# 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. Income inequality and nonhomotheticity of preferences amplify the frequency and severity of crises and increase 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 depreciations. At the same time, they also face high levels of income and consumption inequality. Recent empirical evidence has shown that income elasticities of demand are different across tradable and nontradable sectors, and these differences have important macroeconomic consequences.<sup>1</sup> In this paper, we argue that changes in the consumption bundle across the income distribution affect the relative demand between tradable and nontradable sectors, which in turns affects the real exchange rate during current account reversals.

The research questions are (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 first provide empirical evidence of that income elasticities of demand are relatively different between tradable and nontradable sectors. We consider nonhomothetic CES preferences to generate the differences in income elasticities. We estimate the demand system using the Peruvian household-level data of consumption expenditures and income (ENAHO). The household consumption expenditures are grouped into tradable and nontradable categories. We found that the income elasticity of nontradable sector is larger than the one of tradable sector.

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

<sup>&</sup>lt;sup>1</sup>Comin et al. (2021) estimated that the argiculture and manufacturing sectors have higher income elasticities of demand than the service sector. Agriculture and manufacturing sectors largely account for tradable goods, while the service sector consists of nontradable goods. Structural change theory (? and Comin et al. (2021)) emphasized the role of different income elasticities in explaining macroeconomic patterns. Rojas and Saffie (2020) found that the difference in income elasticities amplifies the severity of current account reversal during crises.

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 debtdeflation 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.

We calibrate the model to match salient features of the Peruvian data. The quantitative 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),Kumhof et al. (n.d.), Primiceri and Van Rens (2009), and Storesletten et al. (2007). In contrast to this literature, 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 heterogeneous 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 exacerbate 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 quantitative analysis. Section 4 then concludes.

# 1 Empirical analysis

This section describes the data and documents trends in consumption inequality during sudden stop episodes. We also provide empirical estimates of income elasticities and elasticity of substitution for tradable and nontradable sectors.

# 1.1 Data description

We use the current account-to-GDP series from the *International Financial Statistics* (IFS) to identify sudden stop episodes. For studying consumption inequality and relative sectoral demand at the household level, we use the Peruvian household survey *Encuesta Nacional de Hogares* (ENAHO).

ENAHO is conducted by the *Instituto Nacional de Estadstica e Informatica* (INEI) of Peru. ENAHO contains detailed data on household's consumption, income, and demographics both at the cross-sectional and panel level. ENAHO is nationally representative and conducted annually. Since 2007, the quality of the data has improved and approximately 20% of the sample is a rotating panel. Both cross-sectional and panel components are representative.

**Sample selection.** We use the data from ENAHO for the period 2007-2019. Following Guntin et al. (2020), we focus on a sample of household units in which the households live in large locations, the head household's ages are between 25-60 years, and the household consumption and income are non-negative. We also exclude observations with an income-to-consumption ratio in the top 0.5% or bottom 0.5% of the distribution so that our results are not driven by outliers. Table A.2 reports the number of observations that are eliminated at each step.

ENAHO reports annualized household consumption expenditures on different final goods. We aggregate these into 15 categories, as listed in Table A.1. Our expenditure categorization follows closely to the *Banco Central de Reserva del Peru* (BCRP)'s categorization of tradable and nontradable goods in the inflation series. These good categories add up to tradable and non-tradable consumption expenditures. The Others category consists of expenditure items that can be either goods or services, which account for approximately 2% of total expenditures. The amount of tradable, nontradable, and others expenditures add up to the ENAHO's measure of annualized monetary expenditures (gashog1d).

We combine the ENAHO data with the disaggregated annual price series of the Metropolitan Lima area from the BCRP. We construct regional price indices for all categories with the base year of 2019.

**Residualization.** Following the consumption literature, we consider measures of consumption that are detrended and residualized by household demographic characteristics. To do so, we project each consumption category onto household characteristics: number of household members, gender, age, education, geographical dummies, and time trends (see Appendix A for details).

We construct the tradable and nontradable prices faced by a household by taking the expenditure-weighted average of the log-price of each expenditure categories in each tradable and nontradable sectors. As discussed in **?**, **?**, and Comin et al. (2021), this procedure provides the effective sectoral prices faced by each household.

