Sudden stops and consumption inequality with nonhomothetic preferences

Fernando Arce [1] Monica Tran-Xuan [2]

Virtual East Asia Macroeconomic Seminar Series
July 2022

[1]Federal Reserve Bank of Chicago [2]University at Buffalo

Disclaimer: *The views expressed here are mine and do not represent the views of the Federal Reserve Bank of Chicago or the Federal Reserve System*

Introduction

Emerging markets have higher levels of income and consumption inequality

Emerging markets are also subject to sudden-stop crises are characterized by sharp real exchange rate depreciation

Recent evidence of differences in income elasticities of demand for tradables and nontradables goods (non-homothetic preferences), and it's important for macro aggregates

Implication: Changes in the consumption bundle across the income distribution could have an impact on the real exchange rate during a current account reversal

Research questions when preferences are nonhomothetic

1. What happens to consumption inequality during sudden stop crises?

2. Should regulators consider income redistribution when setting macroprudential policies?

3. Is overborrowing uniform across the income distribution?

Results

- Under laissez-faire, consumption inequality moves little during crises.
- Under optimal policies, increasing consumption inequality during crises can reduce the frequency and severity of sudden stops
- From a social standpoint, high income households overborrow while low income households underborrow

This paper: SOE with heterogeneous agents

Continuum of households with access to international credit markets

Agents are heterogeneous on the share of the stochastic aggregate endowment they receive

Every agent's debt is constrained by market value of *their* income (credit frictions)

Sudden-stop crisis: Defined as a period where the current account of the economy increases by more than two standard deviations

Preferences: Household have a higher income elasticity for nontradables than for tradables

Two versions

Decentralized version: Continuum of competitive households choose individual debt and consumption taking all aggregate laws of motion as given

Constrained-efficient version: A planner makes all borrowing decisions but is subject to the same credit constraints as the households in the decentralized version

Households choose their consumption competitively subject to their individual budget constraints

Planner can't transfer resources across households directly

Related literature

- Inequality and economic cycles

Broer (2020); Primiceri and van Rens(2009); Storesletten, Telmer, and Yaron (2007, 2004) ; Krebs (2007); Barlevy and Tsiddon (2006);

→ The role of inequality on sudden stops crises in emerging economies

- Macroeconomic impact of nonhomothetic preferences

Rojas and Saffie (2021); Comin, Lashkari, Mestieri (2021),Boppart (2014), Buera, and Kaboski (2009)

→ Sectoral consumption reallocation can increase frequency and severity of crises

- Sudden Stops and inequality

Villalvazo (2021), Hong (2020), Guntin, Ottonello, and Perez (2021), Kumhof, Ranciere, and Winant (2015);

→ Differential effect on the real exchange rate of households with different income levels

Empirical Motivation

Country focus: Peru 2007 - 2019

From 2007 to 2019, Peru had two CA reversals (2009 and 2016)

We complement the macro data with household survey data (ENAHO)

Repeated cross-sections that are consistent with macro aggregates

Income: Net monetary income, includes subsidies and transfers

Consumption: Non-durable monetary consumption

Inequality: The ratio of consumption expenditures of households with income above to below the median

Peru ENAHO: Decomposition and Residualization

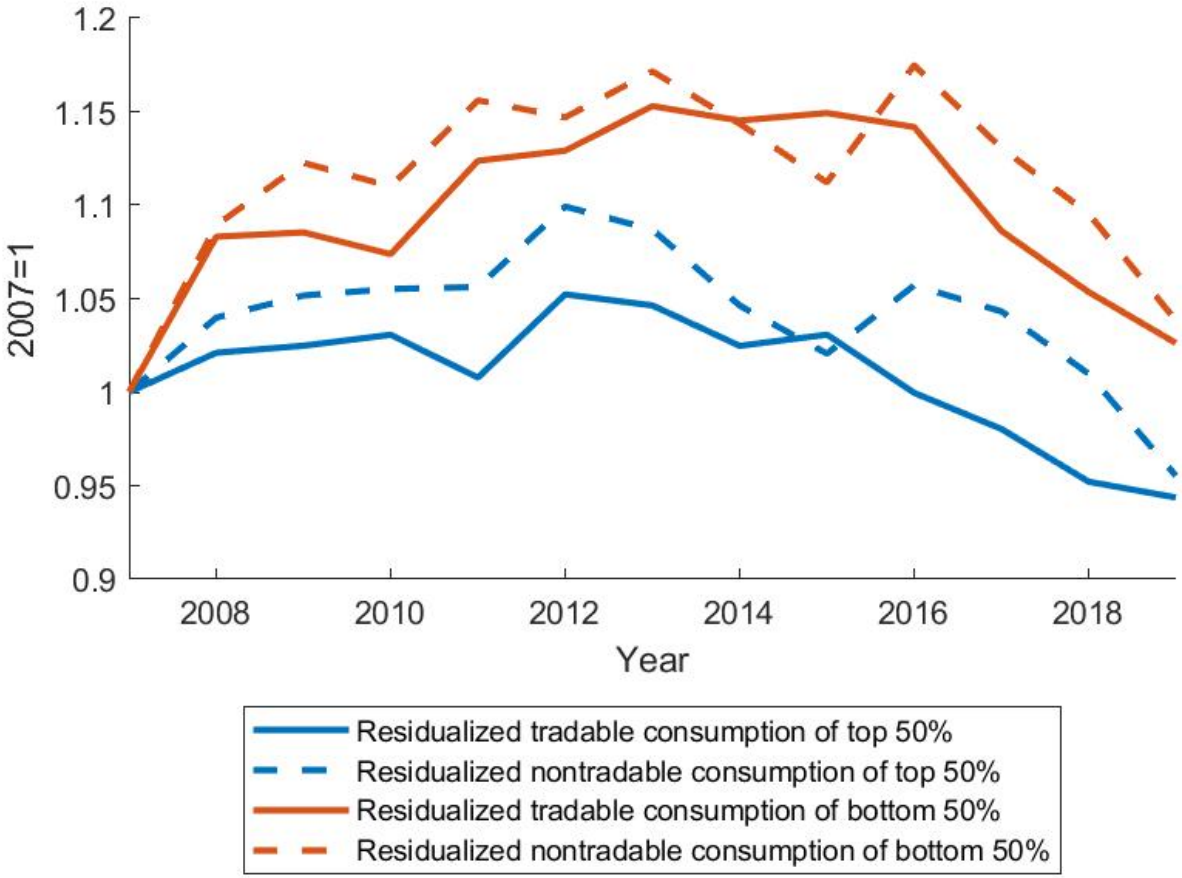
Decompose annualized monetary consumption expenditures at the household level expenditures into four categories:

- Tradable consumption: Food, Clothing, Energy, Home equipment.
- Nontradable consumption: Restaurants, Services, Education, Health, Transportation.
- Durable consumption: Housing, Cars, Furniture, Electronics
- Not classified: Others

Consumption: Tradable + nontradable consumption

Income and consumption are residualized using head of household observables (age, education, gender,...) and time trends Regression

Homothetic preferences?



Source: Encuesta Nacional de Hogares (ENAHO)

Nonresidualized | Consumption inequality | T-NT consumption inequality

Measuring nonhomotheticity

Following Comin, Lashkari, and Mestieri (2021), we assume household's preference in each period $u(c)$, nested generalized CES

c is a composite of tradable c_T and nontradable c_N consumption such that

$$1 = \left[\omega \left(c_T\right)^{-\eta} c^{\epsilon_T(1+\eta)-1} + \left(1-\omega\right)\left(c_N\right)^{-\eta} c^{\epsilon_N(1+\eta)-1}\right]^{-1/\eta}, \eta > -1, \omega \in (0,1)$$

Elasticity of substitution T-NT: $\frac{1}{1+\eta}$

Income elasticity of good j: $\frac{1}{1+\eta} + \frac{\eta}{1+\eta}\frac{\epsilon_j}{\omega\epsilon_T+(1-\omega)\epsilon_N}$

Preference is homothetic CES if $\epsilon_T = \epsilon_N = 1$

Hicksian approach

Expenditure

$$E \equiv p_T c_T + p_N c_N$$

Hicksian demand

$$c_T = \omega^{\frac{1}{1+\eta}} \left(\frac{E}{p_T} \right)^{\frac{1}{1+\eta}} c^{\epsilon_T - \frac{1}{1+\eta}}$$

$$c_N = (1-\omega)^{\frac{1}{1+\eta}} \left(\frac{E}{p_N} \right)^{\frac{1}{1+\eta}} c^{\epsilon_N - \frac{1}{1+\eta}}$$

Shares of tradable and nontradable expenditures

$$\bar{\omega}_T = \omega^{\frac{1}{1+\eta}} \left(\frac{E}{p_T} \right)^{\frac{1}{1+\eta}-1} c^{\epsilon_T - \frac{1}{1+\eta}}$$

$$\bar{\omega}_N = (1-\omega)^{\frac{1}{1+\eta}} \left(\frac{E}{p_N} \right)^{\frac{1}{1+\eta}-1} c^{\epsilon_N - \frac{1}{1+\eta}}$$

Elasticity estimation: Method

We normalize $\epsilon_T = 1$ and estimate parameters ϵ_N and η using GMM

Moment condition:

$$\log\left(\frac{\bar{\omega}^n_{Nt}}{\bar{\omega}^n_{Tt}}\right) = \left(\frac{\eta}{1+\eta}\right)\log\left(\frac{p^n_{Nt}}{p^n_{Tt}}\right) + (\epsilon_N - 1)\log\left(\frac{E^n_t}{p^n_{Tt}}\right) + (\epsilon_N - 1)\left(\frac{1+\eta}{\eta}\right)\log\bar{\omega}^n_{Tt} + \zeta^n_N + \nu^n_{Nt}$$

Data:

- Residualized consumption and expenditure shares
- Effective price faced by each household p^n_{it}
  - Expenditure-weighted average of the log-price of each of the expenditure categories belonging to the sector i

Instruments

Elasticity estimation: Results

	(1)	(2)	(3)	(4)	(5)	(6)
η	0.225***	0.236***	0.243***	0.278***	0.229***	0.242***
	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.003)
ϵ_N	1.928***	2.147***	1.859***	1.997***	2.486***	3.317***
	(0.028)	(0.057)	(0.025)	(0.045)	(0.046)	(0.176)
Expenditure re-weighted	N	Y	N	Y	N	Y
Region FE	N	N	Y	Y	Y	Y
Year FE	N	N	N	N	Y	Y

(1): $\eta = 0.225$ and $\epsilon_N = 1.928$ correspond to

- Elasticity of substitution T-NT is 0.18
- Income elasticity difference of nontradable to tradable is 0.11

Model

Model: Small open endowment economy

Goods: Tradable (y^T) and nontradable (y^N). Bonds denominated in units of tradables

Real exchange rate (p^N): Relative price of nontradables

Aggregate shocks: Tradable income (y^T)

Agents: A unitary mass of households, divided in a finite number F of types $i \in 1, .., F$

Equal mass of each type: $\pi_i = 1/F$

Heterogeneous household

Each household of type i receives a fraction s_i of the endowment

Starts the period with debt b_i and can issue non-state contingent one-period bonds b_i' at price q

Due to imperfect enforcement, the market value of debt issuance cannot exceed a fraction κ of current income

The credit constraint is therefore:

$$qb_i' \leq \kappa s_i [y^T + p^N y^N]$$

Decentralized version: Type i household's problem

Households face agg. state $S = (y^T, B_1, ..., B_F)$

$$V_i(S, b_i) = \max_{b_i', c_i^T, c_i^N} u(c(c_i^T, c_i^N)) + \beta \mathbb{E}[V_i(S', b_i')]$$

subject to

$$\underbrace{c_i^T + p^N c_i^N}_{\text{Consumption}} + \underbrace{b_i}_{\text{Current debt held by } i} = \underbrace{s_i(y^T + p^N y^N)}_{\text{Endowment share}} + q \underbrace{b_i'}_{\text{New debt issued}}$$

$$\underbrace{q b_i'}_{\text{Market value of new debt}} \leq \kappa \; s_i \quad (y^T + \underbrace{p^N}_{\text{Pecuniary aggregate demand externality}} y^N)$$

Taking aggregate prices and laws of motion as given

$$\underbrace{p^N = p^N(S)}_{\text{Real exchange rate}} \; ; \qquad S' = \mathcal{S}'\left(y^{T\prime}, \underbrace{\mathcal{B}_1'(S), .., \mathcal{B}_F'(S)}_{\text{Distribution of debt}}\right) ;$$

Constrained-efficient version

Agents: Planner and risk-neutral foreign lenders

Aggregate shocks: Same as competitive equilibrium (y^T)

Credit frictions: For each type i:

$$qB_i' \leq \kappa s_i \left[y^T + f\left(\{\mathcal{C}_i\}_{i=1}^F \right) y^N \right],$$

Planner's welfare weights $\{\Psi_i\}_{i=1}^F$

Planner chooses aggregate borrowing by type but must still satisfy the household budget constraints

Planner can't transfer resources across households directly

Recursive planner problem

Equilibrium price of nontradables

Nonhomothetic preference ($\epsilon_T < \epsilon_N$) ▸ Hicksian demand

$$p^N = (1-\omega)\left\{\frac{1}{F}\sum_{i=1}^{F}\underbrace{\left[\omega^{\frac{1}{1+\eta}}\,C_i^{\epsilon_T-\frac{1}{1+\eta}} + (1-\omega)^{\frac{1}{1+\eta}}\,p^{N\,\frac{\eta}{1+\eta}}\,C_i^{\epsilon_N-\frac{1}{1+\eta}}\right]^{\frac{1}{\eta}}}_{E_i^{\frac{1}{1+\eta}}} \times C_i^{\epsilon_N-\frac{1}{1+\eta}}\right\}^{1+\eta}$$

