Sudden Stops and Consumption Inequality with Nonhomothetic Preferences

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Abstract

Sudden stops are often accompanied by high income inequality and increases in consumption inequality during crises. We rationalize this fact in a sudden stop model of collateral constraints by incorporating income inequality and nonhomothetic preferences. Nontradable goods are more income-elastic than tradable goods. Borrowings of high income households have a stronger effect on future real exchange rates than low-income households. Excessive international debt accumulation by high income households increases the frequency and severity of sudden stop crises. On the other hand, low income households underborrow from a social perspective. Both income inequality and nonhomotheticity of preferences amplify the inefficiency of the pecuniary externality. Therefore, macroprudential policies are more welfare improving than in standard models.

Keywords: Financial crises; Inequality; Nonhomothetic preference; Sudden Stops
JEL Classifications: E32; F34; F41; H23

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Introduction

Emerging market economies experience financial crises that are characterized by large reversals of capital flows and sharp exchange rate depreciation. At the same time, they also face high levels of inequality. As an empirical motivation, we examine the relationship between sudden stops and inequality in income and consumption. We first look at the cross-country evidence from a panel data of countries on sudden stop indicators, consumption, and income inequality. We find that countries that have high levels of income inequality are more likely to experience sudden stop crises, and that high levels of income inequality are associated with more severe drops in consumption during crises. Using Italian and Peruvian household survey data, we establish that consumption inequality increases during sudden stop episodes. Moreover, sudden stops episodes also coincide with increases in both tradable and nontradable consumption inequality. These results suggest that income inequality and differences in income elasticities between tradable and nontradable goods are important in explaining the inequality and sudden stops patterns.

Motivated by these observations, we aim to answer the following questions (i) how do income inequality and nonhomotheticity of preferences affect frequency and severity of sudden stops? , (ii) what happens to consumption inequality during sudden stop crises?, and (iii) should regulators consider the income redistribution when setting macroprudential policies?

We incorporate heterogeneity in income and in income elasticities between tradable and nontradable goods with nonhomothetic preferences in an international debt model of financial crises caused by collateral debt constraints, as in Mendoza (2002) and Bianchi (2011). Private households face income fluctuations and credit constraints that limit their borrowings to the collateral value of income that endogenously depends on the real exchange rate. Differences in income levels lead to differences in borrowing capacity across households.

We study two versions of the model. In the decentralized version, households make their individual borrowing decisions taking all prices and aggregates laws of motion as given. We contrast this version with a constrained efficient version in which a benevolent social planner makes borrowing decisions for all households in the economy. The planner is subject to the same budget and credit constraints as the households in the decentralized version, but controls aggregate borrowing and the distribution of debt across households.

Similar to Mendoza (2002) and Bianchi (2011), the model features the debt-deflation effect due to the pecuniary externality of credit constraints that depend on current prices. Private households do not internalize the effect of their private borrowings on reducing future real exchange rates that in turns affects their future borrowing capacity. In contrast, the social planner internalizes the effect and chooses lower aggregate levels of private borrowing across households. Private households overborrow, which leads to the decentralized economy subject to more frequent and severe crises than the constrained efficient economy.

The presence of income inequality implies that there exist heterogeneity in the debt-deflation effect across households and interaction of credit constraints between households through the real exchange rate. High income households have less tightened credit constraints than low income households. If the credit constraints bind for low income households but not high-income households, increasing the tradable consumption of high income households appreciates the real exchange rate, which relaxes the credit constraints for low income households.

Nonhomotheticity of preferences implies a nontrivial relationship between tradable consumption levels across households and the real exchange rate. High income households have higher tradable consumption that more strongly affects the real exchange rate than low-income households with lower tradable consumption. In contrast, when preferences are homothetic and thus income elasticities between tradable and nontradable goods are equal, the real exchange rate is a function of the aggregate tradable consumption, in which households' tradable consumption have similar impact on the real exchange rate regardless of the income level.

The numerical analysis shows that excessive international debt accumulation by high income households increases the frequency and severity of sudden stop crises. On the other hand, low income households underborrow from a social standpoint. The distribution of private borrowings matters for the real exchange rates. By progressively decrease the private households borrowings, the social planner reduces the probability of crisis and suffers less real exchange rate depreciation and consumption drops during crises.

We find that income inequality and nonhomotheticity of preferences amplify the inefficiency of the pecuniary externality. With income inequality, the social planner affect real exchange rates by changing the distribution of borrowings and consumption across households that . With nonhomothetic preferences, the high-type households borrowing and consumption matters more for real exchange rates.

We last examine consumption inequality during sudden stops. The constrained efficient economy features increases in consumption inequality during crises. Similar intuition as before, the social planner is willing to increase inequality during sudden stops by giving high type more consumption to relax the credit constraints by increasing the real exchange rate.

Our analysis implies that macroprudential policies that aim to reduce frequency and severity of financial crises are the most welfare improving when they are conditional on individual income levels. Moreover, the effect of macroprudential policies are larger when taking into account the heterogeneity in income and elasticities across goods.

Related Literature. This research draws from the literature that studies the trade-off between debt management and redistribution such as Werning (2007), and Bhandari et al. (2017). By introducing a continuum of households with direct access to international credit markets, the model will highlight the differences between centralized and decentralized international borrowing.

This paper also belongs to the literature that studies changes in inequality along the bussiness cycle. It is therefore related to Broer (2020),kumhof2015inequality, primiceri2009heterogeneous, and storesletten2007asset. In contrast to this litterature, this paper focuses on emerging markets and specifically on sudden stops crises.