We divide the household into two bins based on after-tax income: top (bottom) income group corresponds to household income above (below) the median income. For each income group, we average expenditures across households. The main measure of inequality is the ratio of the mean of the top income group to the mean of the bottom income group.

#### **1.2** Sudden stops and trends in consumption inequality

We identify two episodes of current account reversals around 2008-2009 and 2015-2016. In Figure 1, the current-account-to GDP series sharply increased in 2009 and 2016. The 2008-2009 sudden stop, as a result of the global financial crisis, is widely studied in the literature.

We next examine the dynamics of consumption inequality around sudden stops. Figure 1 also plots the consumption ratio of top income group to bottom income group over time. We find that changes in consumption inequality are often negatively correlated with changes in the current account. During sudden stop episodes in 2009 and 2016, consumption inequality decreases as the current account increases.



Figure 1: Consumption inequality and current account in Peru

Note: This figure depicts the consumption ratio of top income to bottom income groups and the current account-to-GDP ratio. Consumption is residualized for each expenditure category using household's demographic characteristics and time trends. Top income refer to households with after-tax income above the median. Low income refer to households below the median. Source: ENAHO and IFS

We also find similar trends in tradable and nontradable consumption inequality around sudden stops. As Figure 2 shows, both tradable and nontradable consumption inequality levels drop during the sudden stop episodes in 2009 and 2016. Nontradable consumption inequality drops more during sudden stops than tradable consumption inequality. Heterogeneous responses in the consumption inequality across sectors imply that there are different income elasticities between tradable and nontradable sectors, such that the relative demand for tradable and nontradable goods are different for different households across the income distribution.



### Figure 2: Tradable and nontradable consumption inequality and current account in Peru

Note: This figure depicts the tradable and nontradable consumption ratios of top income to bottom income groups and the current account-to-GDP ratio. Consumption is residualized for each expenditure category using household's demographic characteristics and time trends. Top income refer to households with after-tax income above the median. Low income refer to households below the median. Source: ENAHO and IFS

# 1.3 Estimation of Elasticities

In this subsection, we use the household consumption expenditures to estimate the elasticity of substitution and income elasticities for tradable and nontradable sectors. We follow the empirical strategy presented in **?** for nonhomothetic CES preferences.

### 1.3.1 Nonhomothetic CES preferences

Consider preferences over composite consumption  $c = c(c^T, c^N)$  that is an aggregation over tradable consumption  $c^T$  and nontradable consumption  $c^N$ , implicitly defined through the following equation

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

We assume that  $\eta > 0$  and  $\epsilon_j > \frac{1}{1+\eta}$ , for  $j \in \{T, N\}$ , such that the utility is strictly increasing in both tradable and nontradable consumption. In equation (1),  $\omega$  is the weight parameter. The elasticity of substitution between  $c^T$  and  $c^N$  is  $1/(1+\eta)$ . Each sectoral good  $j \in \{T, N\}$  has  $\epsilon_j$ as the nonhomotheticity parameter that affects the income elasticity of good j, which is  $\nu_j = \frac{1}{1+\eta} + \frac{\eta}{1+\eta} \frac{\epsilon_j}{\omega \epsilon_T + (1-\omega)\epsilon_N}$ . When  $\epsilon_T = \epsilon_N = 1$ , the aggregator  $c(c^T, c^N)$  becomes homothetic CES with the elasticity of substitution  $1/(1+\eta)$ .

**Hicksian demand.** Consider the expenditure minimization problem given prices  $P = (P^T, P^N)$  and preferences defined in equation (1). Define total consumption expenditure as

 $E \equiv P^T c^T + P^N c^N$ . The Hicksian demand functions for tradable and nontradable goods are

$$c^{T} = \omega^{\frac{1}{1+\eta}} \left(\frac{E}{P^{T}}\right)^{\frac{1}{1+\eta}} c^{\epsilon_{T}-\frac{1}{1+\eta}}$$
$$c^{N} = (1-\omega)^{\frac{1}{1+\eta}} \left(\frac{E}{P^{N}}\right)^{\frac{1}{1+\eta}} c^{\epsilon_{N}-\frac{1}{1+\eta}}$$