Homothetic preference ($\epsilon_T = \epsilon_N = 1$)

$$p^N = (1-\omega)\omega^{\frac{1}{\eta}}\left[\left(\frac{1}{F}\sum_{i=1}^{F}C_i\right)^{-\eta} - (1-\omega)\right]^{-\frac{1+\eta}{\eta}}$$

Main mechanism

All types of household of make borrowing decisions that ignore the pecuniary externality

High type households have a larger impact on the evolution of the real exchange

Low type households have a lower borrowing capacity and higher marginal returns of consumption

Relative to the decentralized version, the planner decreases borrowing progressively

When the low types are facing a binding constraint but not the high types, the planner will increase borrowing by the high-types to relax the low-types constraints

▸ Euler's equation

Quantitative analysis

Quantitative assumptions

Assume that tradable income follows a discretized AR 1 process, estimated from Peruvian macro data

Reduce the problem to only two types of households

Use the estimated parameters from household survey

- Relative income share
- Share of tradable expenditure
- Elasticity of substitution T-NT (GMM)
- Nontradable income elasticity (GMM)

Calibrated parameters

- Discount factor
- Credit constraint coefficient

Parameters

Estimated from the household survey

Parameter	Description	Value	Method
s^H/s^L	Relative income share	3.05	Res. income shares
ω	Share of tradable expenditures	0.45	Share of res. tradable consumption
ϵ_T	Tradable income elasticity	1	Normalized
η	Elasticity of substitution T-NT	0.23	GMM regression
ϵ_N	Nontradable income elasticity	1.93	GMM regression

Calibrated

Parameter	Description	Value	Moment	Data	Simulation
β	Discount factor	0.93	NFA to GDP	31.46	31.50
κ	Credit constraint	0.33	Sudden stop probability	5.26	5.27

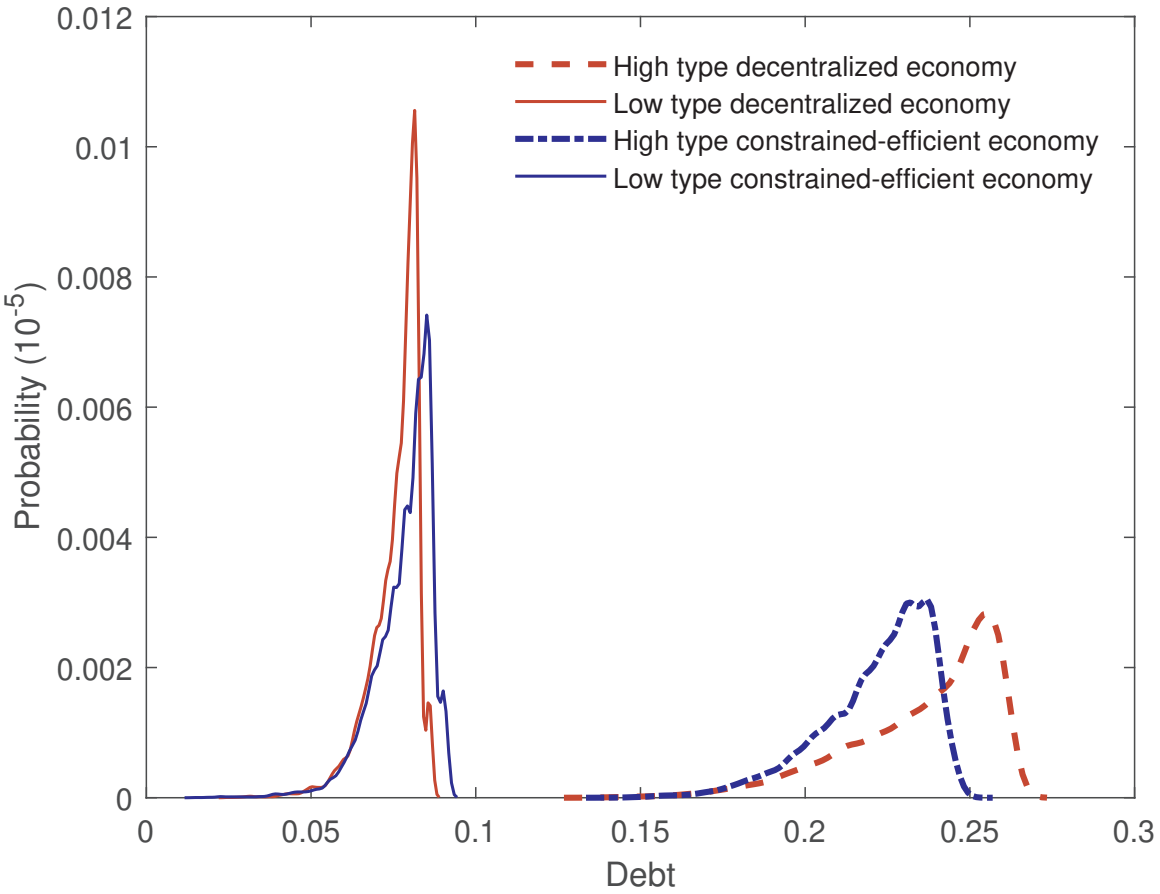
▸ Standard parameters

Decentralized vs. constrained efficient at the ergodic

Average (in %)	DE	CE
Debt/income	31.5	30.4
High type	23.8	22.5
Low type	7.7	8.0
Prob. of crisis	5.27	2.1
RER depreciation	-31.9	-26.5
Welfare gain	–	0.0013

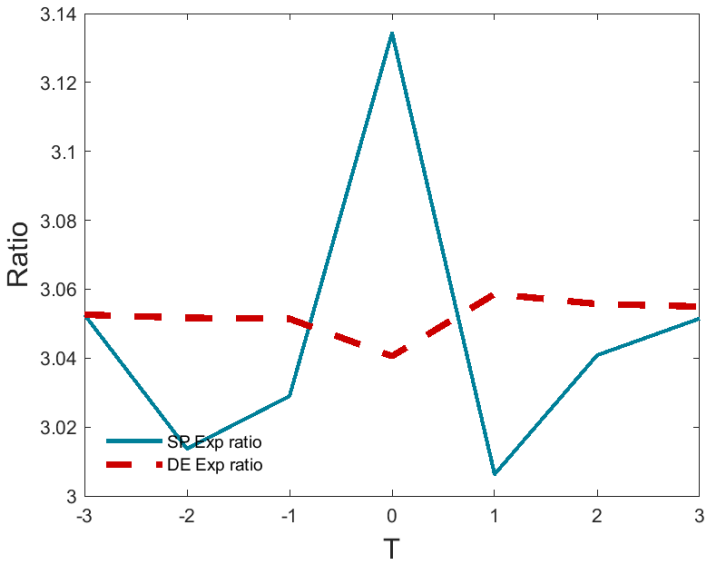
▸ Comparison ▸ Policy functions

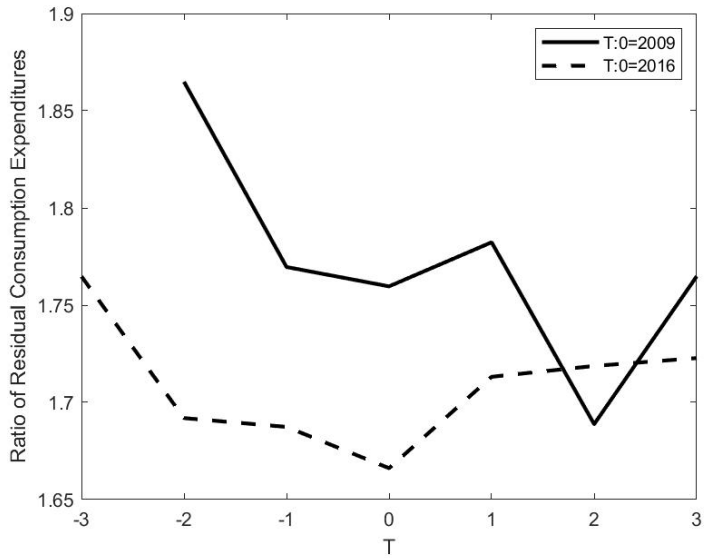
Results: Distribution of debt by type



On average high-types overborrow while low-types underborrow

Expenditure inequality around a sudden stop

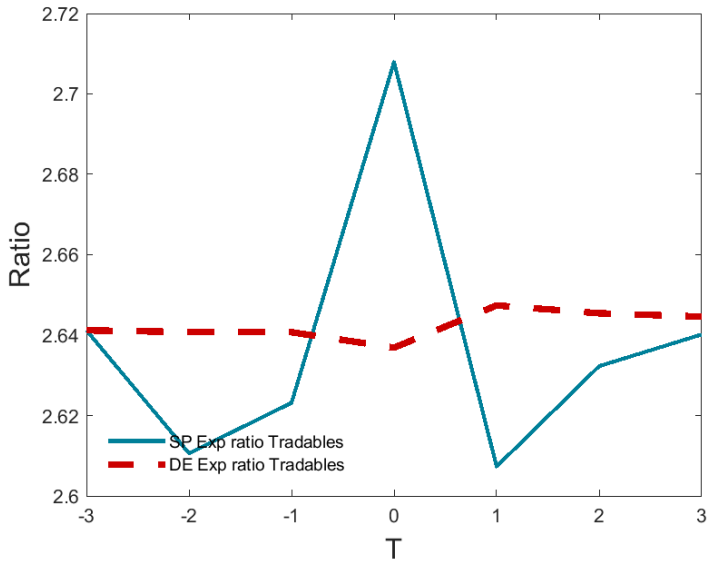


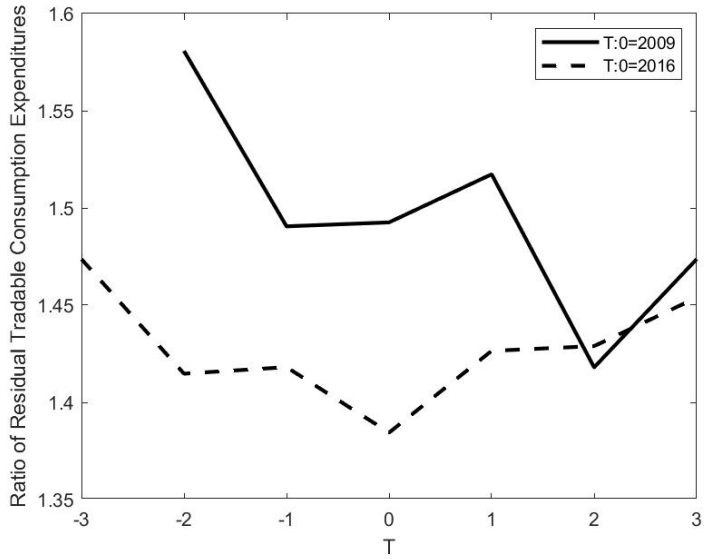


Nonresidualized

Under laissez-faire expenditure inequality declines slightly. In the planned economy, large increase

Tradable expenditure inequality around a sudden stop

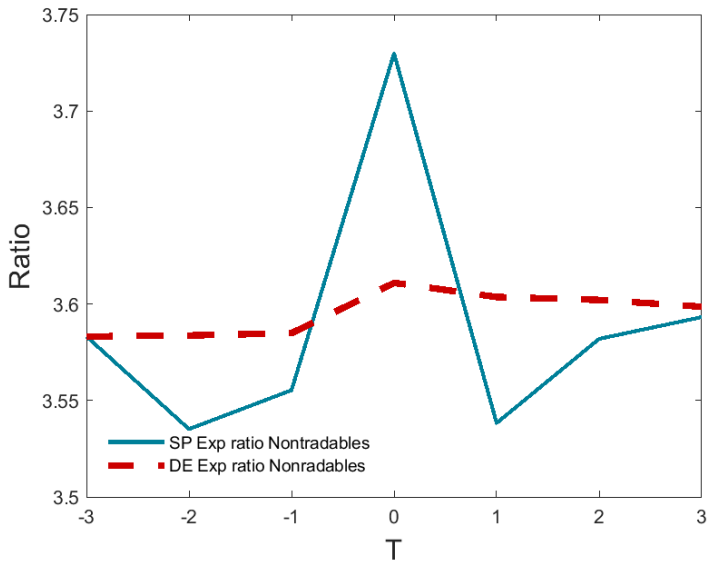


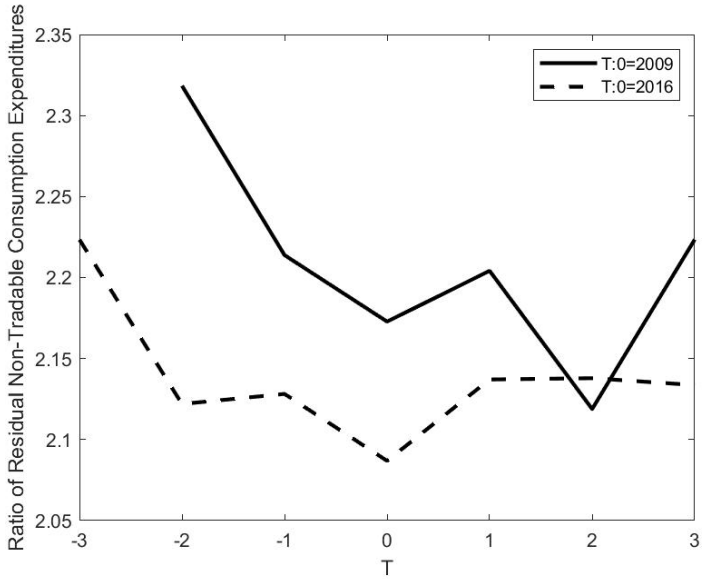


Nonresidualized

Under laissez-faire expenditure inequality declines slightly. In the planned economy, large increase