The model is most closely related to the international borrowing model developed byMendoza (2002) and Bianchi (2011). Relative to this framework we add heterogenous agents and nonhomothetic preferences. Our framework highlights the interaction between international private debt, financial crises, and redistributive policies. Other recent papers that explore the effects of sudden stop crises on redistribution are Villalvazo (2021), Hong (2020), and Guntin et al. (2020).The paper's contribution is to explore how the real exchange rate affects households of different income levels and the distributional implication of macroprudential policies.

Finally, by exploring the macroeconomic impact of nonhomothetic preferences, this paper is related to Rojas and Saffie (2020), Comin et al. (2021), and Boppart (2014). As in Rojas and Saffie (2020), we show that nonhomothetic preferences can excacerbate sudden stop crises. Our contribution here comes from exploring how this preference structure will also imply that sectoral consumption reallocation that occurs during crises will increase consumption inequality.

Outline. The paper is organized as follows. Section 1 provides the empirical motivation. Section 2 describes a model of international private debt and inequality and define the competitive equilibrium and the social planner problem. Section 3 presents the numerical analysis. Section 4 then concludes.

1 Empirical motivation

This section documents the empirical relationship between sudden stops and inequality across countries and in micro-data. We establish that countries that experience high levels of income inequality are vulnerable to more frequent and severe sudden stops. Our micro data also suggests that consumption inequality levels are higher during sudden stops, for both tradable and nontradable goods.

1.1 Cross-country evidence

Sudden stops and income inequality. High levels of income inequality is associated with high frequency of sudden stop crises across countries. To show this, we use data that covers 58 countries over the time period 1980-2017. We measure the frequency of sudden stop crises using the gross flows data from the database on capital flow episodes developed by Forbes and Warnock (2020). A sudden stop crisis indicator has values 0-1 that indicating whether there is a capital flow episode in a given year. A capital flow episode is a surge, stop, flight, or retrenchment, defined by Forbes and Warnock (2020). The income inequality measures are pre-tax (market) Gini indices from the Standardized World Income Inequality Database (SWIID) by Solt (2019). We estimate the following probit model

$$\mathbb{E}(\text{sudden stop crisis}|\text{pre-tax Gini}) = \Phi(\beta_0 + \beta_1 \text{pre-tax Gini}),$$

where Φ is the standard cumulative normal distribution.

Table 1: Sudden stops and income inequality: probit regression result

	Dependent Variable: Sudden stop crisis indicator Time periods: 1980-2017 (1)	 (2)
Gini index, pre tax (%)	0.0129**	0.0126**
	(0.005)	(0.005)
GDP per capita		4e-6***
		(2e-6)
GDP growth		0.501
		(0.824)
No. Countries	58	58
No. Observations	1911	1911

Note: This table presents the results from the probit regression. The dependent variable is a sudden stop crisis indicator of values 0-1 indicating whether there is a capital flow episode defined by Forbes and Warnock (2020). The Gini index of pre-tax income is obtained from SWIID database. GDP per capita is from the IMF WEO database. Estimates are obtained using maximum likelihood estimation. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table 1.1 reports the estimation results of the probit model. The coefficient on the pre-tax Gini index is positive and statistically significant both in the cases of no controls and controlling for GDP per capita. Overall, the marginal effect of a 1% increase in the pre-tax Gini index is 0.5% increase in the frequency of sudden stop crises.

Consumption drop during sudden stops and inequality. Sudden stops are more severe when income inequality is higher. As in Figure 1.1 from Villalvazo (2021), the change in consumption during sudden stops are negatively correlated with income inequality across countries. Higher income inequality coincides with higher consumption drop in crises.

1.2 Micro-data evidence

We next study consumption inequality around sudden stop episodes using household survey data from Peru and Italy. Using series of current account-to-GDP, we identify that Italy experienced one in 2011-2012, and Peru experienced a sudden stop in 2008-2009. Income series are net of monetary income and include subsidies and transfers. Consumption series are non-durable monetary consumption. All variables are residualized using head household observables and

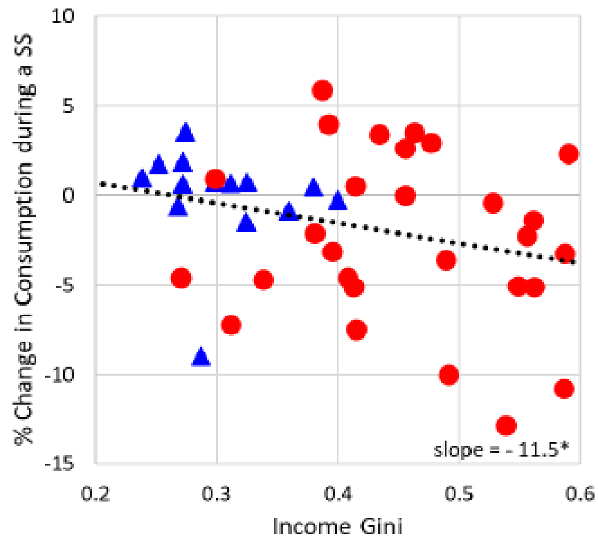

Figure 1: Consumption drop during sudden stops and inequality

Note: Triangle (circle) markers correspond to advanced (emerging) economies. Sudden Stop episodes come from Bianchi and Mendoza (2020). $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$. Source: Villalvazo (2021)

time trends. The measure consumption inequality is the ratio of households with income above to below the median.