**Relative expenditure shares.** Denote the expenditure share for sectoral good  $j \in \{T, N\}$  to be  $\bar{\omega}^j \equiv \frac{p^j c^j}{E}$ . We consider the tradable sector as the base sector and fix  $\epsilon_T = 1$ . The log-relative expenditure share of nontradable to tradable goods satisfies

$$\log\left(\frac{\bar{\omega}^{N}}{\bar{\omega}^{T}}\right) = \left(\frac{\eta}{1+\eta}\right)\log\left(\frac{P^{T}}{P^{N}}\right) + (\epsilon_{N}-1)\log\left(\frac{E}{P^{T}}\right) + (\epsilon_{N}-1)\left(\frac{1+\eta}{\eta}\right)\log(\bar{\omega}^{T}) \qquad (2)$$
$$+ \left(\frac{1}{1+\eta}\right)\log(1-\omega) - \left[\frac{\epsilon_{N}(1+\eta)-1}{\eta(1+\eta)}\right]\log(\omega)$$

#### 1.3.2 Empirical strategy

We estimate income and substitution elasticities by using empirical counterpart of equation (2) and the residualized expenditures and price data. Let i denote the household unit. Given that our data on expenditures are residualized from household's characteristics, equation (2) implies that the log-relative share log-relative nontradable-tradable expenditure share for household i is

$$\log\left(\frac{\bar{\omega}_{t}^{N,i}}{\bar{\omega}_{t}^{T,i}}\right) = \left(\frac{\eta}{1+\eta}\right)\log\left(\frac{P_{t}^{T,i}}{P_{t}^{N,i}}\right) + (\epsilon_{N}-1)\log\left(\frac{E_{t}^{i}}{P_{t}^{T,i}}\right) + (\epsilon_{N}-1)\left(\frac{1+\eta}{\eta}\right)\log(\bar{\omega}_{t}^{T,i}) + \delta_{r} + \delta_{t} + \nu_{t}^{i}$$
(3)

We estimate  $\eta$  and  $\epsilon_N$  using generalized method of moments (GMM) for the system of equations defined by equation (3) and the constraint that the product of the coefficients on relative prices and expenditure is equal to the coefficient on tradable expenditure share. As in Comin et al. (2021), we instrument household expenditures with after-tax income and income quintile and instrument household relative prices with a relative-price instrument à la Hausman. We consider both weights from ENAHO's sampling weight and weights constructed by total household expenditures that yield results consistent with aggregate analysis.

### 1.3.3 Estimation results

Table 1 presents the estimation results for different cases of fixed effects and weighting schemes. The estimates for  $\eta$  and  $\epsilon_N$  are similar across all cases. The estimates of  $\eta$  are consistent with estimates of elasticity of substitution between tradable and nontradable goods in the literature. Tradable and nontradable sectors are complements in household preferences ( $\eta = 0.23$  in column 1 implies an elasticity of substitution equal to 0.81). The estimates of  $\epsilon_N$  are above  $\epsilon_T = 1$ ( $\epsilon_N = 1.93$  in column 1), implying that the nontradable sector have higher income elasticity of demand than the tradable sector. This result is consistent with the estimates in CITE: Comin. Agriculture and manufacturing goods make up for most of the tradable sector, while services are the main components of the nontradable sector.

(1)	(2)	(3)	(4)	(5)	(6)
0.23***	0.24***	0.24***	0.28***	0.23***	0.24***
(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.003)
1.93***	2.15***	1.86***	2.00***	2.49***	3.32***
(0.028)	(0.057)	(0.025)	(0.045)	(0.046)	(0.18)
Ν	Y	Ν	Y	Ν	Y
Ν	Ν	Y	Y	Y	Y
Ν	Ν	Ν	Ν	Y	Y
	(1) 0.23*** (0.001) 1.93*** (0.028) N N N	(1)       (2)         0.23***       0.24***         (0.001)       (0.001)         1.93***       2.15***         (0.028)       (0.057)         N       Y         N       N         N       N         N       N         N       N         N       N	(1)         (2)         (3)           0.23***         0.24***         0.24***           (0.001)         (0.001)         (0.002)           1.93***         2.15***         1.86***           (0.028)         (0.057)         (0.025)           N         Y         N           N         N         Y           N         N         Y           N         N         N	(1)         (2)         (3)         (4)           0.23***         0.24***         0.24***         0.28***           (0.001)         (0.001)         (0.002)         (0.004)           1.93***         2.15***         1.86***         2.00***           (0.028)         (0.057)         (0.025)         (0.045)           N         Y         N         Y           N         N         Y         N           N         N         N         N           N         N         N         N	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

