The Role of Inequality in the Response of Consumption to a Credit Deepening

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Intro

Motivation

- Availability of credit has risen sharply over the past five decades
- Impacts macroeconomic fluctuations through *Household Demand* (credit to HHs) and *Productive Capacity* (credit to firms)

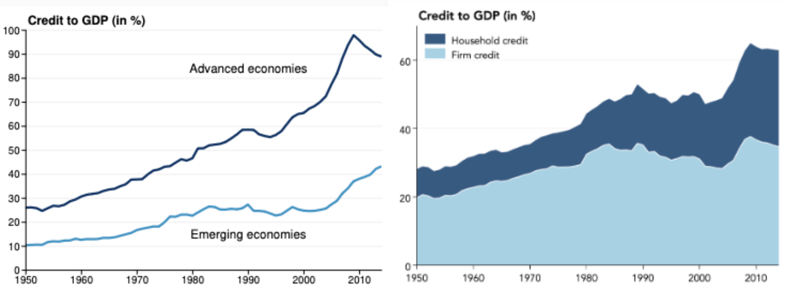

Figure 2: Data by Verner et al. (Forthcoming)

Motivation

- For the policymaker, importance of credit as tool for controlling growth through the Household Demand channel
- ... but also in terms of *macroprudential* policies, as credit expansions precede recessions
- However, Inequality may have an importance in the response of consumption to credit, as it impacts Household Demand
- Question: Does Inequality play a role in the response of consumption to more credit? If yes, which kind of inequality, through which channels it acts and how?

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What I do

1. Study the channels of credit to consumption and how they interact with different dimensions of inequality in a *Heterogeneous Agents* model:
    - **Income**: Fixed effects, permanent and transitory components
    - **Saving rates**: Preference heterogeneity
    - **Wealth**: Liquid asset
2. To make a quantitative assessment, calibrate the model with cross-country micro and macro data on Income and Wealth
3. To make a qualitative assessment, study the role of inequality on credit expansions through counterfactual exercises
4. Use panel data on household debt and aggregate consumption to validate model results empirically

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Preview of Results

1. MPCs matter: Consumption response to credit relief is mapped to MPC of HHs "corrected" by perpetual future consumption loss

2. And Inequality matters because MPCs matter:
   - All sources of Income inequality and different saving rates influence the MPCs of HHs, *but effects are scaled by wealth*
   - Wealth Inequality has major role as it **determines the distribution of MPCs and aggregate effects**

3. The aggregate response of consumption to credit can be decomposed in two channels, which are both amplified in the presence of higher wealth inequality
   - **Direct**: Partial Eq. response $\Rightarrow$ Amplifies "Booms and Busts"
   - **Indirect**: General Eq. response $\Rightarrow$ Reduces persistence of lower consumption

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Related Literature

- **Inequality and Household Heterogeneity**: D. Krueger et al. (2016); Carroll et al. (2017); Guvenen et al. (2021); Heathcote et al. (2009); Kaplan et al. (2022)

- **Inequality and Household Demand**: Auclert et al. (2020); Mian et al. (2021); Straub (2019); Kaplan et al (2017);

- **Household Finance, Credit and Debt**: Mian et al. (2017); Mian et al. (2020); Eggertson & Krugman (2012); Guerrieri & Lorenzoni (2017); Verner et al. (forthcoming); Schularick & Taylor (2012); Jordà et al. (2013)

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Credit to Households

Households

- Continuum of households with *discount rate heterogeneity* $j \in \mathcal{J}$ and *Income fixed effect* $i \in \mathcal{I}$

$$\mathbb{E}_0 \left[\int_0^\infty e^{-\rho_j t} u(c_t) dt \right]$$

- Face **idiosyncratic income risk** through income process, and **incomplete credit markets** given borrowing constraint
- Consume and supply labor inelastically for wage w_t
- Face labor income tax τ and receive cash transfers T_t
- Save in liquid assets a_t (capital), with budget constraint:

$$\begin{aligned} da_t &= \left((1-\tau)w_t z_t + r_t a_t - c_t + T_t\right) dt \\ a_t &\geq \underline{a} \\ z_t &\sim \text{Income Process} \end{aligned}$$

- Income process with FE, permanent and transitory components

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Credit and consumption at the micro level

- Credit Deepening: Defined as relaxing borrowing constraint $\underline{a}$
- Consumption of the HH is $c_{i,j,t}(a, z)$, given $\underline{a}$
- How much does the HH consume out of an infinitesimal increase in the supply of credit?