Nontradable expenditure inequality around a sudden stop





Nonresidualized

Under laissez-faire expenditure inequality declines slightly. In the planned economy, large increase

Conclusion

Model of how sudden stop crises affect countries with ex-ante heterogeneity

1. Excessive debt issuances by high income households lead to sudden stops
2. Without government intervention, consumption inequality falls during crises
3. Optimal macroprudential policies would decrease inequality on average but increase it during crises

Conclusion

Model of how sudden stop crises affect countries with ex-ante heterogeneity

1. Excessive debt issuances by high income households lead to sudden stops
2. Without government intervention, consumption inequality falls during crises
3. Optimal macroprudential policies would decrease inequality on average but increase it during crises

Next steps

- Finish the calibration of the model and check if the dynamics are quantitatively consistent with the micro data
- Allow for idiosyncratic income shocks or shocks to income inequality
- Analyze simple policy recommendations that can approach the CE economy

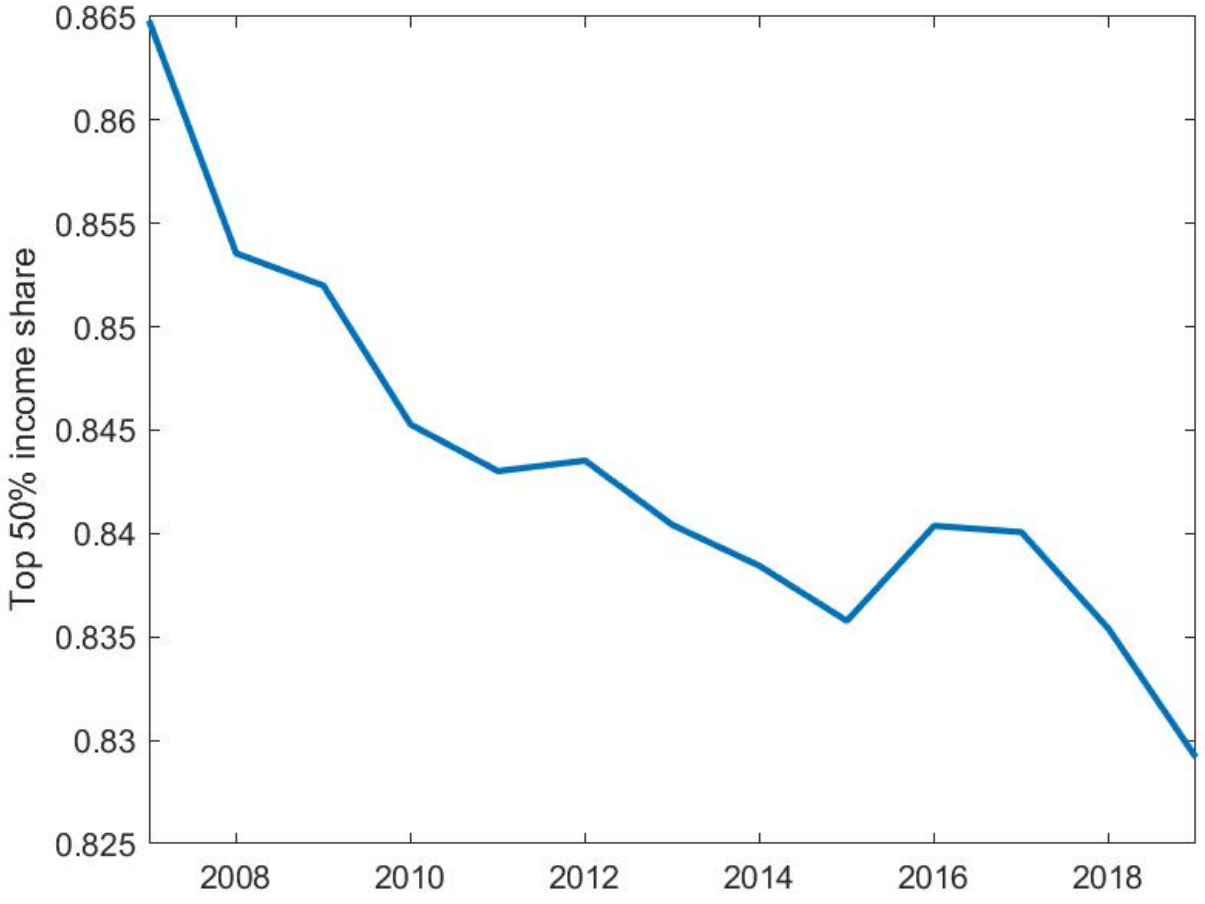
Appendix

Decentralized vs. constrained efficient at the ergodic

	Benchmark		RA & homothetic	
Average (in %)	DE	CE	DE	CE
Debt/income	31.5	30.4	31.23	31.22
High type	23.8	22.5	–	–
Low type	7.7	8.0	–	–
Prob. of crisis	5.27	2.1	4.9	4.7
RER depreciation	-31.09	-26.5	-30.6	-30.5
Welfare gain	–	0.0013	–	0.001

Back

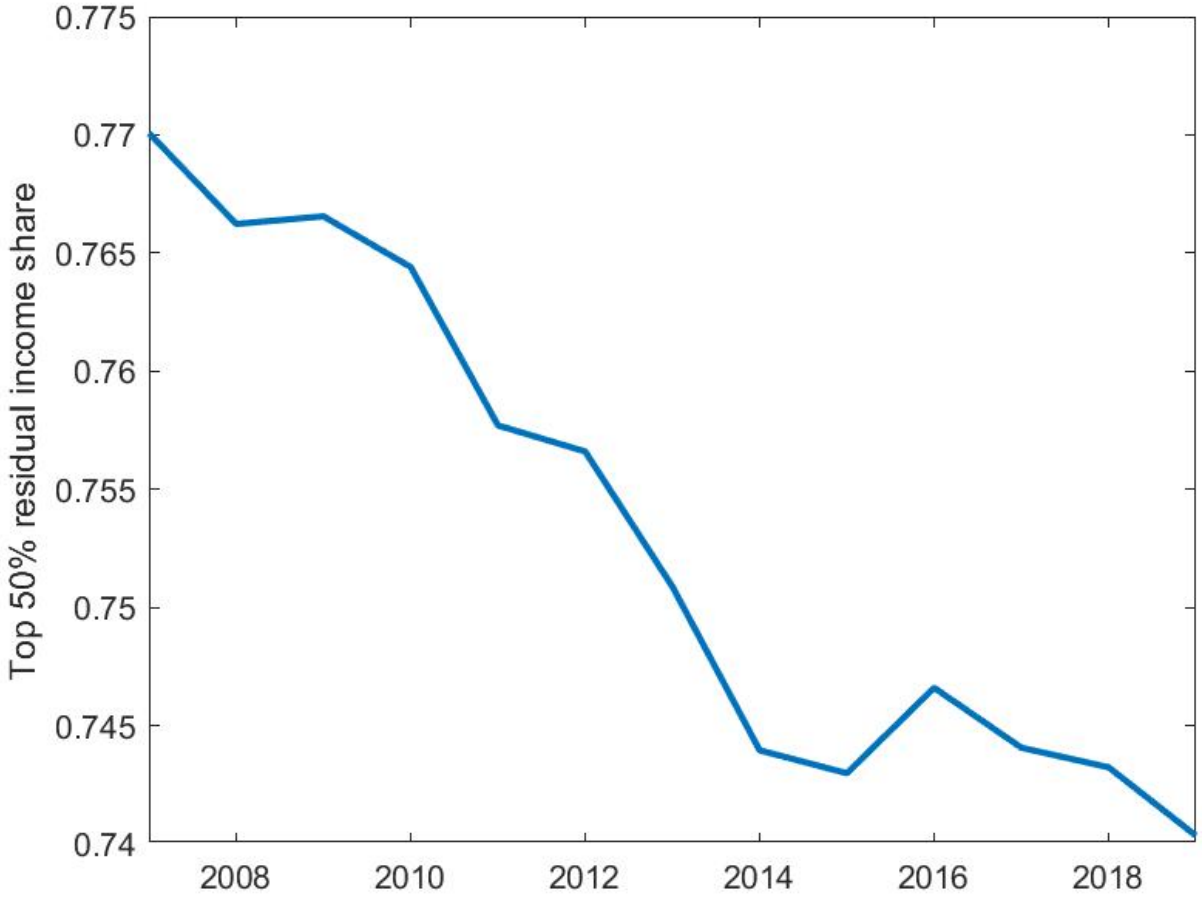
Peru: Income inequality in levels



Source: Encuesta Nacional de Hogares (ENAHO)

Back Residualized Income

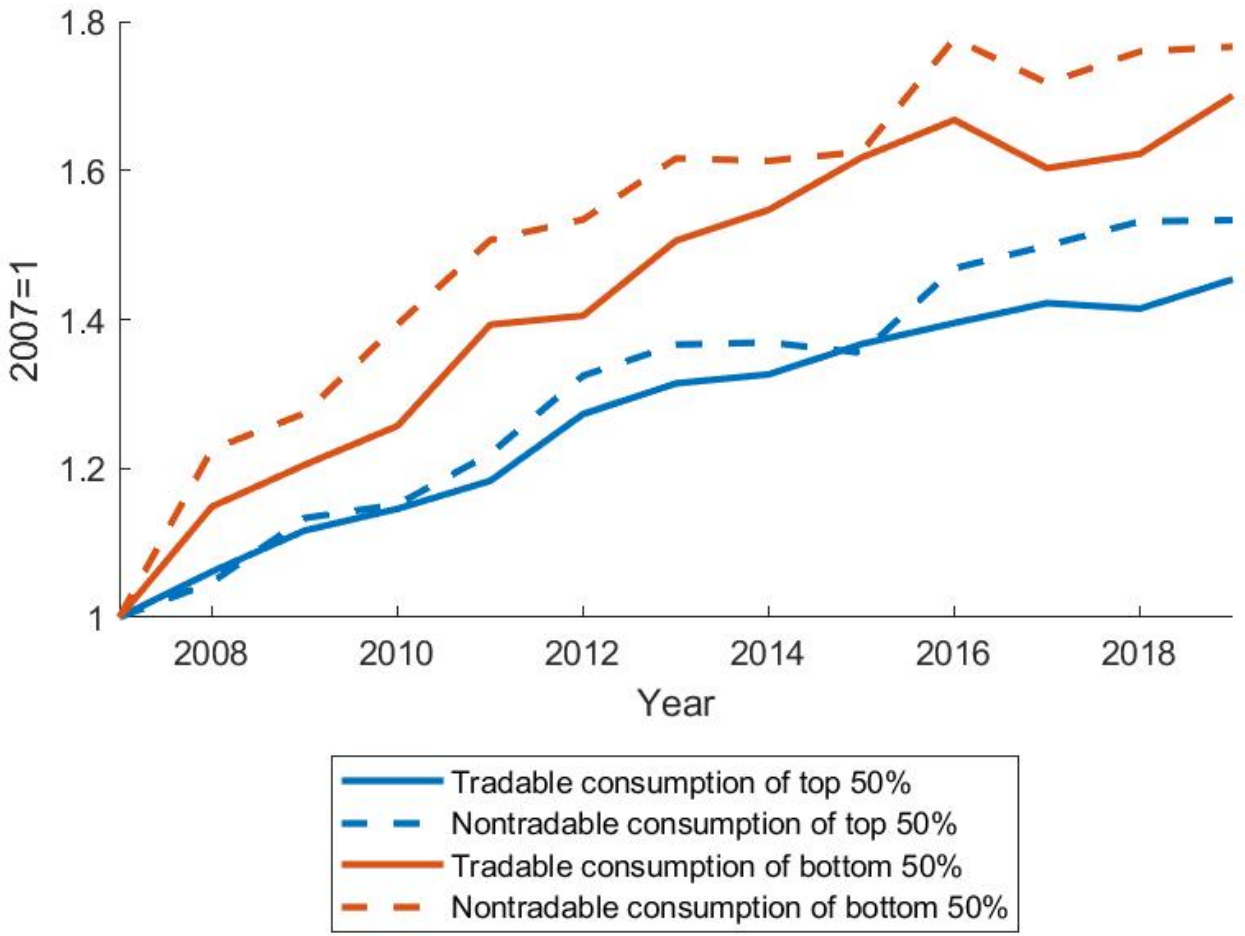
Peru: Income inequality in levels



Source: Encuesta Nacional de Hogares (ENAHO)