Table	1:	Estimates	of	elast	icitv
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Note: This table presents the results of the GMM estimation of equation (3). All expenditure data are residualized with household's demographic characteristics and time trends. Standard errors are clustered at the conglomerate level. The number of observations is 171,089. Source: ENAHO and BCRP.

# 2 Model of sudden stops and inequality

In this section, we present a model that features frequent sudden stops and high inequality. The model is a small open economy with non-state contingent bonds subject to an occasionally binding borrowing constraint and private agents heterogeneous in income. 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 borrowing constraint.

# 2.1 Environment

Time is discrete and indexed by  $t = 0, 1, ..., \infty$ . 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  $\pi^i$ . 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  $C_t^T = \sum_{i \in I} \pi^i c_t^{T,i}$ ,  $C_t^N = \sum_{i \in I} \pi^i c_t^n$ ,  $C_t = \sum_{i \in I} \pi^i c_t^i$ ,  $B_t = \sum_{i \in I} \pi^i b_t^i$ .

Preference. All households have the same preference that is

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}, \quad \sigma > 0,$$
(4)

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 equation (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 collaterial credit constraint such that the market value of debt issuances cannot exceed a fraction  $\theta$  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 (4) subject to the budget constraint

$$c_t^{T,i} + P_t^N c_t^{N,i} + b_t^i = s^i \left( P_t^N Y_t^N + Y_t^T \right) + Q b_{t+1}^i,$$
(5)

and the credit constraint

$$Qb_{t+1}^{i} \le \theta s^{i} \left( Y_{t}^{T} + P_{t}^{N} Y^{N} \right).$$

$$\tag{6}$$

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  $\theta$  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

$$C_t^T + B_t = Y_t^T + QB_{t+1} \tag{7}$$

$$C_t^N = Y_t^N \tag{8}$$

**Recursive formulation.** We consider the optimization problem of individual households in 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  $B = (B^i)_{i \in I}$ . The optimization problem of individual *i* can be written as

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

$$\begin{aligned} c^{T} + P^{N}(Y^{T}, \boldsymbol{B})c^{N} + b &= s^{i}\left(Y^{T} + P^{N}(Y^{T}, \boldsymbol{B})Y^{N}\right) + Qb\\ Qb' &\leq \theta s^{i}\left(Y^{T} + P^{N}(Y^{T}, \boldsymbol{B})Y^{N}\right)\\ \boldsymbol{B}' &= \Gamma(Y^{T}, \boldsymbol{B}), \end{aligned}$$

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

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

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

#### 2.3 Equilibrium price of nontradables

The optimality conditions for individual household *i* include the budget constraint (5), the credit constraint (6), and the first-order conditions. In particular, the intratemporal optimality condition implies that

$$P_t^N = \frac{1-\omega}{\omega} \left(\frac{c_t^{T,i}}{c_t^{N,i}}\right)^{1+\eta} c_t^{i(\epsilon_N - \epsilon_T)(1+\eta)}, \ \forall i \in I$$
(9)

Equation (9) 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

$$P^{N} = \frac{1-\omega}{\omega} \left(\frac{c_{t}^{T,i}}{c_{t}^{N,i}}\right)^{1+\eta}, \ \forall i \in I$$
(10)

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:

$$P_{t}^{N} = (1 - \omega) \left\{ \sum_{i \in I} \pi^{i} \left[ \omega^{\frac{1}{1+\eta}} \left( c_{t}^{i} \right)^{\epsilon_{T} - \frac{1}{1+\eta}} + (1 - \omega)^{\frac{1}{1+\eta}} \left( P_{t}^{N} \right)^{\frac{\eta}{1+\eta}} \left( c_{t}^{i} \right)^{\epsilon_{N} - \frac{1}{1+\eta}} \right]^{\frac{1}{\eta}} \left( c_{t}^{i} \right)^{\epsilon_{N} - \frac{1}{1+\eta}} \right\}^{1+\eta}$$

$$(11)$$

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

$$P_t^N = (1 - \omega)\omega^{\frac{1}{\eta}} \left[ \left( \sum_{i \in I} \pi^i c_t^i \right)^{-\eta} - (1 - \omega) \right]^{-\frac{1 + \eta}{\eta}}$$
(12)