Proposition 1: Credit MPC

Maps HH marginal propensity to take credit and consume (Credit MPC) to a "corrected" iMPC

$$\frac{\partial c}{\partial \underline{a}} = iMPC - r\frac{\partial c}{\partial T}$$

where $iMPC = \frac{\partial c}{\partial a}$ is the iMPC of the HH, and T a lump-sum transfer

CMPC distribution

- Takeaway: iMPCs are the main drivers for HHs taking credit

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iMPCs and inequality

How each source of inequality affects iMPCs of agents? Proposition 2[1]

$$iMPC_{i,j}(a,z) \sim r + \frac{1}{\sqrt{2(a-\underline{a})}} \left[\underbrace{(\rho_j - r) \times IES \times \underline{c}(z)}_{\text{Backward looking}} + \underbrace{\frac{\mathcal{A}(u'(\underline{c}(z)))}{u''(\underline{c}(z))}}_{\text{Forward looking}} \right]^{1/2}$$

1. Fixed Effects in income and preference heterogeneity affect iMPCs of HHs through backward looking component
2. Permanent and Transitory Income inequality influences iMPCs through precautionary savings, conditional on relative position of the HH at the income distribution See how
3. **Wealth Inequality dominates**, as effects are conditional on asset holdings
4. Everything follows directly to credit MPCs

[1]Where $\mathcal{A}$ is the infinitesimal generator, IES the intertemporal elasticity of substitution and $\underline{c}(z) := c(\underline{a}, z)$

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Aggregation

Micro to Macro

- **Credit at Macro level**: Aggregate micro-level response given measure μ_t of HHs

$$C_t = \int c_{i,j,t}(a,z)d\mu_t$$
$$\Rightarrow \frac{\partial C_t}{\partial \underline{a}} = \int \frac{\partial c_{i,j,t}(a,z)}{\partial \underline{a}} d\mu_t$$

- Household Demand impact on consumption given a credit shock is driven (mainly) by:
  1. *Distribution of Credit MPCs* $\Leftrightarrow$ iMPCs
  2. *Wealth distribution*: $\uparrow$ Hand-to-Mouth HHs $\Rightarrow \uparrow$ Average Credit MPC
- Effects are conditional on prices $\Rightarrow$ Need for GE framework

General Equilibrium

Firm

- Hires capital and labor from households to supply final good

Government

- Taxes labor income and redistributes as cash transfers

Market clearing conditions:

- **Labor Market**: $L_t = \int z_t d\mu_t$
- **Gov. Budget constraint**: $\tau_t w_t L_t = \int T_t(a, z^P, z^T) d\mu_t$
- **Capital Markets**: $K_t = A_t = \int a_t d\mu_t$
- **Goods Market**: Clears by Walras' Law

Income-Wealth dynamics: see equations

Bringing the model to the data

Strategy

- **Goal**: Generate realistic wealth distribution
  - *Instrument 1*: Discount rate heterogeneity
  - *Instrument 2*: Income distribution with fat right-tail
  - *Instrument 3*: Income fixed effects
- **Assumptions**:
  1. **Pref. Heterogeneity**: Assume a β-dist model (Caroll et al, 2014)
  2. **Income distribution**: Log-productivity (income) is composed by fixed effects ω_i, permanent z_t^P and transitory z_t^T components:

$$\log z_{i,t} = \omega_i + z_t^P + z_t^T$$

     where z_t^P, z_t^T follow a jump-drift process:

$$dz_t^T = -\beta_T z_t^T dt + \eta_t dJ_{\eta,t} \quad \eta_t \sim \mathcal{N}(0, \sigma_\eta^2)$$
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Calibration

Methodology: Calibrate model to 12 countries matching moments of income and wealth distribution. MoM carried out in 2-steps: Overview

- *Step 1*: Calibrate income process parameters exogenously $\Theta = \{\beta_{z^P}, \beta_{z^T}, \sigma_\eta, \sigma_\varepsilon, \lambda_\varepsilon, \lambda_\eta\}$
- *Step 2*: Use $\hat{\Theta}$ to calculate steady-state and match other model parameters $\Omega = \{\underline{a}, \bar{\rho}, \nabla_1, \nabla_2, \tau\}$