Figure 2 plots the consumption ratios and current account-to-GDP for Italy and Peru. We find that the consumption ratios series follow closely to the current account-to-GDP series over time. For both Italy and Peru, consumption inequality sharply increases during sudden stops episodes as the current-account-to-GDP increases.

We also find a positive correlation of inequality in tradable and nontradable goods and the current account over time in the case of Peru. Figure 3 plots the Peruvian tradable and nontradable goods ratios and the current account-to-GDP over time. Both tradable and nontradable inequality levels increase during the sudden stop episode of 2008-2009 for Peru.

In the next section, we propose a model of sudden stops and inequality that speaks to the cross-sectional and micro-data evidence.

2 Model of sudden stops and inequality

This section presents a heterogeneous-agent dynamic model of a small open economy with non-state contingent bonds subject to an occasionally binding credit constraint. We define and characterize the decentralized equilibrium. We then present the constrained efficient allocation that solves a social planner's problem in which the planner directly choose the debt level subject to the credit constraint.

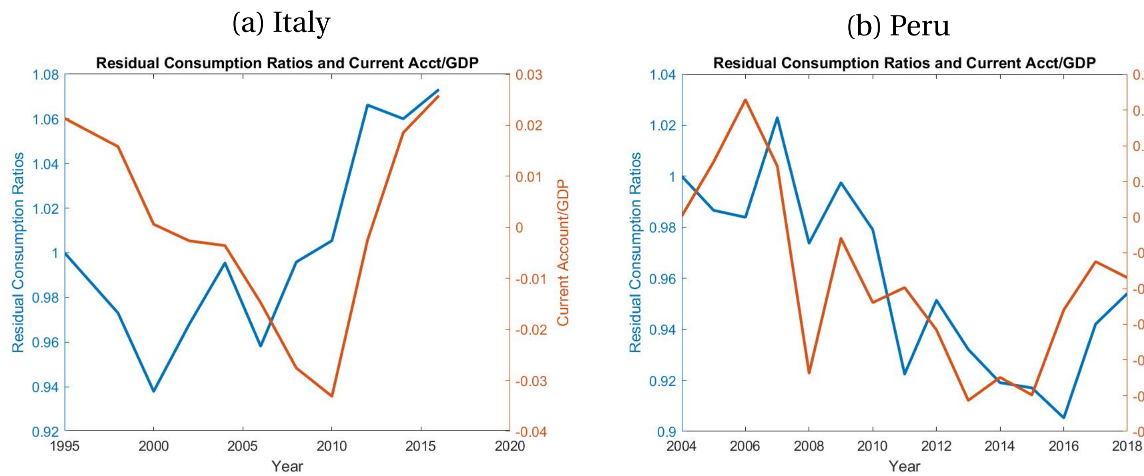

Figure 2: Consumption Inequality and Current Account

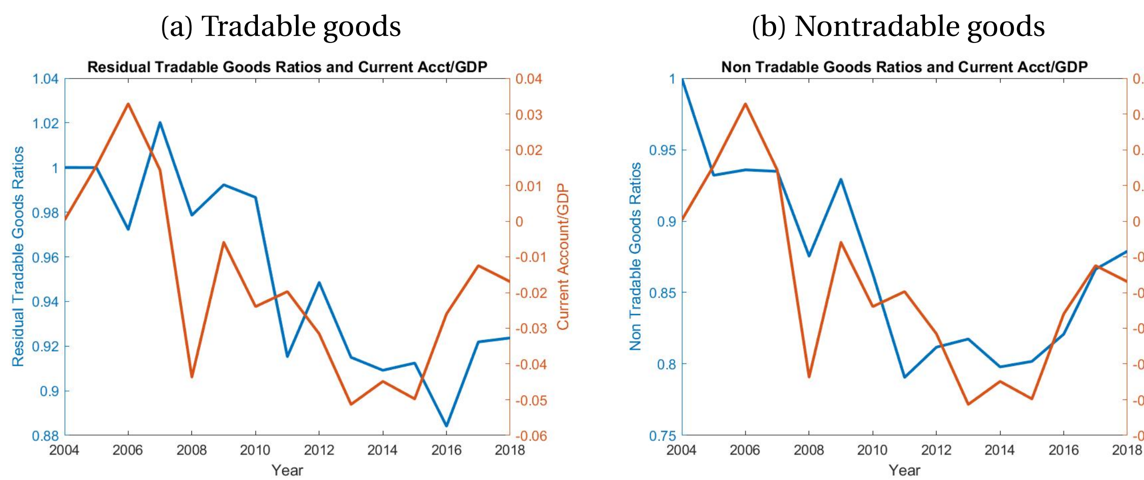

Figure 3: Peruvian Tradable and Nontradable Consumption Inequality and Current Account

2.1 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 of a unit-measure continuum of infinitely lived households that are differentiated by endowment shares $(s^i)_{i \in I}$, where I is finite. The fraction of households with endowment share s^i is π^i. We normalize $(\pi^i)_{i \in I}$ and $(s^i)_{i \in I}$ such that $\sum_{i \in I} \pi^i = 1$ and $\sum_{i \in I} \pi^i s^i = 1$.

Allocation. Following the standard convention, lowercase denotes the individual level, while uppercase denotes the aggregate level. Individual household i's allocation on consumption and borrowing is $c_t^{T,i}, c_t^{N,i}, c_t^i, b_{t+1}^i$. The aggregate allocation is then $C_t^T = \sum_{i \in I} \pi^i c_t^{T,i}$, $C_t^N = \sum_{i \in I} \pi^i c_t^{N,i}$, $C_t = \sum_{i \in I} \pi^i c_t^i$, $B_t = \sum_{i \in I} \pi^i b_t^i$.