### 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

$$\sum_{i \in I} \gamma^i \pi^i \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t^i), \tag{13}$$

where the social welfare weights are  $\gamma = (\gamma^i)_{i \in I}, \gamma^i \ge 0, \forall i, \sum_i \pi^i \gamma^i = 1$ . The optimization

problem of the social planner is choosing all individual allocation to maximize social welfare (13) subject to the resource constraints (7)–(8), the household's budget constraints (5), the credit constraints (6), and the equilibrium price condition (9).

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

$$V(Y^{T}, \boldsymbol{B}) = \max_{\{c^{T,i}, c^{N,i}, b^{\prime i}\}_{i \in I}} \sum_{i \in I} \gamma^{i} \pi^{i} \frac{c \left(c^{T,i}, c^{N,i}\right)^{1-\sigma}}{1-\sigma} + \beta \mathbb{E}_{Y^{T'}|Y^{T}} V(Y^{T'}, \boldsymbol{B}')$$
subject to
$$\sum_{i \in I} \pi^{i} c^{T,i} + \sum_{i \in I} \pi^{i} b^{i} = Y^{T} + Q \sum_{i \in I} \pi^{i} b^{\prime i}$$

$$\sum_{i \in I} \pi^{i} c^{N,i} = Y^{N}$$

$$c^{T,i} + P^{N} c^{N,i} + b^{i} = s^{i} \left(Y^{T} + P^{N} Y^{N}\right) + Q b^{\prime i}, \quad \forall i \in I$$

$$Q b^{\prime i} \leq \theta s^{i} \left(Y^{T} + P^{N} Y^{N}\right), \quad \forall i \in I$$

$$P^{N} = \frac{1-\omega}{\omega} \left(\frac{c^{T,i}}{c^{N,i}}\right)^{1+\eta} c^{i(\epsilon_{N}-\epsilon_{T})(1+\eta)}, \quad \forall i \in I$$
(15)

**Definition 2.2.** A *recursive socially planned equilibrium* is the allocation rule  $\left\{c_{SP}^{T,i}(Y^T, B), c_{SP}^{N,i}(Y^T, B), b_{SP}^{'i}(Y^T, B)\right\}_{i \in I}$  and the value function  $V_{SP}(Y^T, B)$  that solve (14) given the welfare weights  $\gamma$ .

# 3 Quantitative analysis

This section presents the quantitative 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.** The economy is populated by two types of households receiving  $s^H$  and  $s^L$  shares of the endowment in every period, respectively, where  $s^H \ge s^L > 0$  and  $\pi^H = \pi^L = 0.5$ .

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 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  $\rho_z, \sigma_z$  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.

**Parameter values.** Table 2 reports the parameter values used in the quantitative analysis. We set the risk-free rate to  $r^* = 0.04$  and the risk aversion to  $\sigma = 2$  as standard values in the literature. The income elasticity of the tradable sector is normalized to  $\epsilon_T = 1$ . We estimate the persistence and standard deviation of tradable endowments using the series of Peruvian tradable output in period of 1970-2019. Tradable output is defined as the HP-filtered series of total agriculture and manufacturing value added.

The next set of parameters are estimated from the household survey ENAHO. The endowment shares  $s^H$ ,  $s^L$  are normalized such that  $\sum_{i=H,L} \pi^i s^i = 1$  and  $s^H/s^L = 3.05$ , which matches the after-tax income share of average residualized top income (>p50) to average residualized bottom income (<p50). The weight on tradable expenditure is  $\omega = 0.45$ , which is the average share of residualized tradable expenditure. Section **??** provides the estimates for the elasticity of substitution between tradable and nontradable sectors of  $\eta = 0.23$  and the income elasticity of the nontradable sector of  $\epsilon_N = 1.93$ .