	Scope	Description	Value (Brazil)	Source/Target
$1/\gamma$	Cross-country	IES	1	(Kaplan et al, 2018)
α	Cross-country	Capital share	0.33	(Kaplan et al, 2018)
δ	Cross-country	Depreciation rate	10% (p.a.)	Literature
Cross-Country parameters				
$\underline{a}$	Country specific	Borrowing Limit	-2.541	HH Debt-to-GDP
$\bar{\rho}$	Country specific	Avg. Discount Rate	0.074	Net Wealth to Income ratio
$\{\nabla_1, \nabla_2\}$	Country specific	Discount rate Heterogeneity	{0.0033, 0.002}	Wealth Quintiles
τ	Country specific	Labor Income Tax	21.7%	Cash transfers to GDP
β_{z^T}	Country specific	Persistence Transitory inc.	0.791	Log Earnings dist.
β_{z^P}	Country specific	Persistence Permanent inc.	0.002	Log Earnings dist.
λ_{z^P}	Country specific	Arrival rate Permanent	0.008	Log Earnings dist.
λ_{z^T}	Country specific	Arrival rate Transitory	0.177	Log Earnings dist.
σ_ε	Country specific	Variance Permanent	1.171	Log Earnings dist.
σ_η	Country specific	Variance Transitory	1.692	Log Earnings dist.

Earning dynamics

- Earning dynamics are *leptokurtic*: larger probability of small or extreme income changes than a normal distribution

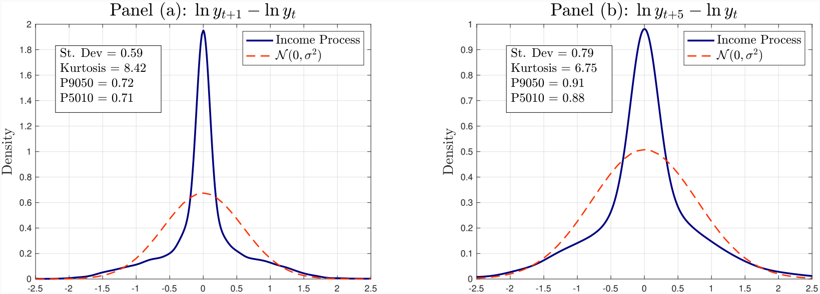
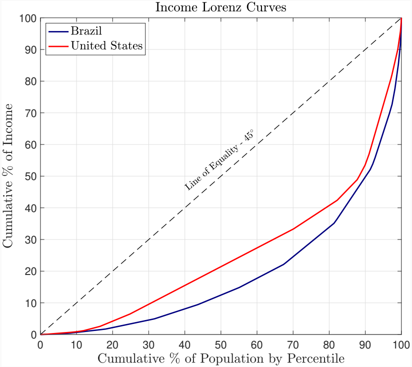


Figure 3: Distribution of 1 and 5 year log income changes calibrated with *RAIS* data

- Income distribution features high level of right-tail inequality, *consistent with data* (Guvenen et al, 2022) See Distribution

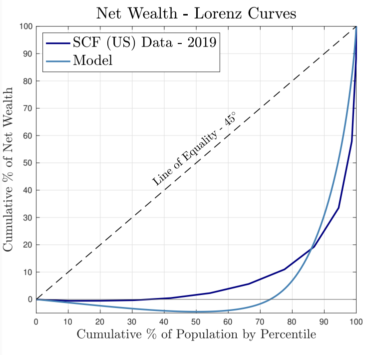
Targeted Moments: Income data

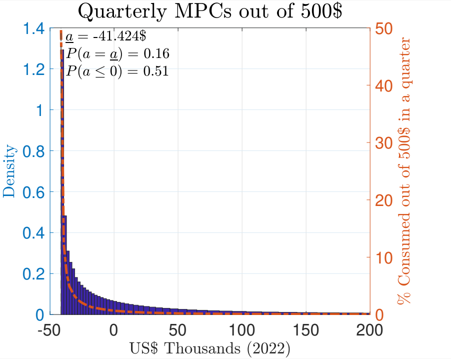


Targeted Moments	United States		Brazil	
	Model	Data	Model	Data
St. Dev. of Log Earnings	0.89	0.93	1.07	1.04
St. Dev. 1yr Log Earnings growth	0.48	0.56	0.59	0.68
St. Dev. 5yr Log Earnings growth	0.81	0.78	0.78	0.82
Kurt. 1yr Log Earnings growth	13.37	12.86	8.42	8.53
Kurt. 5yr Log Earnings growth	7.91	8.82	6.75	6.34
P9050 1yr Log Earnings growth	0.43	0.43	0.72	0.61
P5010 1yr Log Earnings growth	0.46	0.46	0.70	0.70
P9050 5yr Log Earnings growth	0.72	0.71	0.91	0.84
P5010 5yr Log Earnings growth	0.75	0.77	0.87	0.94
Untargeted Moment:				
Pre-tax Income Gini	0.46	0.47	0.58	0.55