Preference. All households have the same preference that is

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

where $\mathbb{E}_t(\cdot)$ is the time-t expectation operator, and $0 < \beta < 1$ is the discount factor. 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 $\nu_j = \frac{1}{1+\eta} + \frac{\eta}{1+\eta} \frac{\epsilon_j}{\omega\epsilon_T + (1-\omega)\epsilon_N}$. 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 $\epsilon_T = \epsilon_N = 1$.

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. Both endowments are drawn from first-order Markov processes independent of each other and of all other stochastic shocks in the model. The numeraire is the tradable good.

Assets. 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,individual household i's borrowing b_{t+1}^i is subject to a collateral credit constraint such that the market value of debt issuances cannot exceed a fraction θ of the market value of current income.

2.2 Decentralized equilibrium

Individual household's problem. Given the price of bond q and the of nontradable goods in units of tradables P_t^N, individual household i chooses allocation $\left\{c_t^{T,i}, c_t^{N,i}, b_{t+1}^i\right\}_{t \geq 0}$ that maximizes utility (1) subject to the budget constraint

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

and the credit constraint

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

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 θ of the value of current endowment owned by a defaulting household.

Resource constraints. Given the aggregate allocation, the resource constraints in the tradable and nontradable goods sectors are

$$C_t^T + B_t = Y_t^T + QB_{t+1} \tag{4}$$

$$C_t^N = Y_t^N \tag{5}$$

Recursive formulation. We consider the optimization problem of individual households in the recursive form. Individual household i makes decisions on current consumption and next-period debt based on the current individual debt b, the current exogenous shock on tradables Y^T, and the current aggregate distribution of debt $\boldsymbol{B} = (B^i)_{i\in I}$. The optimization problem of individual i can be written as

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

subject to

$$c^T + P^N(Y^T, \boldsymbol{B})c^N + b = s^i\left(Y^T + P^N(Y^T, \boldsymbol{B})Y^N\right) + Qb'$$

$$Qb' \leq \theta s^i\left(Y^T + P^N(Y^T, \boldsymbol{B})Y^N\right)$$

$$\boldsymbol{B}' = \Gamma(Y^T, \boldsymbol{B}),$$

where Γ is the law of motion for the distribution of debt. The solution to the household problem gives the individual allocation rule $\left\{c^{T,i}(b, Y^T, \boldsymbol{B}), c^{N,i}(b, Y^T, \boldsymbol{B}), b'^i(b, Y^T, \boldsymbol{B})\right\}$. Then we have the following definition for a recursive competitive equilibrium.

Definition 2.1. A *recursive competitive equilibrium* is an individual allocation rule $\left\{c^{T,i}(b, Y^T, \boldsymbol{B}),\ c^{N,i}(b, Y^T, \boldsymbol{B}),\ b'^i(b, Y^T, \boldsymbol{B})\right\}$ sand individual value function $V^i(b, Y^T, \boldsymbol{B})$,for each $i \in I$, aggregate allocation rule $\left\{C^T(Y^T, \boldsymbol{B}),\ C^N(Y^T, \boldsymbol{B}),\ B'(Y^T, \boldsymbol{B})\right\}$, a pricing function $P^N(Y^T, \boldsymbol{B})$, and a law of motion $\Gamma(Y^T, \boldsymbol{B})$ such that

- Household optimization: given $P^N(Y^T, \boldsymbol{B})$ and $\Gamma(Y^T, \boldsymbol{B})$, for each $i \in I$, $\left\{c^{T,i}(b, Y^T, \boldsymbol{B}),\ c^{N,i}(b, Y^T, \boldsymbol{B}),\ b'^i(b, Y^T, \boldsymbol{B})\right\}$ solves household i's problem and $V^i(b, Y^T, \boldsymbol{B})$ is the associated value function
- Rational expectation: $\Gamma(Y^T, \boldsymbol{B}) = \left(b'^i(b, Y^T, \boldsymbol{B})\right)_{i\in I}$
- Aggregation: $C^T(Y^T, \boldsymbol{B}) = \sum_i \pi^i c^{T,i}(b, Y^T, \boldsymbol{B})$, $C^N(Y^T, \boldsymbol{B}) = \sum_i \pi^i c^{N,i}(b, Y^T, \boldsymbol{B})$, $B'(Y^T, \boldsymbol{B}) = \sum_i \pi^i b'^i(b, Y^T, \boldsymbol{B})$,

- Market clearance: $C^N(Y^T, \boldsymbol{B}) = Y^N$, $C^T(Y^T, \boldsymbol{B}) + \sum_i \pi^i B^i = Y^T + QB'(Y^T, \boldsymbol{B})$

2.3 Equilibrium price of nontradables

The optimality conditions for individual household $i \in I$ include the budget constraint (2), the credit constraint (3), and the first-order conditions. In particular, the intratemporal optimality condition implies that

$$P_t^N = \frac{1-\omega}{\omega} \left(\frac{c_t^{T,i}}{c_t^{N,i}} \right)^{1+\eta} c_t^{i(\epsilon_N - \epsilon_T)(1+\eta)}, \ \forall i \in I \tag{6}$$