Back

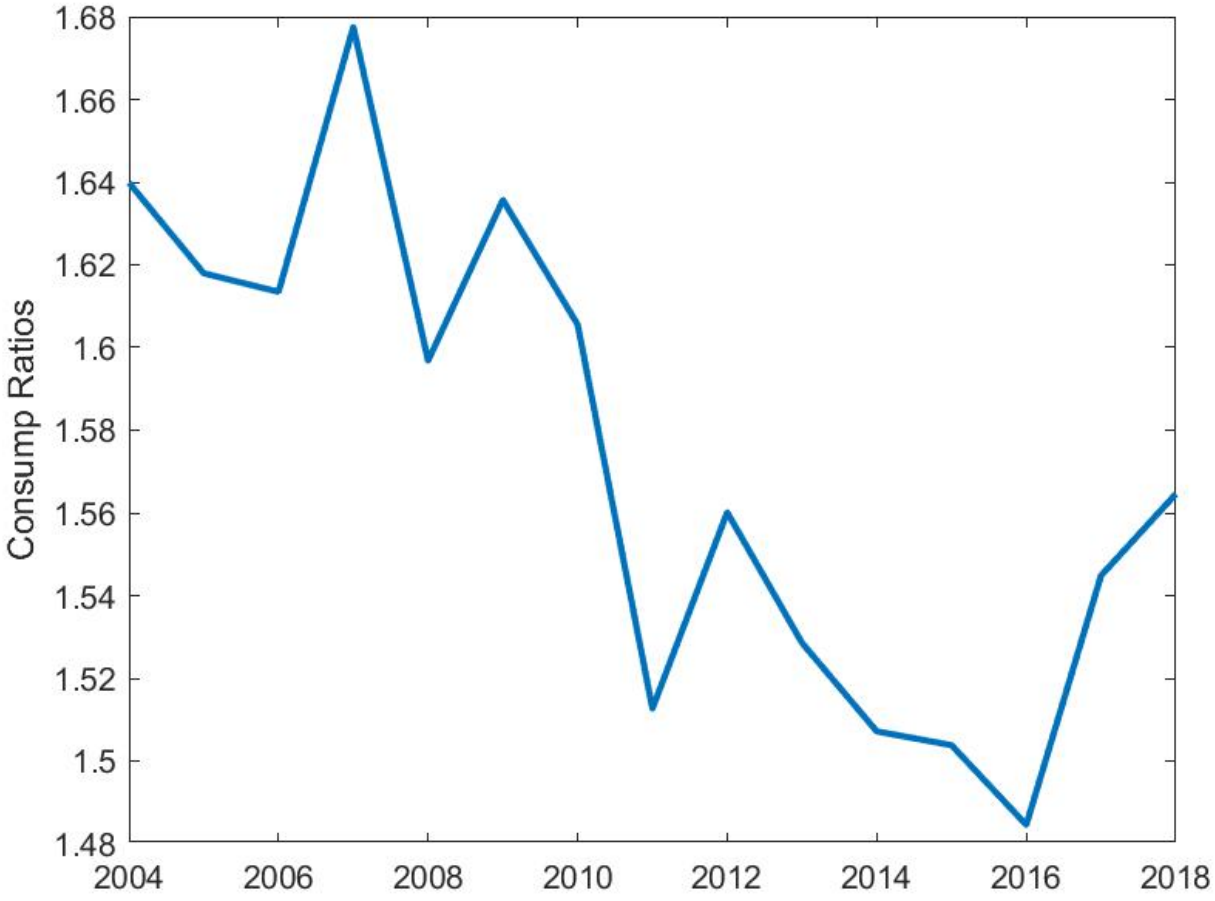
Homothetic preferences?



Source: Encuesta Nacional de Hogares (ENAHO)

Back

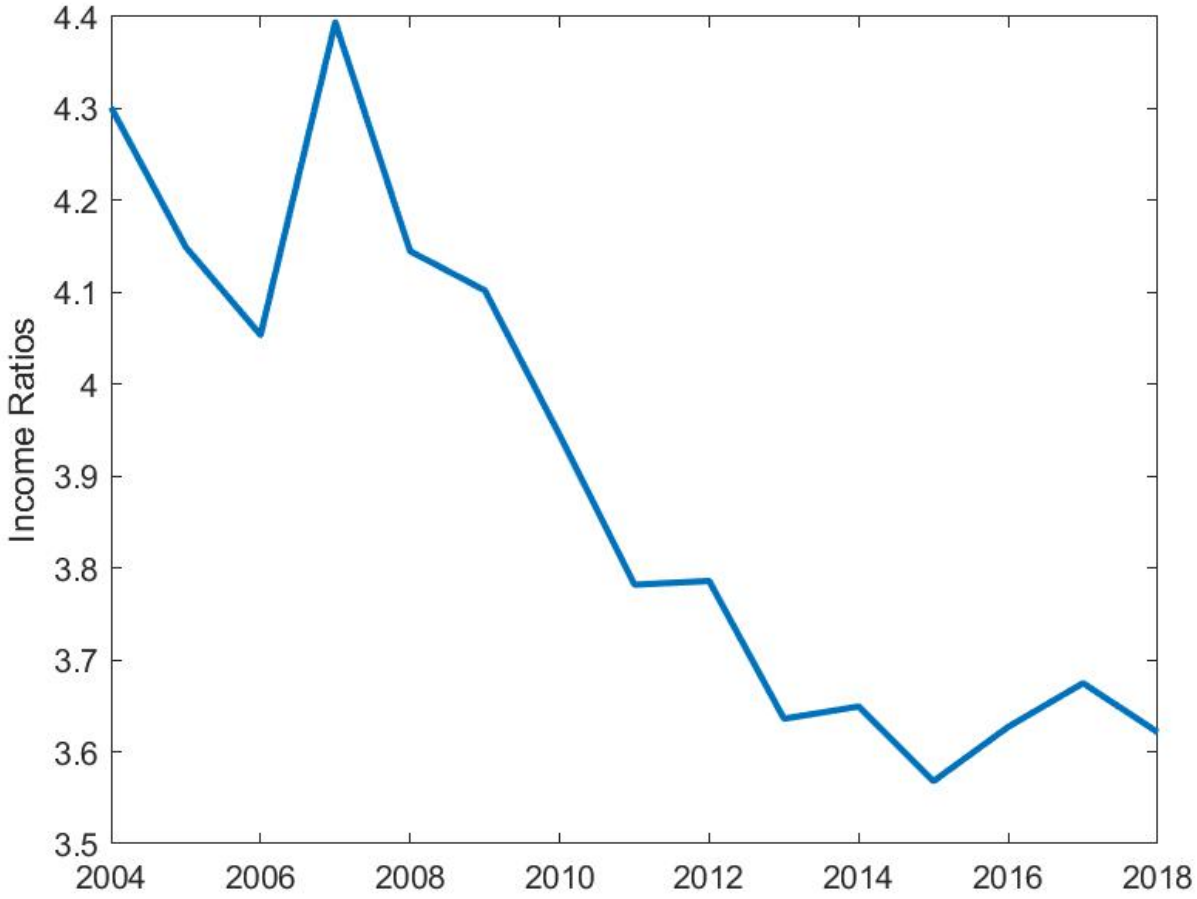
Peru: Consumption inequality in levels



Source: Encuesta Nacional de Hogares (ENAHO), and IMF IFS

Back

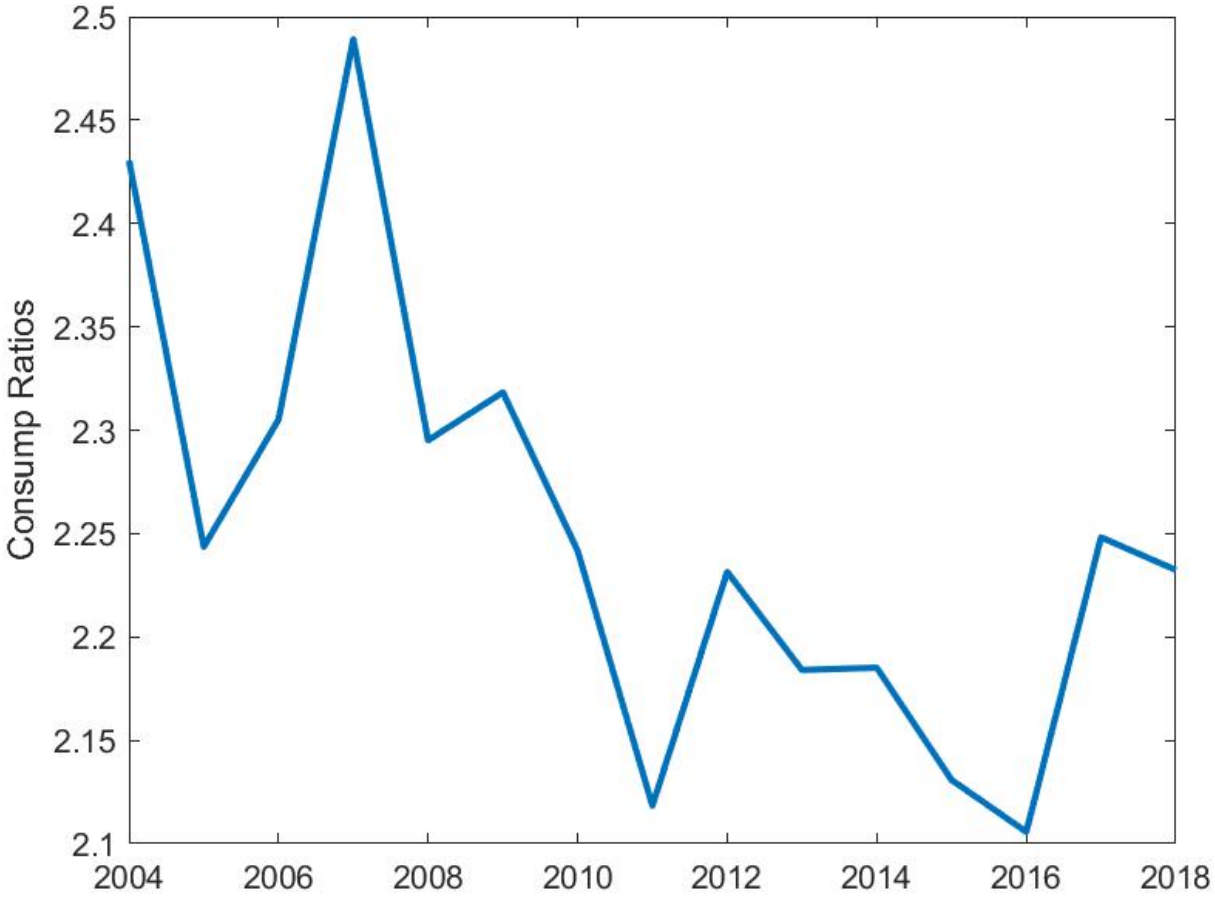
Peru: Income inequality in levels (non residualized)



Source: Encuesta Nacional de Hogares (ENAHO), and IMF IFS

Back

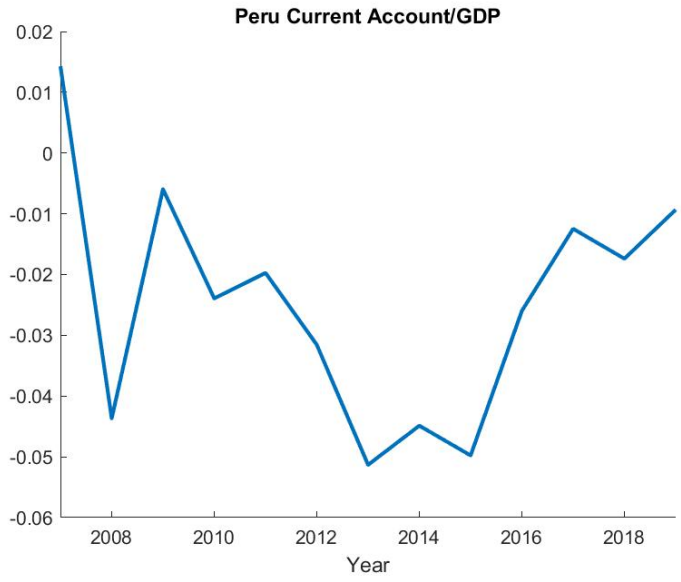
Peru: Consumption inequality in levels (non residualized)