Parameters   All countries

Targeted Moments: Wealth Data





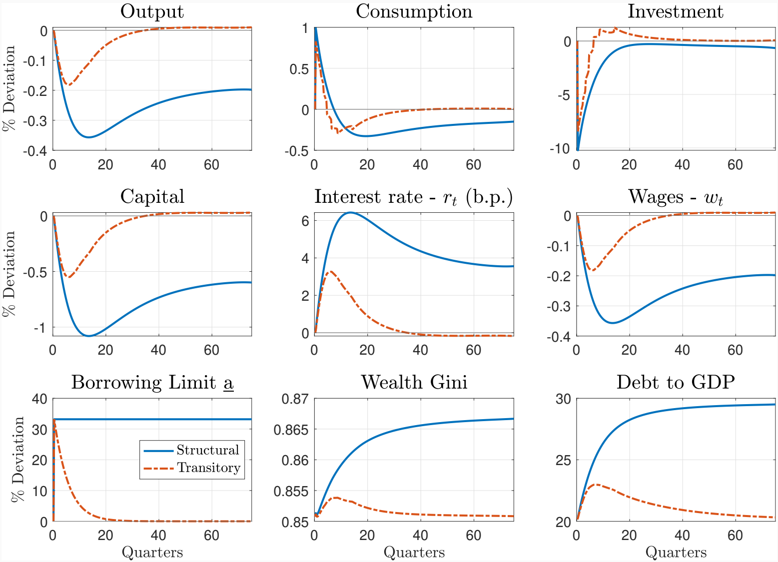
Targeted Moments	United States		Brazil	
	Model	Data	Model	Data
Mean Wealth to GDP ratio	5.16	4.88	3.79	3.61
$P0P20$	0	-1.54	-2.15	-2.14
$P20P40$	-3.99	0.35	-3.16	1.23
$P40P60$	-0.13	3.24	1.12	3.75
$P60P80$	10.14	12.06	11.98	9.50
$P80P100$	93.99	85.88	92.21	87.65
Cash transfers to GDP (%)	13.14	12.74	14.53	14.56
Household (unsecured) Debt-to-GDP	23.35	27.09	21.15	23.20

Computing MPC
All countries
Other moments

Quantitative Analysis

Credit Shock IRFs - Brazil

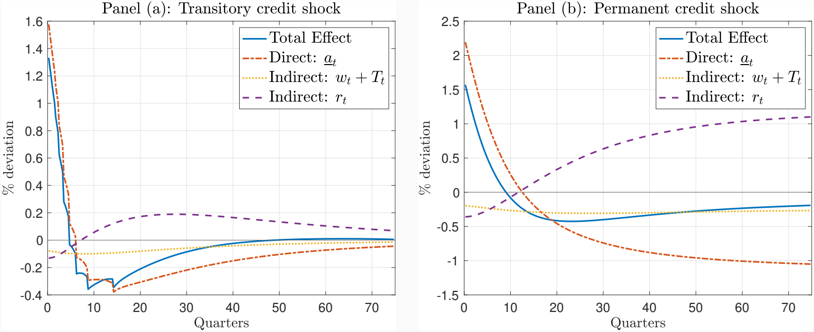
- Structural & Transitory MIT-Shock to borrowing constraint $\underline{a}$



Decomposition

Decomposing Partial and General equilibrium effects: Proposition 3

$$dC_0 = \underbrace{\int_0^\infty \frac{\partial C_0}{\partial \underline{a}_t} d\underline{a}_t dt}_{\text{PE direct effect}} + \underbrace{\int_0^\infty \left(\frac{\partial C_0}{\partial r_t} dr_t + \frac{\partial C_0}{\partial w_t} dw_t + \frac{\partial C_0}{\partial T_t} dT_t \right) dt}_{\text{GE indirect effects}}$$