Equation (6) is a static optimality condition equating the relative price of nontradable to tradable goods to the marginal rate of substitution between them for any household $i \in I$. This condition implies that the marginal rate of substitution between tradable and nontradable goods are the same across households. Due to the nonhomothetic property of the utility function, the relative price of nontradables also depends on $c_t^{i(\epsilon_N - \epsilon_T)(1+\eta)}$. When $\epsilon_T = \epsilon_N = 1$, the preference is homothetic CES, and the relative price of nontradables becomes

$$P^N = \frac{1-\omega}{\omega} \left(\frac{c_t^{T,i}}{c_t^{N,i}} \right)^{1+\eta}, \ \forall i \in I \tag{7}$$

We normalize $Y_t^N = 1, \forall t$. In equilibrium, The relative price of nontradables relates to the tradable consumption levels across households by the following implicit equation:

$$P_t^N = (1-\omega) \left\{ \sum_{i \in I} \pi^i \left[\omega^{\frac{1}{1+\eta}} + (1-\omega)^{\frac{1}{1+\eta}} \left(P_t^N\right)^{\frac{\eta}{1+\eta}} \left(c_t^{T,i}\right)^{\epsilon_N - \epsilon_T} \right]^{\frac{1}{\eta}} \left(c_t^i\right)^{\frac{\epsilon_N(1+\eta) - 1 - (\epsilon_N - \epsilon_T)}{\eta}} \right\}^{1+\eta} \tag{8}$$

When the preference is homothetic ($\epsilon_T = \epsilon_N = 1$), we can write the relative price of nontradables as a function of the aggregate tradable consumption:

$$P_t^N = (1-\omega)\omega^{\frac{1}{\eta}} \left[\left(\sum_{i \in I} \pi^i c_t^{T,i} \right)^{-\eta} - (1-\omega) \right]^{-\frac{1+\eta}{\eta}} \tag{9}$$

2.4 Social planner's problem

We now formulate the problem of a benevolent social planner with restricted planning abilities. Specifically, we consider that 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 effects of borrowing decisions on the relative price.

The objective of the social planner is

$$\sum_{i\in I}\gamma^i\pi^i\mathbb{E}_0\sum_{t=0}^{\infty}\beta^t u(c_t^i), \tag{10}$$

where the social welfare weights are $\boldsymbol{\gamma} = \left(\gamma^i\right)_{i\in I}, \gamma^i \geq 0, \forall i, \sum_i \pi^i\gamma^i = 1$. The optimization problem of the social planner is choosing all individual allocation to maximize social welfare (10) subject to the resource constraints (4)–(5), the household's budget constraints (2), the credit constraints (3), and the equilibrium price condition (6).

Recursive formulation. The social planner's problem in recursive form is

$$\begin{aligned}
V(Y^T,\boldsymbol{B}) = \max_{\left\{c^{T,i},c^{N,i},b'^i\right\}_{i\in I}} &\quad \sum_{i\in I}\gamma^i\pi^i\frac{c\left(c^{T,i},c^{N,i}\right)^{1-\sigma}}{1-\sigma} + \beta\mathbb{E}_{Y^{T'}|Y^T}V(Y^{T'},\boldsymbol{B}')\\
\text{subject to} &\\
\sum_{i\in I}\pi^i c^{T,i} + \sum_{i\in I}\pi^i b^i &= Y^T + Q\sum_{i\in I}\pi^i b'^i\\
\sum_{i\in I}\pi^i c^{N,i} &= Y^N \qquad\qquad (11)\\
c^{T,i} + P^N c^{N,i} + b^i &= s^i\left(Y^T + P^N Y^N\right) + Qb'^i, \quad \forall i\in I\\
Qb'^i &\leq \theta s^i\left(Y^T + P^N Y^N\right), \quad \forall i\in I\\
P^N = \frac{1-\omega}{\omega}\left(\frac{c^{T,i}}{c^{N,i}}\right)^{1+\eta} & c^{i(\epsilon_N-\epsilon_T)(1+\eta)}, \quad \forall i\in I \qquad\qquad (12)
\end{aligned}$$

Definition 2.2. A *recursive socially planned equilibrium* is the allocation rule $\left\{c_{SP}^{T,i}(Y^T,\boldsymbol{B}),\right.$ $\left.c_{SP}^{N,i}(Y^T,\boldsymbol{B}),\, b_{SP}'^i(Y^T,\boldsymbol{B})\right\}_{i\in I}$ and the value function $V_{SP}(Y^T,\boldsymbol{B})$ that solve (11) given the welfare weights $\boldsymbol{\gamma}$.

3 Numerical analysis

This section presents the numerical analysis with three goals. First, we examine how income inequality and nonhomotheticity of preferences affect borrowing decisions and the real exchange rate. Second, we show how these effects amplify the inefficiency from peculiar externality. Lastly, we study the severity of sudden stops and distributional consequences of sudden stops on consumption inequality. Throughout our analysis, we compare the decentralized equilibrium outcomes to the constrained efficient outcomes, in aggregates and distributions.

3.1 Parameterization and values

Functional forms and assumptions. We assume that the economy is populated by two types of households receiving s^H and s^L shares of the endowment in every period, respectively, where $s^H \geq s^L > 0$ and $\pi^H = \pi^L = 0.5$.

We normalize the endowment of nontradable goods in every period to $Y_t^N = 1$. The endowment of tradable goods Y_t^T follows a logged first-order autoregressive process:

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

where ρ_z, σ_z are the auto-correlation and the residual standard deviation, respectively. We discretize the tradable endowment process into a Markov chain using Tauchen's method with 20 evenly-spaced nodes.

We also assume that the social planner is utilitary and has equal welfare weights across households.

