}} \\ & - \underbrace{\frac{Q}{\beta}\frac{\Psi_{\mathrm{P}}^n}{\mathbb{E}[U_T^{H'}]}}_{\substack{\text{Current}\\ \text{labor}}} + \underbrace{\frac{\mathbb{E}[\Psi_{\mathrm{P}}^{n'} + \Psi_{\mathrm{P}}^{a'}] - (Q/\beta)\Psi_{\mathrm{P}}^a}{\mathbb{E}[U_T^{H'}]}}_{\substack{\text{Future}\\ \text{labor}}}.\end{aligned} \tag{D.31}$$

This is equation (26). The current labor term captures the employment effect today. The future labor term includes the change in the inherited wage generated today and the expected labor effects at the next state.

□

At interior unemployment, $\partial w/\partial X = 0$ and $\Psi_{\mathrm{P}}^a = 0$. At strict full employment, $\partial n/\partial X = 0$ and $\Psi_{\mathrm{P}}^n = 0$. With $\pi = 0$, the distributional wedge vanishes, while employment and inherited-wage effects remain. With $\gamma = 0$, both labor wedges vanish and the flexible-wage decomposition is recovered.

D.2.4 Calibration

Table D.2: Parameters and Values: Production Economy with Downward Wage Rigidity

Parameter	Description	Value	Target
r^*	Risk-free rate	0.04	Standard literature value
σ	Risk aversion	2	Standard literature value
η	Substitution parameter	0.205	Elasticity of substitution T-NT $= 0.83$
ϵ_T	Tradable nonhomotheticity	1	Normalized
ϵ_N	Nontradable nonhomotheticity	2.162	GMM estimate, ENAHO
ω	Preference weight of tradables	0.354	Tradable output share $= 37\%$
ρ_z	Tradable productivity persistence	0.592	Baseline persistence
σ_z	Std. dev. of log productivity	0.0568	Std. dev. of tradable output $= 0.048$
π	Share of hand-to-mouth households	0.6	Share of adults borrowing $= 40\%$
s^H/s^L	Relative labor productivity	2.25	Top 40%/bottom 60% income $= 1.5$
β	Discount factor	0.896	NFA of private sector $= -20\%$
κ	Credit constraint coefficient	0.334	Sudden-stop probability $= 5.1\%$
α	Production elasticity	0.2	Rojas and Saffie (2022)
γ	Downward wage rigidity	0.96	Schmitt-Grohé and Uribe (2016)

Note: This table reports the parameter values and targets for the production economy with downward nominal wage rigidity. The discount factor, credit constraint coefficient, productivity volatility, and preference weight are recalibrated to the targets of Table D.1.

E Long-run moments and welfare in the production economies

This appendix reports the long-run moments and welfare gains of the production economies with flexible wages (Table E.1) and with downward wage rigidity (Table E.2).

Debt and sudden stops with flexible wages Table E.1 compares the long-run moments and welfare across the production economies with flexible wages. The heterogeneous-agent economies sustain substantially lower average debt than the representative-agent benchmarks, while sudden-stop frequencies remain similar under decentralized equilibrium. The planner has little effect on average debt across the specifications. It reduces sudden-stop frequency in both representative-agent economies, with a smaller decline in the heterogeneous nonhomothetic baseline. Under heterogeneous homothetic preferences, sudden-stop frequency instead increases.

The planner also moderates the real depreciation and decline in tradable consumption during sudden stops in both representative-agent economies. These improvements are smaller in the heterogeneous nonhomothetic baseline, while both responses become slightly larger under heterogeneous homothetic preferences. Aggregate nontradable consumption falls during sudden stops in all production economies. Within the heterogeneous-agent economies, borrowing households reduce

Table E.1: Long-run moments in a production economy with flexible wages

	Baseline		**Heterogeneous-Homothetic**		**Representative-Nonhomothetic** Rojas and Saffie (2022)		**Representative-Homothetic** Bianchi (2011)	
	DE	SP	DE	SP	DE	SP	DE	SP
Average (%)								
Debt/income	20.5	20.4	20.4	20.4	33.5	32.9	33.5	32.9
Prob. of sudden stop	5.0	4.4	5.0	5.2	5.3	2.1	5.3	2.3
Macroprudential tax	–	0.6	–	-0.5	–	3.2	–	3.1
Change in sudden stop (%)								
Real exchange rate	-19.3	-18.9	-17.6	-17.7	-27.0	-21.4	-24.2	-19.5
Tradable consumption	-15.8	-15.4	-15.6	-15.7	-22.8	-17.7	-21.9	-17.4
Welfare gain (%)	–	0.0002	–	0.0002	–	0.0210	–	0.0179
High type	–	0.0032	–	-0.0040	–	–	–	–
Low type	–	-0.0014	–	0.0015	–	–	–	–