Household demand channels of credit

- **Decomposition**: Maps household demand channels of credit

Direct Channel: PE response

1. Short-run C_t "Boom" through constrained HHs
2. Medium-run C_t "Bust" through "debt-overhang"
3. Slow HH deleverage induces persistent C_t slowdown

Indirect Channel: GE response through prices $\{r_t, w_t, T_t\}$

1. **Budget effect**: $\downarrow C_t$ as lowers available income
2. **Wealth effect**: $\downarrow C_t$ in short-run, $\uparrow C_t$ long-run. Composed by:
   - Income eff. of wealthy
   - Deleveraging of the poor

- **Role of Inequality**: Obtained simulating counterfactual credit expansions in economies with different initial wealth inequality

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- **Role of Inequality**: Obtained simulating counterfactual credit expansions in economies with different initial wealth inequality

Household demand channels of credit

- **Decomposition**: Maps household demand channels of credit

Direct Channel: PE response

1. Short-run C_t "Boom" through constrained HHs
2. Medium-run C_t "Bust" through "debt-overhang"
3. Slow HH deleverage induces persistent C_t slowdown

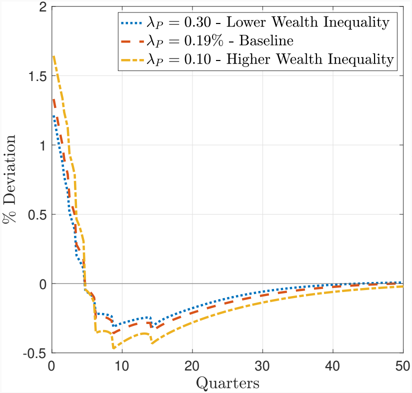
Indirect Channel: GE response through prices $\{r_t, w_t, T_t\}$

1. **Budget effect**: $\downarrow C_t$ as lowers available income
2. **Wealth effect**: $\downarrow C_t$ in short-run, $\uparrow C_t$ long-run. Composed by:
   - Income eff. of wealthy
   - Deleveraging of the poor

- **Role of Inequality**: Obtained simulating counterfactual credit expansions in economies with different initial wealth inequality

Counterfactual: Idiosyncratic permanent income risk

Idiosyncratic Income risk (z^P): More permanent income shocks (higher λ_P) means higher incentive for precautionary savings, reducing wealth inequality



Elasticity and decomposition of consumption response to a credit shock

	Wealth Ineq.	1yr	3yr	5yr	10yr	20yr
Elasticity of C_t	Higher	0.330	0.051	-0.012	-0.021	-0.017
	Baseline	0.240	0.035	-0.012	-0.013	-0.010
	Lower	0.206	0.027	-0.012	-0.010	-0.008
Contribution of each component (%)						
Direct Effect of $\underline{a}_t$	Higher	130	213	122	-237	-289
	Baseline	127	208	35	-231	-276
	Lower	125	207	-7	-226	-265
Indirect Effect of r_t	Higher	-14	-26	118	265	329
	Baseline	-14	-22	103	262	325
	Lower	-13	-18	92	260	319
Indirect Effect of $w_t + T_t$	Higher	-11	-82	-235	-134	-150
	Baseline	-11	-82	-234	-134	-150
	Lower	-11	-85	-183	-136	-154

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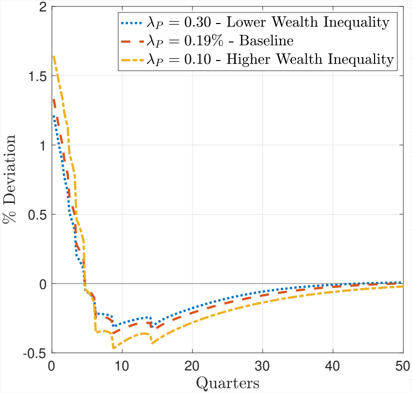

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Wealth Inequality and channels of credit

Wealth Inequality amplifies the elasticity of consumption to a credit shock, doing such through two channels:

1. **Direct channel**: $\uparrow$ Wealth Inequality $\Rightarrow$ $\uparrow$ HtM HHs $\Rightarrow$ $\uparrow$ Average Credit MPCs
   - *Short-run*: Amplifies "boom" as more HHs have bigger propensities to take credit
   - *Medium-run*: Amplifies "bust" as more HHs face debt-overhang
2. **Indirect channel**: $\uparrow$ Wealth Inequality $\Rightarrow$ amplifies elasticity of r_t to credit $\Rightarrow$ consumption "slump" becomes less persistent
   - It amplifies the *Wealth effect*
   - Stronger wealth effects imply stronger *Deleveraging effects*