Parameter values. Table 2 reports the parameter values used in the analysis. We set values for the risk-free rate to $r^* = 0.04$, the discount factor to $\beta = 0.91$, the persistence of tradable output to $\rho_y = 0.77$, and the standard deviation of the tradable output shock to $\sigma_y = 0.029$, following Bianchi and Mondragon (2018). The tradable and nontradable income elasticities values are from Rojas and Saffie (2020): $\epsilon_T = 1$ and $\epsilon_N = 5$. The weight of tradables is $\omega = 0.31$, and the credit constraint coefficient is set to $\kappa = 0.32$, as in Bianchi (2011). The endowment shares s^H, s^L are normalized such that $\sum_{i=H,L} \pi^i s^i = 1$ and $s^H/s^L = 2.78$, which matches the average relative income share of households above the median income level to ones below the median income level according to the Italian household survey.

Table 2: Parameters and Values

Parameter	Description	Value
r^*	Risk-free rate	0.04
β	Discount factor	0.91
σ	Risk aversion	2
η	Elasticity of substitution T-NT	0.205
ω	Weight of tradables	0.31
ϵ_T	Tradable income elasticity	1
ϵ_N	Nontradable income elasticity	5
s^H/s^L	Relative endowment share	2.78
ρ_y	Tradable output persistence	0.77
σ_y	Std. dev. of tradable shock	0.029
κ	Credit constraint coefficient	0.32

3.2 Borrowing decisions and real exchange rate

We show how debt issuance decisions of the social planner differ from those of private households, and the differences depend on the household type. We analyze how these differences affect the long-run distribution of debt across household types and the real exchange rate.

Figure 4 plots the policy functions of debt issuance for each household type. On panel (a), we fix the income shock to its average value and the current level of debt of the low type household to its average at the ergodic distribution. We then plot the evolution of optimal debt issuances of the high type as a function of the initial debt of the high type for each version of our model. Similarly, on panel (b), we fix the income shock at the same value and the current level of debt of the high type household to its average at the ergodic distribution. We then plot the evolution of optimal debt issuances of the low type as a function of the initial debt of the low type for both versions of the model.

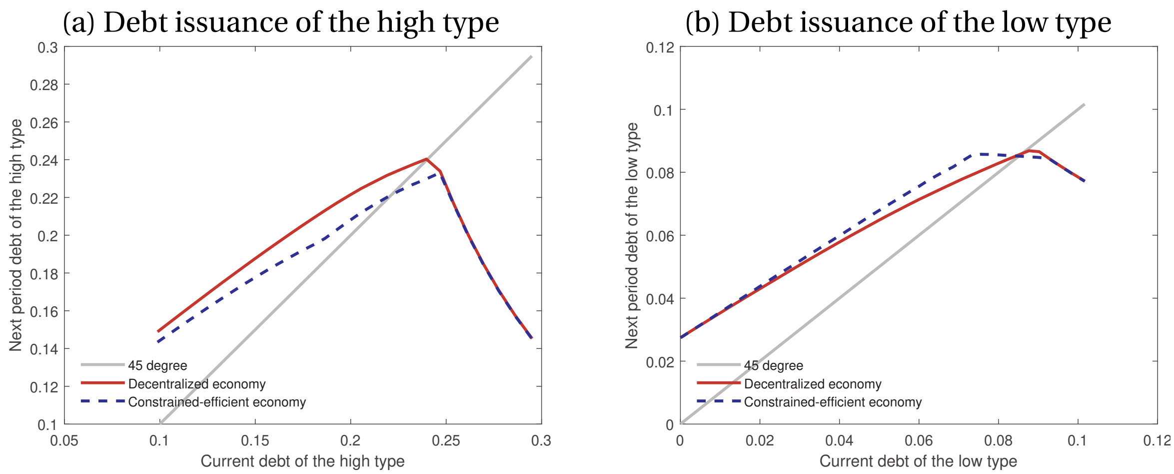

Figure 4: Policy functions of debt issuances by type

The results of panel (a) are inline with the standard sudden-stop literature. As in Bianchi (2011), we find that the social planner would like the high-type households to issue less debt than in the decentralized economy when the credit constraint is not binding. However, the results of panel (b) differ from the standard model as the social planner would like the low-type households to issue more debt than in the decentralized economy when the credit constraint does not bind.

Another novelty of our environment is the presence of the interaction between the debt issuances of the low and high types. Figure 5 plots the policy function of the high type's debt issuance as a function of the initial debt of the low type when we keep income and the initial debt of the high type fixed at their values from the previous figure. As the level of initial debt of the low types increases, the economy moves from the case in which credit constraints for both types are slacking to one in which credit constraints for both types are binding. The social planner has an additional region where the credit constraint of the low type is binding but not the one of the high type. In this area, the social planner pushes the high type to issue more debt to relax the credit constraint of the low type creating an additional kink relative to the standard monotonicity exhibited by the decentralized policy function.