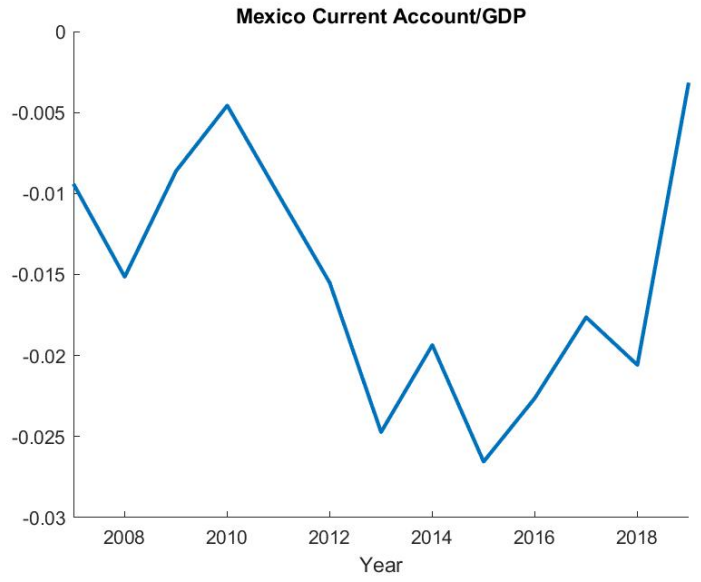


Source: Encuesta Nacional de Hogares (ENAHO), and IMF IFS

Back

Sudden stops in Peru and Mexico





Source: IMF IFS

Back

Residualized Income and Consumption

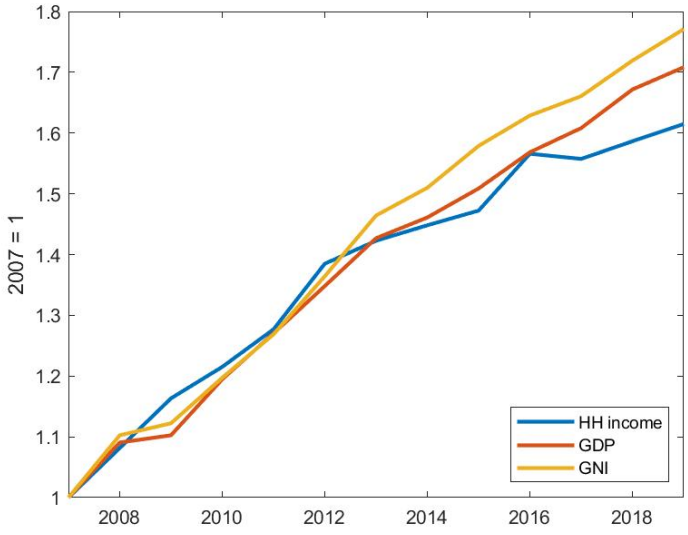
	(1) Income	(2) Consumption	(3) Tradables	(4) Nontradables
Age	0.00963***	0.0207***	0.0145***	0.0369***
	(4.13)	(12.34)	(8.63)	(13.48)
Female	-0.460	4.359*	1.159	8.788*
	(-0.15)	(1.99)	(0.53)	(2.54)
Year	0.0596***	0.0535***	0.0538***	0.0577***
	(28.30)	(36.47)	(37.06)	(21.90)
Constant	Yes	Yes	Yes	Yes
Controls for Household Size	Yes	Yes	Yes	Yes
Controls for Education Level	Yes	Yes	Yes	Yes
Controls for Region	Yes	Yes	Yes	Yes
Interaction Time and Education	Yes	Yes	Yes	Yes
Interaction Time and Gender	Yes	Yes	Yes	Yes
Observations	171202	171202	171197	171061
R^2	0.327	0.421	0.435	0.287

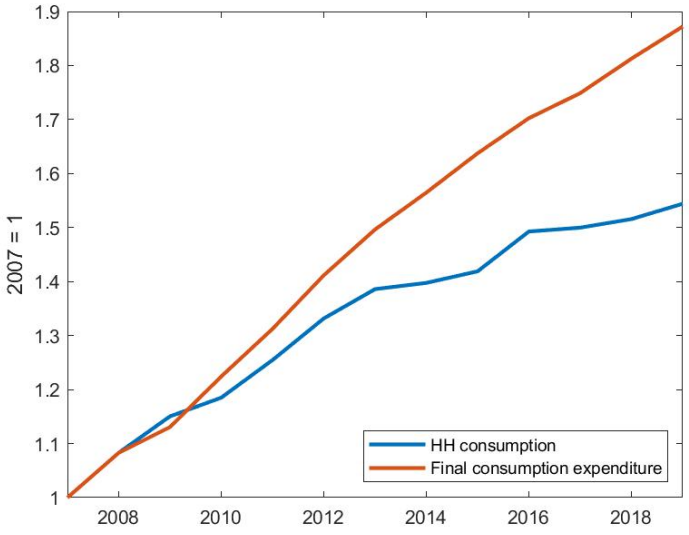
t statistics in parentheses

Period: 2007-2019. Least Squares Estimation. **,***: significant levels of 5%,1%.