Lastly, we use the model to calibrate the discount factor  $\beta$  and the credit constraint coefficient  $\kappa$  to match the Peruvian net foreign asset-to-GDP ratio of 31.5% and the sudden stop probability of 5.26%. In both the data and the model, we define a sudden stop episode as the period in which the current account increases by more than two standard deviations. We find that  $\beta = 0.93$  and  $\kappa = 0.33$ , which are consistent with the findings in the literature.

### 3.2 Borrowing decisions and the real exchange rate

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

Figure 3 plots the policy functions of debt issuance for each type of household. On panel (a), we fix the aggregate tradable income shock to its average value and the current level of debt of the low-income household to its average at the ergodic distribution. We then plot the evolution of optimal debt issuance of the high-income household as a function of the initial debt of the high-income household for each version of our model. Similarly, on panel (b), we fix the aggregate tradable income shock at the same value and the current level of debt of the high-income household to its average at the ergodic distribution. We then plot the evolution of optimal debt issuance of the low shock at the same value and the current level of debt of the high-income household to its average at the ergodic distribution. We then plot the evolution of optimal debt issuance of the low type as a function of the initial debt of the low-income households for both versions of the model.

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-income households to issue less debt

Parameter	Description	Value	Source/Moment
Standard			
$r^*$	Risk-free rate	0.04	Standard literature value
$\sigma$	Risk aversion	2	Standard literature value
$\epsilon_T$	Tradable income elasticity	1	Normalized
$ ho_{y^T}$	Tradable output persistence	0.53	Peruvian tradable output
$\sigma_{y^T}$	Std. dev. of tradable shock	0.047	Peruvian tradable output
Estimated for $s^H/s^L$ $\omega$	<i>rom ENAHO</i> Relative income share Weight on tradable expenditure	$3.05 \\ 0.45$	Residualized income share Share of residualized tradable expenditure
$\eta$	Elasticity of substitution T-NT	0.23	GMM regression
$\epsilon_N$	Nontradable income elasticity	1.93	GMM regression
Calibrated			
$\beta$	Discount factor	0.93	NFA to $\text{GDP} = 31.5\%$
κ	Credit constraint coefficient	0.33	Sudden stop probability = $5.26\%$

#### Table 2: Parameters and values

Note: This table presents the parameter values and sources or moments to compute these values. Standard parameters have values taken from the literature or from estimating macroeconomic series. Estimated parameters from ENAHO includes values that are estimated with moment calculation or GMM regression from the ENAHO survey data. Calibrated parameters are calibrated from the model using simulated methods of moments.

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-income households to issue more debt than in the decentralized economy when the credit constraint does not bind.

The differences in the social planner and private households borrowing decisions across households imply novel properties in the long-run distribution of debt. Figure 4 plots the density probabilities of debt issuance by household type at this ergodic distribution. We find that relative to the decentralized economy, the constrained-efficient economy has a higher probability of observing higher levels of debt for the low-type households and lower levels of debt for the high type. In the decentralized economy, low-income households underborrow while highincome households overborrow from a socially efficient standpoint. These findings imply that type-dependent taxes on private borrowing are welfare improving.

In addition, we also find a new interaction between the debt issuance between high-income and low-income households. Figure 5 plots the policy function of the high-income household



Figure 3: Policy functions of debt issuances by type

Note: This figure depicts the policy functions of debt issuance for high-type and low-type households in the decentralized economy and the constraint-efficient economy.



Figure 4: Distribution of debt by type at the ergodic distribution

Note: This figure plots the ergodic distribution of debt for high-income and low-income households in the decentralized and constrained-efficient economies. We simulate 10,500 periods of data using the policy rules of each version and exclude the first 500 periods of this simulation.

as function of the initial debt of the low-income household when we keep income and the initial debt of the high-income household fixed at their values from the previous figure. As the level of initial debt of the low-income household increases, the economy moves from the case in which all credit constraints are slacking to one in which all credit constraints are binding. There is an additional region where the credit constraint of the low-income household slacks. In this region, the social planner finds



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

Note: This figure depicts the policy functions of debt issuance for high-type and low-type households as functions of the current debt of the low type in the decentralized economy and the constraint-efficient economy.

it optimal to increase debt issuance for high-income households, creating an additional kink relative to the standard monotonicity exhibited by the decentralized policy function.