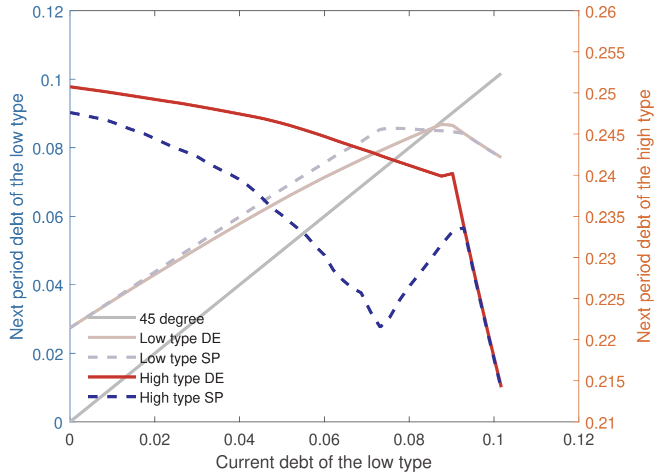

Figure 5: Debt issuance of the high type as function of current debt of the low type

The differences in the social planner and private households borrowing decisions across types imply novel properties in the long-run distribution of debt. We simulate 10,500 periods of data using the policy rules of each version. We then exclude the first 500 periods of this simulation to focus on the ergodic distribution and not the transitionary dynamics. Figure 6 plots the density probabilities of debt issuance by household type at this ergodic distribution. Relative to the decentralized economy, the constrained-efficient economy has a higher probability of observing higher levels of debt for the low type and lower levels of debt for the high type. In the decentralized economy, the low type underborrows, while the high type overborrows from a socially efficient standpoint. These findings imply that type-dependent taxes on private borrowings that discourage borrowing from high income households and encourage borrowing from low income households are welfare improving.

Lastly, we find that the social planner's debt issuance policies across households affect the real exchange rate. Figure 7 plots the real exchange rate and debt issuances of the high type as a function of the current debt of the low type for the private sector and the social planner. In the region where the low type is credit constrained but the high type is not, the social planner finds it optimal to increase borrowings of the high type to increase real exchange rates, which in turns relaxes the low type's credit constraints.

3.3 Long-run moments

Table 3 reports the long-run averages of the decentralized economy (DE) and the constrained efficient economy (CE) from the simulations. We focus on the averages of average debt-to-income, probability of financial crisis, changes in real exchange rate during sudden stops, and welfare gains. A sudden stop is defined as a period in which the current account of the economy increases by more than two standard deviations. The first two columns report the statistics for

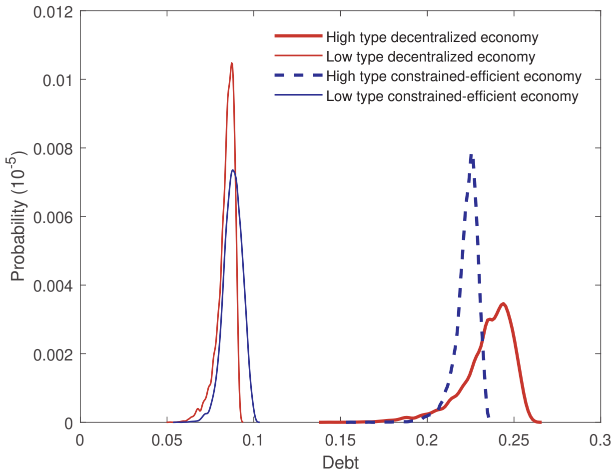

Figure 6: Distribution of debt by type at the ergodic distribution

Note: We simulate 10,000 samples and compute the distribution of debt issuance by type for each version of the model.

the benchmark model. We find that in the benchmark model, the private sector overborrows comparing to the social planner, and that exposes the decentralized economy to higher probability of crisis and worsens the drops in real exchange rate during sudden stops. Relative to the decentralized economy, the social planner is able to avoid more crises by progressively decreasing the private sector's borrowing: decreases borrowing for high-type households and increases borrowing for low-type households.

Table 3: Long-run moments: Decentralized and Constrained-Efficient Economies

	Benchmark		Homothetic		No Inequality	
Average (in %)	DE	CE	DE	CE	DE	CE
Debt/income	31.97	31.14	32.00	31.75	32.05	31.59
High type	23.54	22.34	23.26	23.00	-	-
Low type	8.43	8.79	8.39	8.48	-	-
Prob. of crisis	5.87	0.66	5.00	3.54	6.08	1.31
ΔRER in crises	-26.9	-12.17	-29.15	-25.73	-25.88	-15.18
Welfare gain	–	0.004	–	0.005		0.003

3.4 Amplification effect: inequality and nonhomotheticity

Both inequality and the nonhomotheticity of preferences amplify the inefficiency of the peculiary externality in the decentralized economy. To quantify this amplification effect, we compare

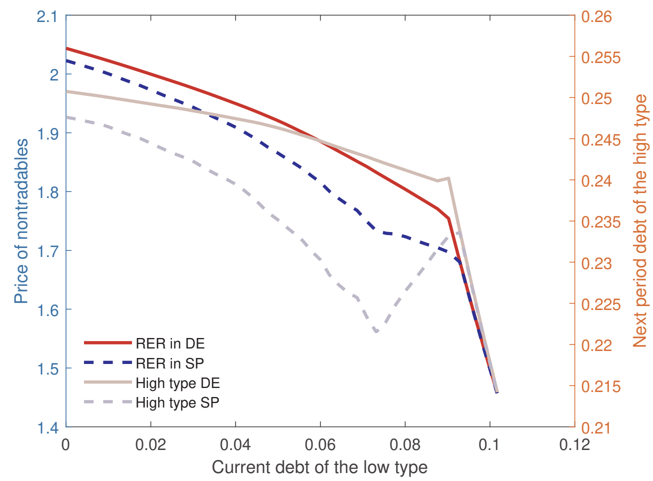

Figure 7: Real exchange rate and debt issuance of the high type

the long-run averages in the benchmark model to ones in the homothetic model in which the preferences are homothetic ($\epsilon_T = \epsilon_N = 1$) and the no-inequality model in which there is only a representative private household ($s^H = s^L = 1$). The third and fourth columns of Table 3 report the statistics for the decentralized and constrained efficient economies of the homothetic model. The fifth and sixth columns of Table 3 report the statistics for the decentralized and constrained efficient economies of the no-inequality model.