Back

Macro vs Micro aggregates

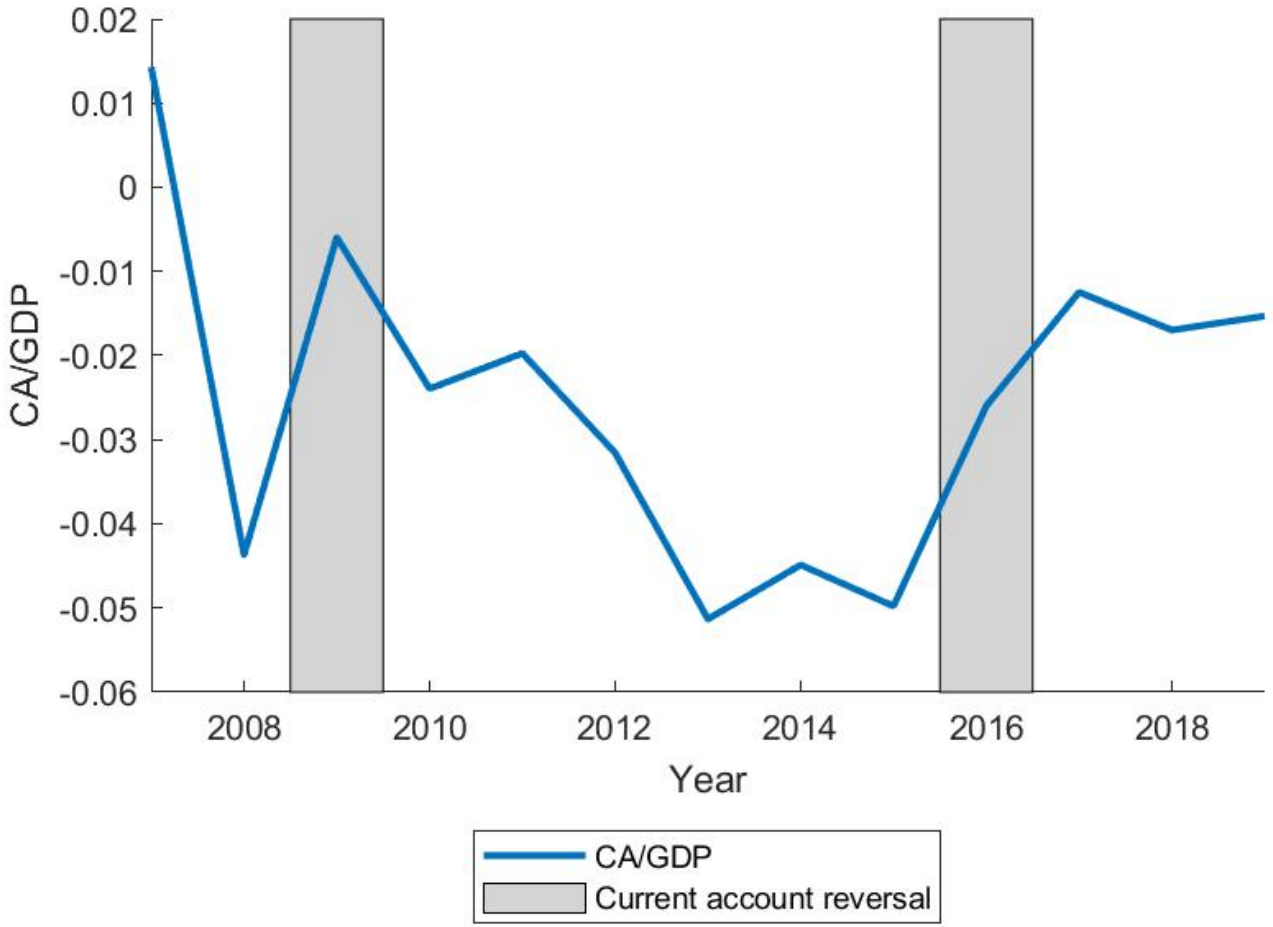




Source: IMF IFS, ENAHO, and ENIGH

Back

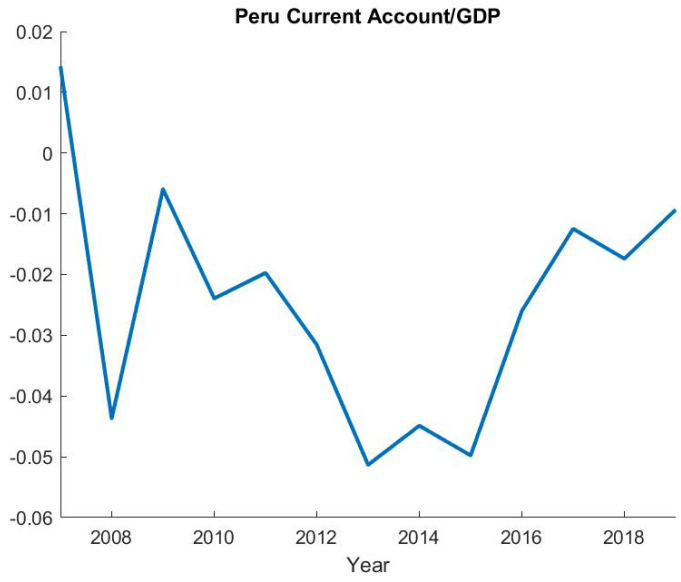
Current account reversals in Peru

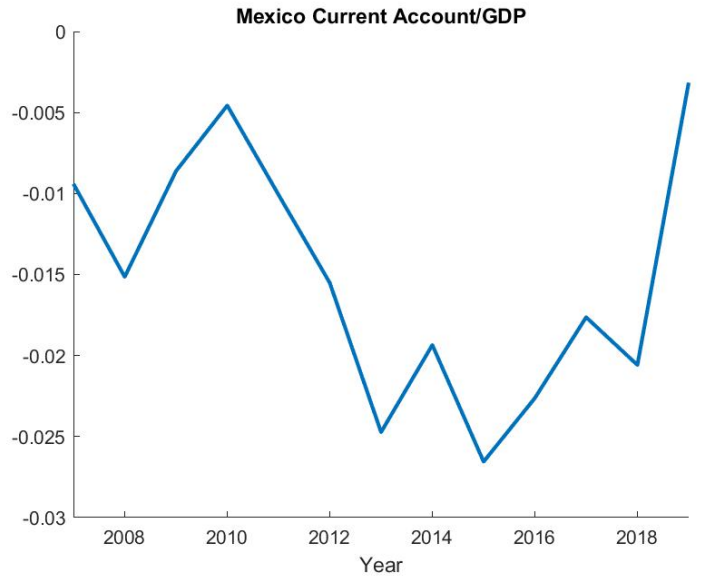


Source: IMF IFS

Back

Sudden stops in Peru and Italy

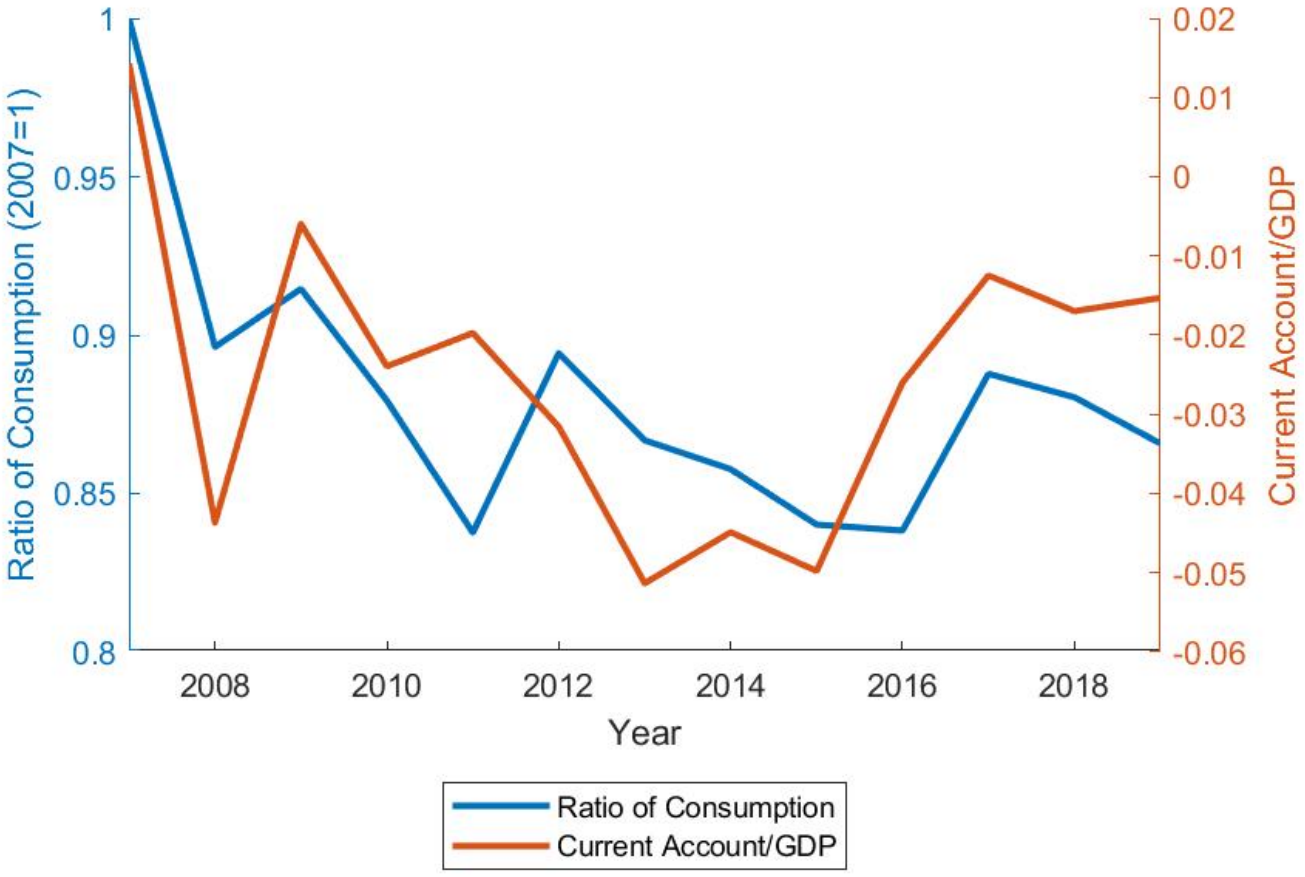




Source: IMF IFS

Back

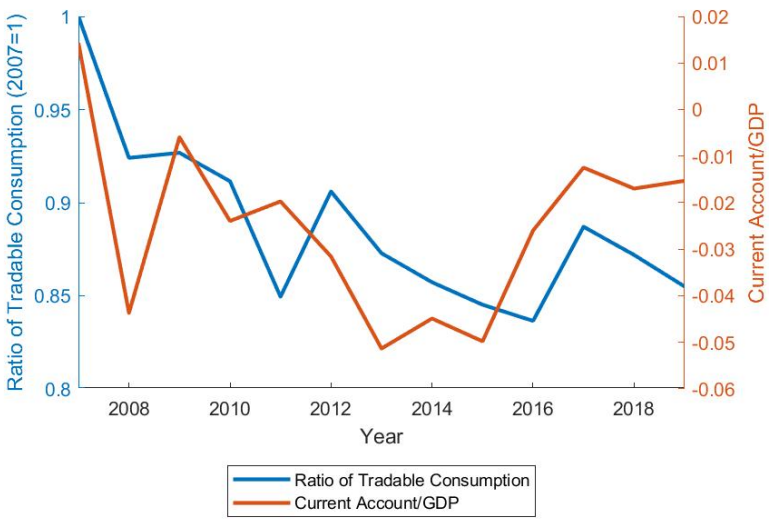
Peru: Consumption inequality and the current account

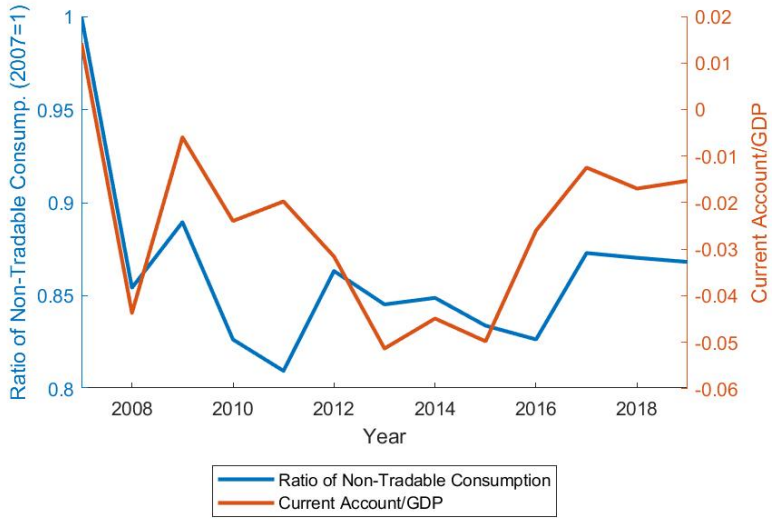


Source: Encuesta Nacional de Hogares (ENAHO) and IMF IFS

Back

Peru: Tradable and nontradable inequality





Source: Encuesta Nacional de Hogares (ENAHO) and IMF IFS

Back

Elasticity Estimation: Instruments

Instruments on expenditures

- Annual income after taxes
- Income quintile

Instruments on relative price

- Compute the average price for each category across regions excluding the own region
- Sectoral price for a region is constructed using the average region expenditure shares in each sub-component as weights

Back

Constrained-efficient version

Planner faces agg. state $S = (y^T, B_1, ..., B_F)$

$$V^{CE}(S) = \max_{\forall i \in \{1,..,F\} B_i', c_i^T, c_i^N} \sum_{i=1}^{F} \frac{1}{F} u(C(c_i^T, c_i^N)) + \beta \mathbb{E}[V^{CE}(S')]$$

subject to

$$\forall i \quad \underbrace{c_i^T + p^N c_i^N}_{\text{Consumption}} + \underbrace{B_i}_{\text{Current debt held by } i} = s_i \underbrace{(y^T + p^N y^N)}_{\text{Endowment share}} + q \underbrace{B_i'}_{\text{New debt issued}}$$

$$\forall i \quad \underbrace{qB_i'}_{\text{Market value of new debt}} \leq \kappa \; s_i \quad (y^T + p^N y^N)$$

$$p^N = f\left(\{C_i\}_{i=1}^F\right)$$

Where

$$S' = \mathcal{S}'\left(y^{T\prime}, \underbrace{B_1'(S), .., B_F'(S)}_{\text{Distribution of debt}}\right)$$

Back

General equilibrium objects

$$\bar{X} = \frac{1}{EC_{-i}} \left(\frac{\frac{dp^N}{dc_{-i}}}{\frac{dp^N}{dc_i}} \Psi_i c_i^{-\sigma} - \Psi_{-i} c_{-i}^{-\sigma}) \right)$$

$$\bar{Z} = \frac{EC_i}{EC_{-i}} \frac{\frac{dp^N}{dc_{-i}}}{\frac{dp^N}{dc_i}}$$

$$EP_i = (1-\omega)^{\frac{1}{1+\eta}} c_i^{\epsilon_N - \frac{1}{1+\eta}} E_i^{\frac{1}{1+\eta}} (p^N)^{\frac{-1}{1+\eta}}$$

$$EC_i = \frac{1}{\eta} E_i^{\frac{1}{1+\eta}} \left[\omega^{\frac{1}{1+\eta}} (\epsilon_T(1+\eta) - 1) c_i^{\epsilon_T - 1 - \frac{1}{1+\eta}} \right.$$
$$\left. + (1-\omega)^{\frac{1}{1+\eta}} (\epsilon_N(1+\eta) - 1) c_i^{\epsilon_N - 1 - \frac{1}{1+\eta}} (p^N)^{1-\frac{1}{1+\eta}} \right]$$

▸ Back

Constrained-efficient multiplier λ

Benchmark

$$\lambda_i = \frac{\frac{1}{\frac{dP^N}{dc_i}}\Psi_i c_i^{-\sigma} + \bar{X}\left(EP_{-i} - s_{-i}\right) + \kappa\left(\mu_i s_i + \mu_{-i} s_{-i}\right)}{\frac{EC_i}{\frac{dP^N}{dc_i}} + EP_i - s_i + \bar{Z}\left(EP_{-i} - s_{-i}\right)}$$

Homothetic preference

$$\lambda_i = \frac{\frac{1}{\frac{dP^N}{dc}}\Psi_i c_i^{-\sigma} + \bar{X}\left(EP_{-i} - s_{-i}\right) + \kappa\left(\mu_i s_i + \mu_{-i} s_{-i}\right)}{\frac{EC}{\frac{dP^N}{dc}}}$$

No inequality

$$\lambda = \frac{\frac{1}{\frac{dP^N}{dc}} c^{-\sigma} + \kappa\mu}{\frac{EC}{\frac{dP^N}{dc}} + EP - 1}$$

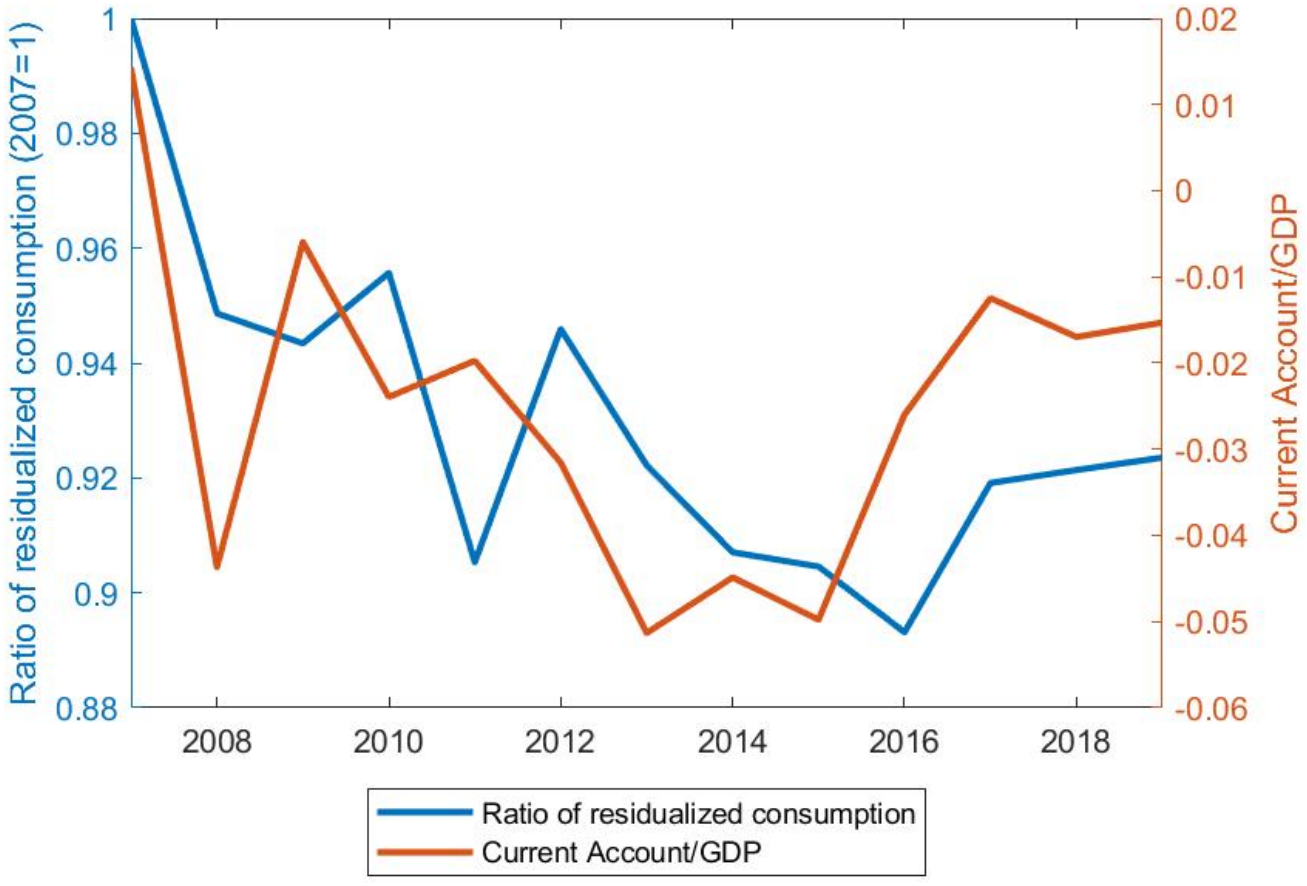
Back

Standard parameters

Parameter	Description	Value	Source
r^*	Risk-free rate	0.04	Standard literature value
σ	Risk aversion	2	Standard literature value
ρ_{y^T}	Tradable output persistence	0.53	Peruvian macro data
σ_{y^T}	Std. dev. of tradeable shock	0.047	Peruvian macro data

▸ Back

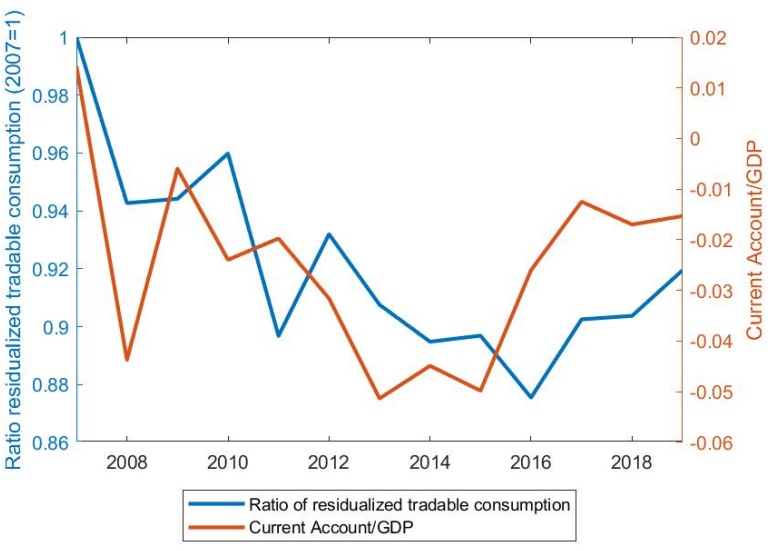
Peru: Consumption inequality and the current account