### 3.3 Effect on the real exchange rate

We argue that the differences in debt issuance policies across households are due to their effects on the real exchange rate as the equilibrium relative price of nontradables. Using the Hicksian demand, we can show that the relative price of nontradables satisfies

$$P_t^N = (1 - \omega) \left\{ \sum_{i \in I} \pi^i \left( E_t^i \right)^{\frac{1}{1+\eta}} \left( c_t^i \right)^{\epsilon_N - \frac{1}{1+\eta}} \right\}^{1+\eta}.$$
 (16)

High-income households have higher expenditures than low-income households. Therefore, in the first-order effect, changes in consumption for high-income households have a larger impact in the real exchange rate than for low-income households.

In the decentralized equilibrium, sudden stop crises are mainly driven by high-income households. High-income households have higher debt capacity and borrow more than low-income households. This implies further reduction in future consumption of high-income households, which leads to a larger depreciation in the real exchange rate and increases the likelihood of tightening credit constraints for all households in the economy. In contrast, low-income households have lower borrowing capacity and thus have lower impact on depreciation of the real exchange rate than high-income households.

The social planner chooses optimal policies that aim to achieve redistribution and efficiency. The desire for redistribution results in the social planner chooses, on average, higher debt issuance for low-income households and lower debt issuance for high-income households than the decentralized economy allocation. This leads to a more equal consumption distribution across households and increases welfare. In addition, when the social planner chooses less borrowing for high-income households, it reduces the impact on future real exchange rate depreciation and likelihood of crises, which in turns increases efficiency.

Figure 6 illustrates the effect of debt policies on the real exchange rate. In the region where low-income households are credit constrained but high-income households are not, the social planner finds it optimal to increase borrowing of high-type households to increase the real exchange rate, which relaxes the low-income credit constraints.



Figure 6: Real exchange rate and debt issuance of the high type

Note: This figure depicts the policy functions of debt issuance for high-type households and the real exchange rates as functions of the current debt of the low type in the decentralized economy and the constraint-efficient economy.

### 3.4 Amplification effect of inequality and nonhomotheticity

We argue that both inequality and the nonhomotheticity of preferences amplify the inefficiency of the pecuniary externality in the decentralized economy. To do so, we compare the longrun averages in the benchmark model to ones in the homothetic-representative-agent model  $(\epsilon_T = \epsilon_N = 1 \text{ and } s^H = s^L = 1)$ . 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, drop in real exchange rate during sudden stops and welfare gains. The first two columns report the statistics for 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.

	Benchmark		Homothetic RA		
Average (in %)	DE	CE	DE	CE	
Debt/income High-income Low-income	31.5 23.8 7.7	30.4 22.5 8.0	31.23 - -	31.22 - -	
Prob. of crisis $\Delta$ RER in crises	5.27 -31.9	2.1 -26.5	4.9 -30.6	4.7 -30.5	
Welfare gain	-	0.0013	-	0.001	

Table 3: Long-run moments: Decentralized and constrained-efficient economies

Note: This table presents the long-run moments of simulated data for decentralized economy (DE) and constrained-efficient economy (CE). We simulate 10,500 periods of data using the policy rules of each version and exclude the first 500 periods of this simulation. Homothetic RA is the alternative model with a representative agent and homothetic preferences.

In the presence of inequality and nonhomothetic preferences, the social planner has access to an additional tool that improves efficiency by changing the distribution of debt issuance and consumption across households, which in turns affects the evolution of the real exchange rate and crisis frequency. Nonhomothetic preferences amplify the large impact of high-income households consumption on the real exchange rate. Comparing to the homothetic-representative-agent model, 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.

### 3.5 Inequality during sudden stops

We next examine how sudden stops affects consumption expenditure inequality. Figure 7 depicts the dynamics of consumption expenditure inequality, measured as the ratio of consumption expenditure of high-income to low-income households around a sudden stop (T = 0). Consumption expenditure inequality slightly decreases during sudden stop crises in the model's decentralized economy (panel (a)) and in the data (panel (b)). However, the optimal policies for the social planner would be to increase consumption expenditure inequality during sudden stop crises while decreasing inequality before and after crises. This feature is in line with the mechanism that by increasing consumption for high-income households more than low-income households, the social planner can mitigate further the real exchange rate depreciation, which results in lower likelihood and less severity of crises.