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Empirical Evidence

Goal

1. Check whether short and long-run patterns of the model are present in the data
    - **Short-run "Boom" (2 $\sim$ 3 yrs)**: Consumption growth and debt overshoot
    - **Bust and debt overhang (> 4-5yrs)**: consumption "Bust" and slow deleveraging
2. See if "Boom & Bust" cycles amplify with inequality:
    - Does inequality amplifies the elasticity of consumption growth given a credit shock?

Data

- Panel data of 82 countries covering 1961-2021, with average time-span of 25.5 years
- **Issue**: Don't observe HH credit, use HH debt as observable instead
- **Dynamic Specification**: Estimate IRF of consumption following HH debt shock. Include $d^{HH}_{it-j} * g^{W,I}_{it-j}$ to capture role of inequality

Table 1: Summary Statistics of Sample

	Description	Source	N	Mean	St. Dev.	Min	Median	Max
d^{HH}	Household Debt to GDP	IMF Debt Db.	2,091	39.439	29.533	0.183	34.086	137.939
d^{F}	Firm Debt to GDP	IMF Debt Db.	2,091	71.124	51.299	1.094	64.615	566.649
g^{Inc}	Income Gini	SWIID	2,091	0.337	0.079	0.203	0.320	0.635
g^{W}	Wealth Gini	WID	1,713	0.757	0.067	0.577	0.744	1.002
c	Log Real Consumption	World Bank	2,005	27.285	2.830	21.065	27.216	36.343
y	Log Real GDP	World Bank	2,052	27.804	2.907	21.074	27.807	36.948

Full specification Robustness exercise

IRFs from Local Projections

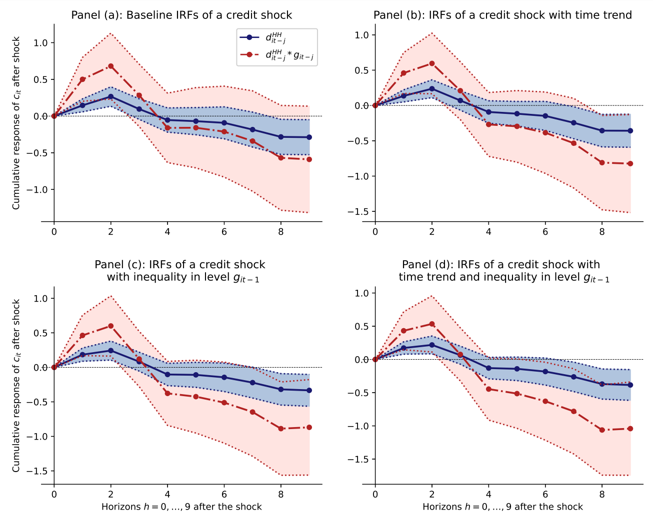

Figure 5: Consumption IRFs following a HH debt shock. Shaded regions correspond for 95% confidence intervals. Different panels include diverse controls for robustness exercises

Conclusion & Next Steps

Conclusion

- Income inequality or preference heterogeneity are of second order, wealth inequality is what really matters
- Wealth inequality has two roles in a credit deepening
    1. Amplifies the elasticity of consumption “Booms & Busts”
    2. Reduces persistence of HH demand “slump” in the long-run
- “Booms & Busts” are amplified through the direct channel of credit in HH demand
    1. Composed by aggregation of micro-level credit MPCs
    2. $\uparrow$ Wealth Inequality $\Rightarrow \uparrow$ HtM HHs $\Rightarrow \uparrow$ Aggregate credit MPCs
- Whereas consumption rebound happens through the indirect channel of credit, driven by wealth effects

Next Steps

- **Theoretical Part**: Some avenues for improvement
  1. Study if cheaper credit through borrowing spreads χ implies the same results
  2. Introduce simple Neo-Keynesian framework to study aggregate demand through household demand effects
  3. Fine tune wealth distribution calibration to enhance results
  4. Role of defaults in a credit expansion
- **Empirical part**: Work with state-dependent dynamic models to correctly specify the nonlinearity of the relationship
  1. STVAR (Auerbach et al, 2012)
  2. State-Dependent LPs (Tenreyro et al, 2016)