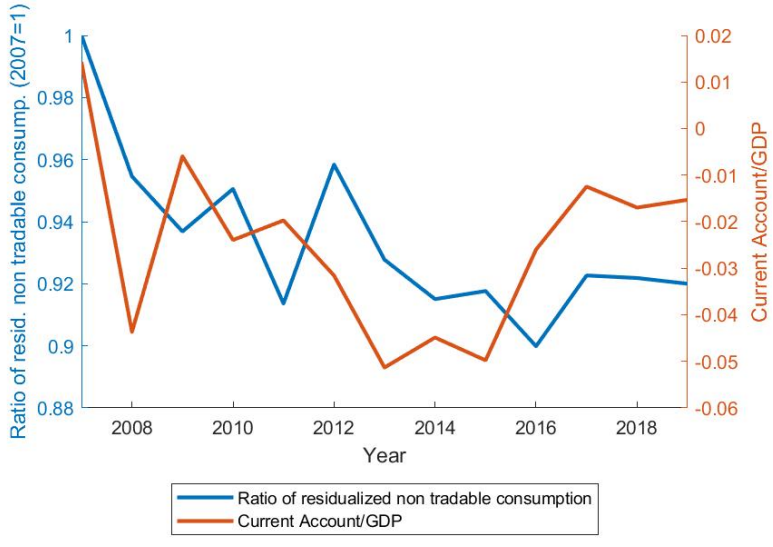


Source: Encuesta Nacional de Hogares (ENAHO), and IMF IFS

Nonresidualized Income Inequality Back

Peru: Tradable and nontradable inequality





Source: Encuesta Nacional de Hogares (ENAHO), and IMF IFS

Nonresidualized Back

Euler's equation

$$\lambda_i = \frac{\beta}{q}\mathbb{E}\left[\lambda_i^{'}\right] + \mu_i$$

- λ_i: multiplier on the agent's budget constraint
- μ_i: multiplier on the agent's credit constraint

Decentralized version

$$\lambda_i = \boldsymbol{c_i^{-\sigma}}$$

Constrained-efficient version

$$\lambda_i = \frac{\frac{1}{\frac{dP^N}{dc_i}}\Psi_i \boldsymbol{c_i^{-\sigma}} + \overbrace{\bar{X}}^{\text{redistribution: } \neq 0}\left(EP_{-i} - s_{-i}\right) + \kappa\left(\mu_i s_i + \mu_{-i} s_{-i}\right)}{\frac{EC_i}{\frac{dP^N}{dc_i}} + EP_i - s_i + \underbrace{\bar{Z}}_{\text{nonhomotheticity: } \neq 1}\left(EP_{-i} - s_{-i}\right)}$$

▸ General equilibrium objects ▸ Comparison ▸ Back

Hicksian approach

Household's i consumption Expenditures are defined as

$$E_i = c_i^T + p^N c_i^N$$

It can be shown that E_i can be rewritten in terms of the composite consumption C_i and the price of nontradables p^N:

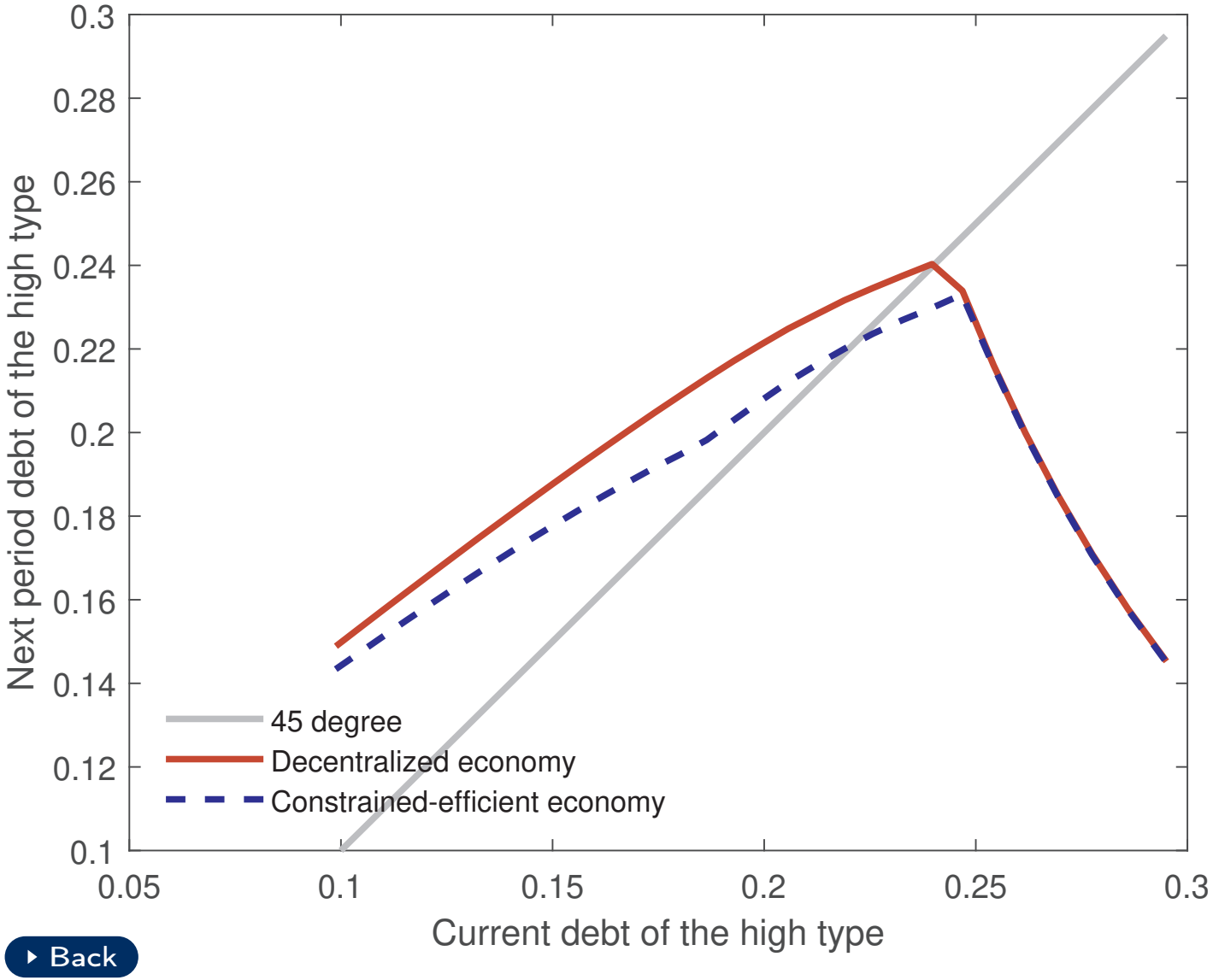
$$E_i = \left[\omega^{\frac{1}{1+\eta}} C_i^{\epsilon_T - \frac{1}{1+\eta}} + (1-\omega)^{\frac{1}{1+\eta}} C_i^{\epsilon_N - \frac{1}{1+\eta}} (p^N)^{\frac{\eta}{1+\eta}} \right]^{\frac{1+\eta}{\eta}}$$

Note that when preferences are homothetic

$$E_i = \underbrace{\left[\omega^{\frac{1}{1+\eta}} + (1-\omega)^{\frac{1}{1+\eta}} (p^N)^{\frac{\eta}{1+\eta}} \right]^{\frac{1+\eta}{\eta}}}_{\text{Shadow Price of Composite} \perp\!\!\!\perp i} C_i$$