Figure 7: Expenditure inequality around a sudden stop

Note: This figure depicts the dynamics of the ratio of consumption expenditure of high-income to low-income households around a sudden stop. A sudden stop period is normalized to T = 0. Panel (a) plots the averages across sudden stop episodes in the model simulation. Panel (b) plots the ratios around the two sudden stop episodes in 2009 and 2016.

Patterns of inequality dynamics around crises are also similar for tradable and nontradable consumption expenditures, as shown in Figure 8 and 9.



Figure 8: Tradable expenditure inequality around a sudden stop

Note: This figure depicts the dynamics of the ratio of tradable consumption expenditure of highincome to low-income households around a sudden stop. A sudden stop period is normalized to T = 0. Panel (a) plots the averages across sudden stop episodes in the model simulation. Panel (b) plots the ratios around the two sudden stop episodes in 2009 and 2016.



Figure 9: Nontradable expenditure inequality around a sudden stop

Note: This figure depicts the dynamics of the ratio of nontradable consumption expenditure of high-income to low-income households around a sudden stop. A sudden stop period is normalized to T = 0. Panel (a) plots the averages across sudden stop episodes in the model simulation. Panel (b) plots the ratios around the two sudden stop episodes in 2009 and 2016.

# 4 Conclusion

This paper studies sudden stop crises in the presence of inequality and nonhomothetic preferences. We argue that changes in the consumption bundle across the income distribution affect the relative demand between tradable and nontradable sectors, which in turns affects the real exchange rate during current account reversals.

We provide micro-level evidence that the nontradable sector has higher income elasticity of demand than the tradable sector. 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 non-homotheticity 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.

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 take 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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# A Data

In ENAHO, consumption data are organized in modules. They are then aggregated by groups and added up to total monetary expenditures. We consider all consumption items included in the definition of total monetary expenditures (gashog1d) in ENAHO and disaggregate these consumption items into 15 categories as presented in Table A.1. We excludes items that are mixed of tradable or nontradable goods in the measures of consumption. The aggregation is consistent with the definitions of the 15 categories in the inflation series from *Banco Central de Reserva del PerÃo* (BCRP). Mapping from the module items to the categories is available upon request.

	Expenditure share in 2019 (%)			
	All income	Top income	Bottom income	
Tradable	32.1	30.8	34.9	
Food	13.3	11.9	16.4	
Clothing and shoes	4.5	4.7	4.2	
Energy	2.6	2.5	2.9	
Electrical appliances	1.0	1.0	1.0	
Other tradables	10.6	10.7	10.4	
Nontradable	67.9	69.2	65.1	
Food	17.3	15.5	21.3	
Utilities	4	3.8	4.3	
Personal services	0.7	0.7	0.6	
Health	5	5.4	4.3	
Transportation	7.9	8.4	6.8	
Education	7.2	8.4	4.7	
Restaurants	14.2	14.3	14.1	
Rents	3.2	3.4	2.7	
Other services	7.6	8.6	5.3	
Other nontradables	0.7	0.6	1	
Others (not categorized)	2.3	2.6	1.7	

Table A.1: Expenditure category and share, ENAHO

Note: This table presents the expenditure shares of categories in total monetary expenditures for all households, top income households, and bottom income households in the sample in 2019. Tradable food and nontradable food categories add up to food at home. Food away from home is included in the nontradable restaurants category. Top (bottom) income households are households that have the after-tax income above (below) the median income. Source: ENAHO

**Sample selection.** Table A.2 presents the number of observations for all households in the dataset and after each step of the sample selection.

We merge the consumption data with the price series for the 15 categories from BCRP. The

	No. of Observations
All households, 2007-2019	471,072
After sample restriction	
Large towns	349,014
Ages 25 to 60	173,784
Nonnegative consumption and income	173,188
Consumption/income non-outliers	171,248

# Table A.2: Sample selection, ENAHO

price series are reported in percentage variation for Lima Metropolitan area. We construct the regional price index series with base year of 2019 by combining the data from BCRP with the regional price data and expenditure shares reported in ENAHO.