Appendix

Issues

First, acknowledge limitations and challenges of our current framework:

- One-asset framework fails to capture well wealth inequality, which is one of the key features of the model
- Fails to capture the correct dynamics of household demand in general equilibrium, as flexible prices make Household Demand and Aggregate demand disconnected
- Model cannot speak properly to Household debt as it is, would need to capture gross-asset positions
- Cross-country general equilibrium exercises are hard to rationalize

Overview of the Algorithm

I employ Guvenen's (2016) quasi-global optimization procedure, which consists of a Global and a Local stage, over which I evaluate a loss-function $\mathcal{L}$:

1. **Global stage**: Generate a quasi-random (sobol) sequence of guesses $S = \{\Theta_i\}_n$ and evaluate $\mathcal{L}(\Theta_i)\ \forall\ \Theta_i \in S$

$$\mathcal{L}(\Theta_i) = F(\Theta_i)' W F(\Theta_i)$$

   where $F_l(\Theta) = \frac{\hat{\mu}(\Theta)_l - \hat{\mu}_l}{\hat{\mu}_l}$ are the arc-percent deviations of simulated and targeted moments
2. **Local stage**: Take 5% best guesses and perform local search with Nelder-Mead algorithm:

$$\widehat{\Theta} = \arg\min_{\Theta} \mathcal{L}(\Theta)$$

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All countries: Targeted moments of Income Data

	Targeted Moments of the distribution of Log Earnings Growth								
	Standard Deviation			Kurtosis		P9050		P5010	
	$\Delta t = 0$	$\Delta t = 1$	$\Delta t = 5$	$\Delta t = 1$	$\Delta t = 5$	$\Delta t = 1$	$\Delta t = 5$	$\Delta t = 1$	$\Delta t = 5$
Argentina	0.992	0.622	0.824	10.472	7.262	0.517	0.855	0.512	0.814
Brazil	1.041	0.682	0.825	8.535	6.347	0.614	0.845	0.708	0.943
Canada	0.799	0.503	0.696	14.926	10.044	0.379	0.653	0.352	0.601
Denmark	0.581	0.407	0.561	17.634	11.622	0.255	0.447	0.246	0.430
France	0.671	0.453	0.579	15.863	11.682	0.254	0.422	0.258	0.447
Germany	0.767	0.384	0.533	17.803	11.210	0.241	0.454	0.183	0.382
Italy	0.775	0.448	0.560	16.980	13.323	0.260	0.434	0.233	0.386
Mexico	1.123	0.650	0.902	8.293	6.034	0.617	0.946	0.649	1.066
Norway	0.771	0.517	0.747	17.047	12.574	0.302	0.540	0.317	0.547
Sweden	0.603	0.425	0.604	15.522	10.070	0.300	0.520	0.278	0.496
Spain	0.776	0.482	0.681	14.084	9.152	0.333	0.514	0.329	0.731
US	0.937	0.567	0.785	12.865	8.827	0.437	0.716	0.461	0.771

Table 2: Targeted moments of the earning dynamics of the income process. We discretize the stationary distribution and simulate 5000 individuals over 20 quarters to obtain simulated counterparts of the empirical moments. All moments are sample averages

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All countries: Targeted moments of Wealth Data

	Wealth to Income Ratio	Wealth Shares per Quintile					Household Debt to GDP	Transfers to GDP
		$P0P20$	$P20P40$	$P40P60$	$P60P80$	$P80P100$		
Argentina	2.115	-0.011	0.024	0.067	0.147	0.773	-	-
Brazil	3.613	-0.021	0.012	0.038	0.095	0.877	23.20	14.565
Canada	5.255	-0.010	0.028	0.078	0.167	0.737	40.15	9.296
Denmark	4.676	0.002	0.014	0.060	0.205	0.718	21.16	16.755
France	6.090	0.004	0.021	0.078	0.166	0.731	25.91	18.359
Germany	5.221	-0.009	0.017	0.073	0.176	0.743	14.87	16.827
Italy	6.277	-0.013	0.033	0.082	0.185	0.713	21.72	17.563
Mexico	4.210	-0.022	0.012	0.037	0.094	0.879	-	2.085
Norway	6.371	-0.041	0.028	0.109	0.218	0.687	-	13.829
Spain	7.331	0.000	0.033	0.095	0.161	0.711	19.96	13.550
Sweden	3.288	-0.010	0.027	0.078	0.165	0.740	23.11	14.303
US	4.883	-0.015	0.004	0.032	0.121	0.859	27.09	12.774