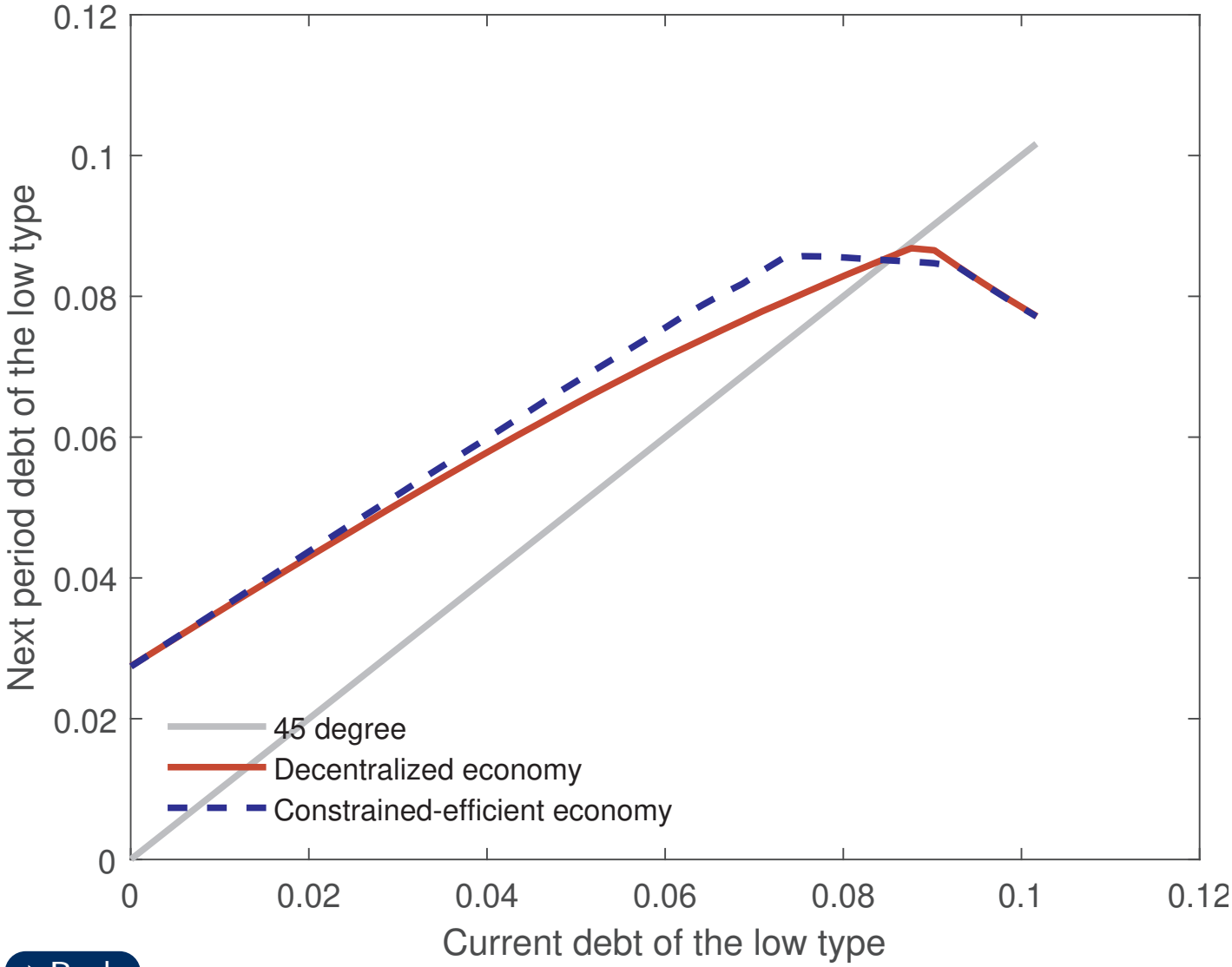
Back

Policy function of debt for the high type



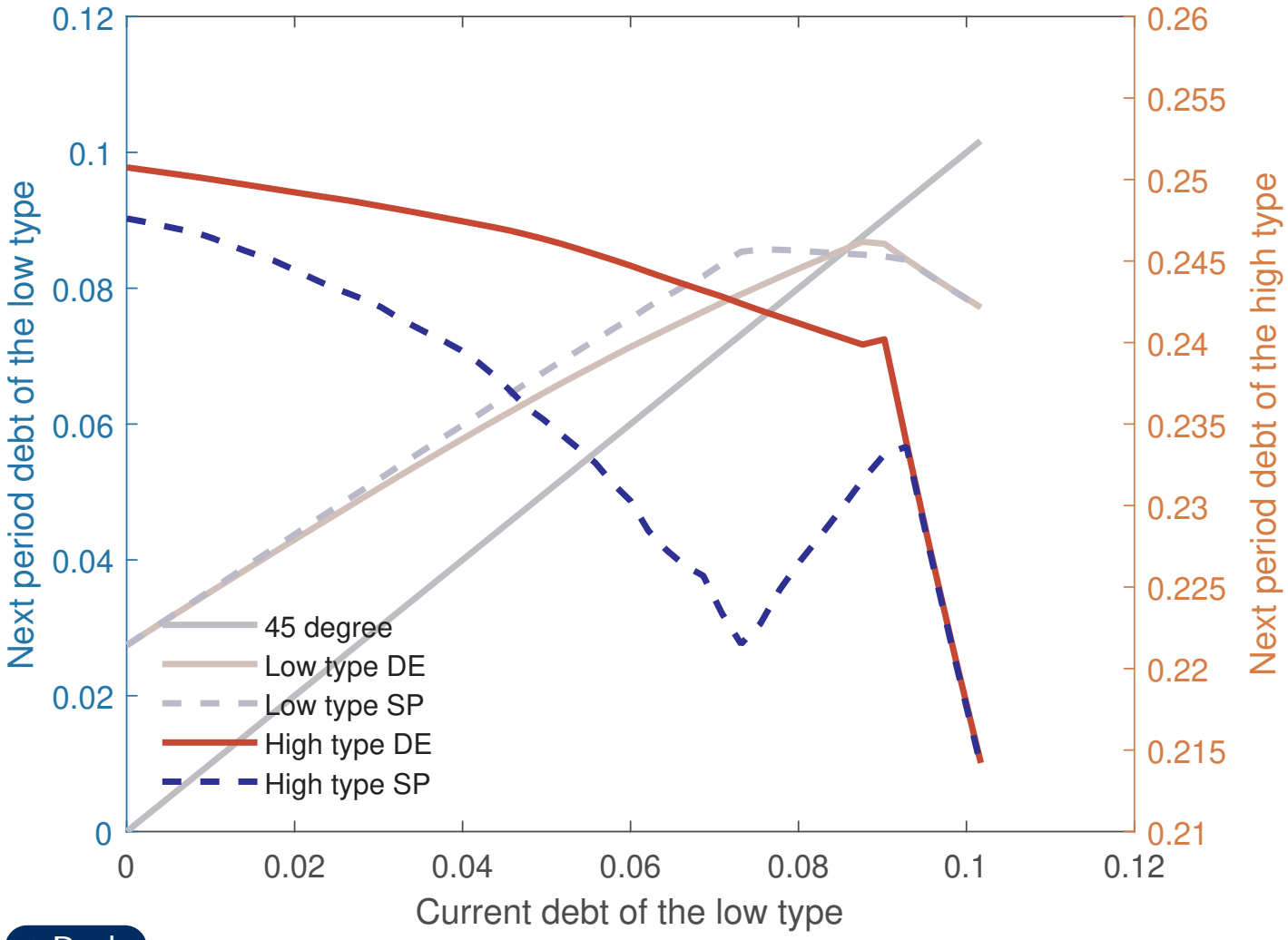
Back

Policy function of debt for the low type



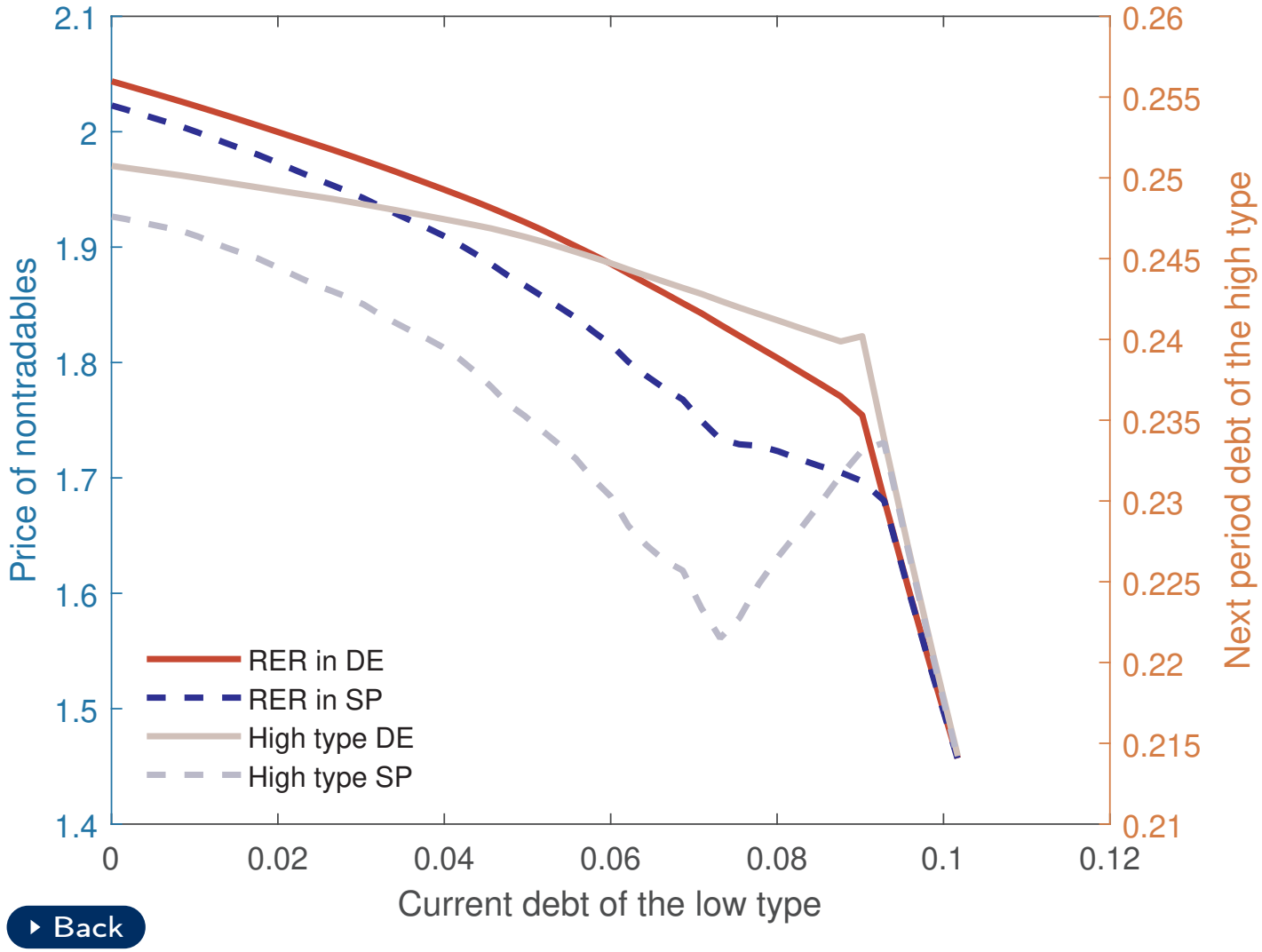
Back

Debt of the high type as a function the current debt of the low type



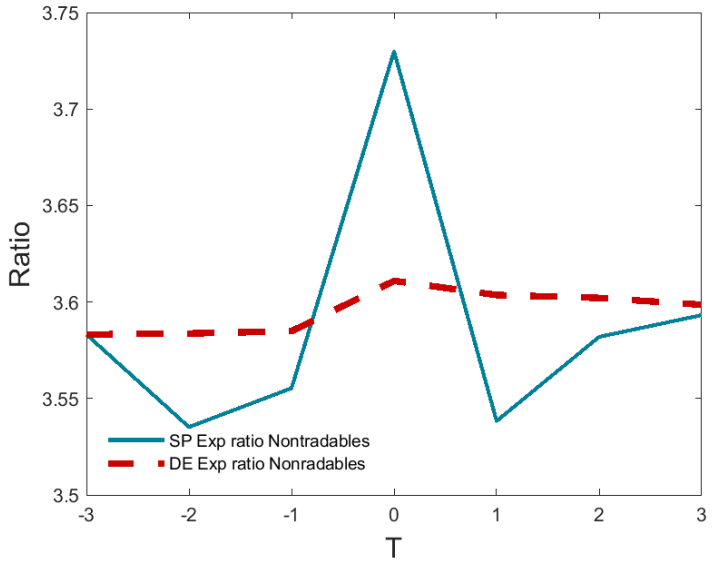
Back

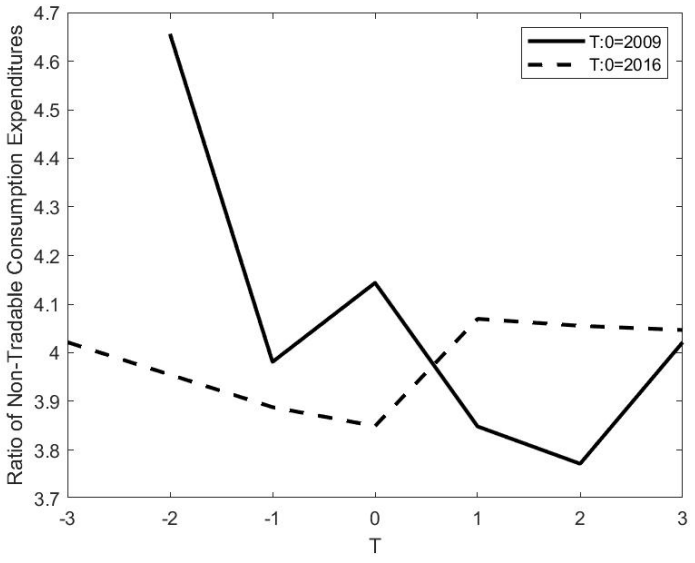
Relaxing the real exchange rate



Back

Nontradable expenditure inequality around a sudden stop

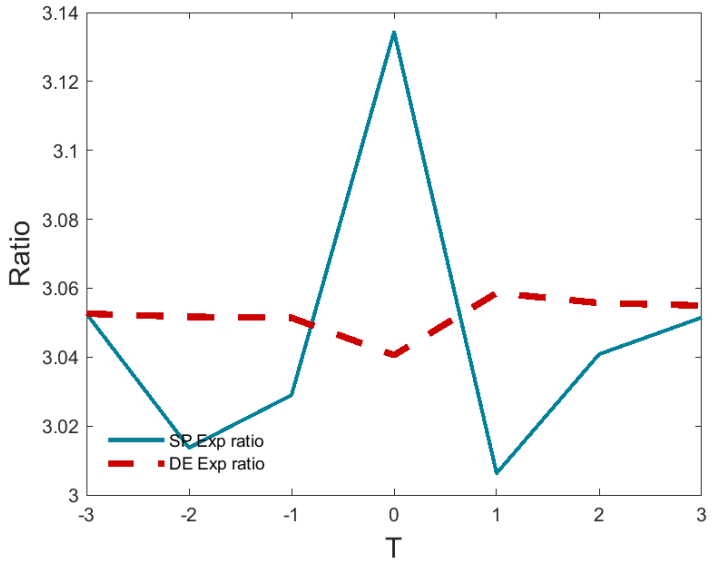


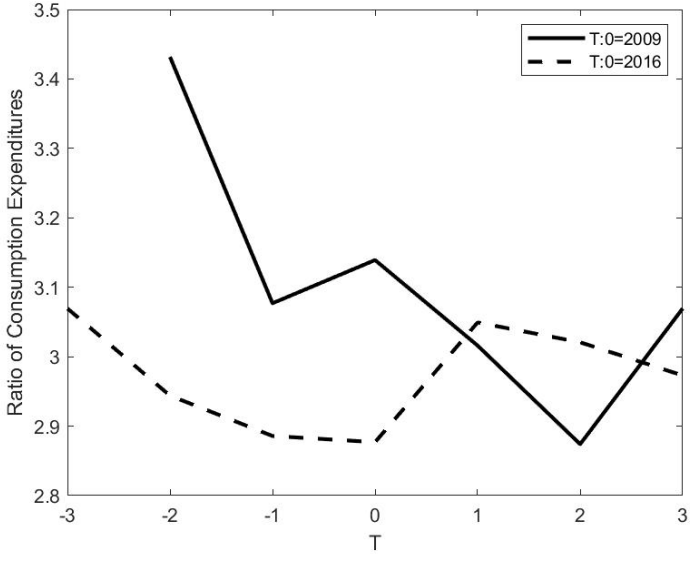


Back

Under laissez-faire expenditure inequality increases slightly. In the planned economy, large increase

Expenditure inequality around a sudden stop

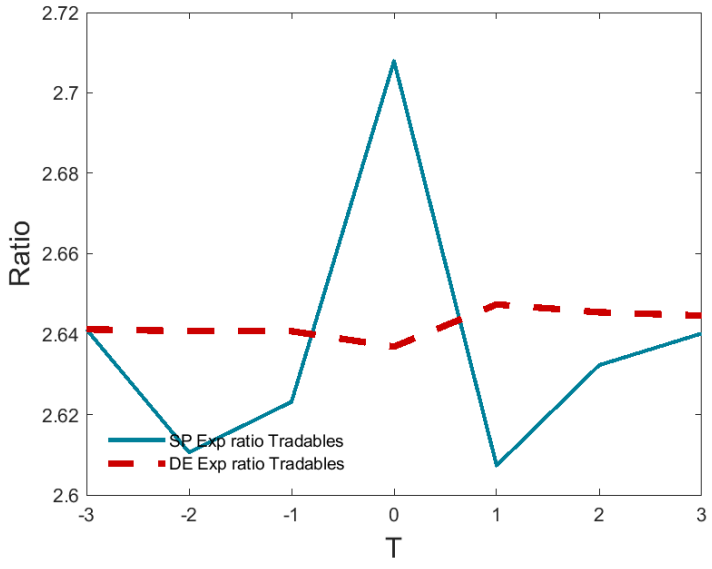


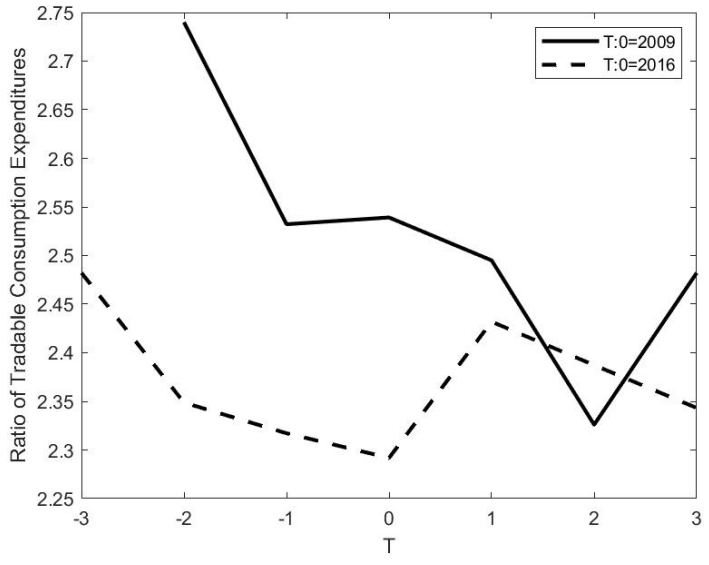


Back

Under laissez-faire expenditure inequality declines slightly. In the planned economy, large increase

Tradable expenditure inequality around a sudden stop





Back

Under laissez-faire expenditure inequality declines slightly. In the planned economy, large increase