Note: The table reports long-run moments and welfare gains in the production economy with flexible wages under the Decentralized Equilibrium (DE) and Social Planner's constrained efficiency (SP). The baseline features heterogeneous agents and nonhomothetic preferences. The Heterogeneous-Homothetic specification retains household heterogeneity but imposes homothetic preferences. The Representative-Nonhomothetic specification follows Rojas and Saffie (2022), while the Representative-Homothetic specification follows Bianchi (2011). A sudden stop is defined as a period in which the current account increases by more than two standard deviations and the credit constraint binds under the decentralized equilibrium. Welfare gains are reported as expenditure-equivalent variations. The macroprudential tax is the average optimal borrowing tax in the planner's ergodic distribution, computed over periods in which the collateral constraint is slack; the tax is undefined when it binds.

nontradable consumption, while hand-to-mouth households increase it.

Welfare Table E.1 reports welfare gains from constrained efficiency in expenditure-equivalent units. Aggregate gains are substantially smaller in the heterogeneous-agent economies than in the representative-agent benchmarks. Nonhomotheticity also reverses the incidence of welfare gains across household types. Under heterogeneous homothetic preferences, high-income households lose, while hand-to-mouth households gain. In the nonhomothetic baseline, high-income households gain and hand-to-mouth households lose. These results preserve the small aggregate gains and opposing welfare effects across household types found in the endowment economy.

Table E.2: Long-run moments in a production economy with downward wage rigidity

	Baseline		**Heterogeneous-Homothetic**		**Representative-Nonhomothetic**		**Representative-Homothetic**	
	DE	SP	DE	SP	DE	SP	DE	SP
Average (%)								
Debt/income	20.1	16.5	20.1	15.8	32.4	28.9	32.5	29.3
Prob. of sudden stop	5.1	0.4	4.9	0.4	4.9	0.6	4.8	0.7
Unemployment rate	2.6	0.4	2.0	0.3	3.0	0.6	2.4	0.6
Macroprudential tax	–	6.9	–	7.1	–	6.5	–	6.3
Change in sudden stop (%)								
Real exchange rate	-21.3	-4.7	-18.3	-4.0	-33.3	-8.6	-28.2	-9.0
Tradable consumption	-19.7	-3.9	-18.6	-3.2	-31.5	-7.4	-29.1	-8.6
Welfare gain (%)	–	0.337	–	0.275	–	0.475	–	0.369
High type	–	0.218	–	0.066	–	–	–	–
Low type	–	0.396	–	0.338	–	–	–	–

Note: The table reports long-run moments and welfare gains in the production economy with downward wage rigidity under the Decentralized Equilibrium (DE) and Social Planner's constrained efficiency (SP). The baseline features heterogeneous agents and nonhomothetic preferences; the Heterogeneous-Homothetic specification retains household heterogeneity but imposes homothetic preferences. The Representative-Nonhomothetic and Representative-Homothetic specifications have a single borrowing household. All four economies share the parameter values of Table D.2, which are calibrated to the baseline only. A sudden stop is defined as a period in which the current account increases by more than two standard deviations and the credit constraint binds under the decentralized equilibrium; changes in sudden stops are measured in the periods identified under the decentralized equilibrium. Welfare gains are reported as expenditure-equivalent variations. The macroprudential tax is the average optimal borrowing tax in the planner's ergodic distribution, computed over periods in which the collateral constraint is slack; the tax is undefined when it binds.

Debt, sudden stops, and unemployment with downward wage rigidity Table E.2 reports the same moments for the production economies with downward wage rigidity.

Average debt and the sudden-stop frequency match the targets under the decentralized equilibrium, and the average unemployment rate is 2.6% in the baseline. The planner's intervention is much stronger than with flexible wages: it lowers average debt by about four percentage points of income, cuts the sudden-stop frequency to below 0.5%, and nearly eliminates unemployment. Crises are also much milder: the real depreciation and the fall in tradable consumption in a sudden stop shrink from about 20% to 4%. Because the planner removes unemployment that hurts both household types, welfare gains are orders of magnitude larger than in the endowment economy and in the production economy with flexible wages, and positive for both groups, with hand-to-mouth households gaining the most. The representative-agent economies sustain higher debt, about 32% of income, and deeper crises, and the planner reduces sudden stops and unemployment in similar proportions. Their welfare gains are larger than in the heterogeneous-agent economies, but only by about 40% in the nonhomothetic case. With flexible wages, by contrast, the representative-agent gains are about a hundred times larger: the labor externality, which is present even without household heterogeneity, dominates the welfare gains under wage rigidity.