Role of inequality. In the presence of inequality, the social planner has access to an additional tool that improves efficiency by changing the distribution of debt issuances and consumption across households, which in turns affects the evolution of the real exchange rate and crisis frequency. Comparing to the model without inequality, the benchmark model generates lower debt-to-income in both economies and higher reduction in the probability of crisis from the decentralized to the constrained efficient economy.

Role of nonhomotheticity. In the benchmark model with nonhomothetic preferences, the private sector overborrows more, and the decentralized economy is subject to more frequent crises than in the model of homothetic preferences. The social planner progressively decrease the private sector's borrowing in both models, but is able to reduce further the frequency of crises in the case with nonhomothetic preferences than with homothetic preferences. This result is because nonhomothetic preferences amplify the large impact of high-type households consumption on the real exchange rate, as shown in equation (8). In fact, the drop in real exchange rate in crises for the planner of the benchmark case in much lower than one for the planner of the homothetic-preference case.

3.5 Severity of sudden stops

We analyze the severity of sudden stops by measuring how much consumption has dropped during sudden stops. Table 4 reports the long-run averages of the drops in tradable and composite consumption in crises across household types. The first two columns present the consumption drops for the decentralized and constrained efficient economies of the benchmark model. The last two columns are of the model with homothetic preferences. We find that in crises, the social planner wants to reduce significantly less consumption of the high type than consumption of the low type. This motive is because the high type's consumption has a higher impact on the real exchange rate than the low type's consumption, given that preferences are nonhomothetic. By increasing the high type's consumption, the planner can appreciates the real exchange rate, relaxing the credit contraints for both types.

Table 4: Severity of Sudden Stops: Benchmark and Homothetic

	Benchmark		Homothetic	
Average (in %)	DE	CE	DE	CE
ΔC^T in crises				
High type	-21.27	-8.93	-24.88	-21.56
Low type	-21.11	-10.99	-24.94	-23.11
ΔC in crises				
High type	-0.49	-0.16	-8.79	-7.37
Low type	-0.65	-0.4	-8.84	-8.79

Nonhomotheticity of preferences reduces the severity of crises by amplifies the impact of consumption on the evolution of the real exchange rate and relaxing credit constraints. The drops in consumption during sudden stops are larger with homothetic preferences than with nonhomothetic preferences.

3.6 Inequality during sudden stops

We next examine how consumption and expenditure inequality evolve during sudden stops. Table 5 reports the high-type-to-low-type ratios of tradable consumption, nontradable consumption, and consumption expenditure, defined as $c^T + P^N c^N$, on average during boom periods, crisis periods, and the change from boom to crisis. In the decentralized economy, tradable consumption and expenditure inequality levels decrease, while the nontradable inequality level increases during sudden stops. In contrast, in the constrained efficient economy, consumption and expenditure inequality levels increase during sudden stops. The social planner is willing to increase inequality during sudden stops by giving the high type more consumption to relax the

Table 5: Inequality: Booms vs. Crises

High type/low type						
	Tradable c^T		Nontradable c^N		Expenditure $E = c^T + P^N c^N$	
	DE	CE	DE	CE	DE	CE
Boom	2.3587	2.3585	3.045	3.046	2.776	2.776
Crisis	2.354	2.416	3.059	3.152	2.768	2.856
Change	-0.0047	0.0575	0.014	0.106	-0.008	0.08

credit constraints by appreciating the real exchange rate. This feature allows the planner to be less vulnerable to frequent and severe sudden stops.

4 Conclusion

This paper studies sudden stop crises in the presence of inequality and nonhomothetic preferences. We provide empirical evidence that countries that have higher levels of income inequality are more likely to experience sudden stop crises, and that higher levels of income inequality are associated with more severe drops in consumption during crises. We also establish that consumption inequality increases during sudden stop episodes, especially for both tradable and nontradable consumption inequality.

To rationalize these facts, we develop a model of sudden stops with heterogeneity in income and in income elasticities between tradable and nontradable goods. The preferences are nonhomothetic as nontradable goods are more income-elastic than tradable goods. In our model, there is heterogeneity in the debt-deflation effect across households and interaction of credit constraints between households through the real exchange rate. Because of the nonhomotheticity of preferences, borrowings and consumption of high income households have a stronger effect on future real exchange rates than ones of low-income households.

Excessive international debt accumulation by high income households increases the frequency and severity of sudden stop crises. A social planner who could choose the distribution of international borrowing, while respecting the credit and budget constraints of the households would on average lower borrowing from high income households and increase debt insurances for low income households.

We also find that both income inequality and nonhomotheticity of preferences amplify the inefficiency of the pecuniary externality. The social planner, by progressively decrease the private sector's borrowing, can reduce further frequency and severity of crises.

Our constrained efficient outcomes feature increases in consumption inequality during sudden stops. The social planner is willing to increase inequality during sudden stops by giving high type more consumption to relax the credit constraints by increasing the real exchange rate.

Our theory implies that macroprudential policies that aim to reduce private sector's borrowing should takes into account distributional effects. Policies that discourage private borrowing from high income households while encouraging higher borrowing from low income households can be more welfare improving than policies that discourage private borrowing across households.

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