Table 3: Targeted moments in the calibration of the steady state of the model. All series besides Household debt to GDP are sample averages of the available data. Household Debt to GDP stands for non-mortgage debt

back

Uncertainty Decomposition

$$\frac{1}{u''(\underline{c})}(\mathcal{A}u'(\underline{c}(z^T, z^P)) \approx \underbrace{\mu(z^T)\partial_{z^T} c + \mu(z^P)\partial_{z^P} c}_{\text{Persistence of income shocks}}$$

$$+ \underbrace{\lambda_\varepsilon \int_{-\infty}^{\infty} (\underline{c}(z^T, u) - \underline{c}(z^T, z^P))\phi_\varepsilon(u)du + \lambda_\eta \int_{-\infty}^{\infty} (\underline{c}(s, z^P) - \underline{c}(z^T, z^P))\phi_\eta(s)ds}_{\text{Potential consumption gains/losses of receiving an income shock}}$$

- **Persistence matters**: After a negative permanent income shock, HHs perceive higher future income sooner, reducing precautionary savings and increasing current consumption (and vice-versa).
- **So does frequency**: More shocks mean higher chance of being hit by a positive income shock for the poor, thus poorer HHs decrease precautionary savings to increase current consumption (and vice-versa)

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iMPCs and persistence of income shocks

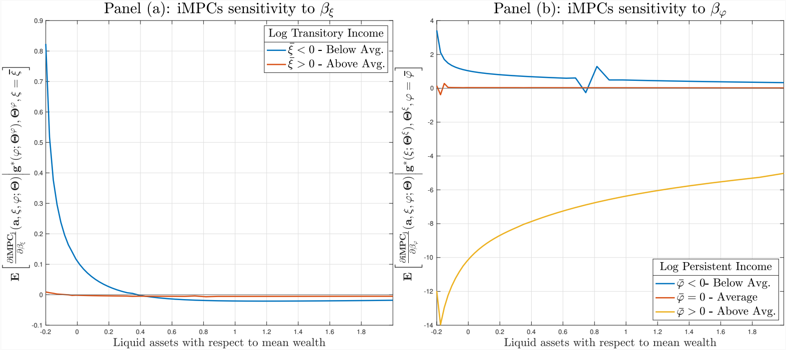

Figure 7: Panel (a) stands for the partial derivative of iMPCs with respect to mean-reverting parameter β_ξ, evalued at a fixed persistent income value $\bar{\xi}$ and weighted by the stationary distribution of $g^*(\phi;\Theta^\varphi)$; while in Panel (b), the same but for β_φ and weighted by the distribution $g^*(\xi;\Theta^\xi)$. The x-axis stands for the liquid wealth with respect to mean wealth of the distribution, $\mathbb{E}[a]$

iMPCs and Variance of income shocks

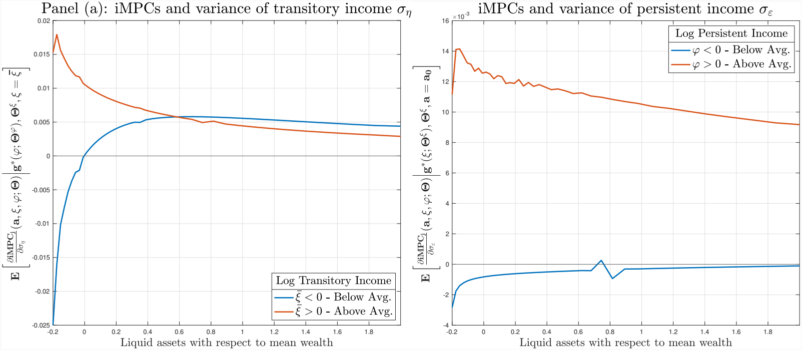

Figure 9: Panel (a) stands for the partial derivative of iMPCs with respect to variance of the amplitude of transitory shocks σ_η, evalued at a fixed persistent income value $\bar{\xi}$ and weighted by the stationary distribution of $g^*(\phi;\Theta^\varphi)$; while in Panel (b), the same but for σ_ε and weighted by the distribution $g^*(\xi;\Theta^\xi)$. The x-axis stands for the liquid wealth with respect to mean wealth of the distribution, $\mathbb{E}[a]$

iMPCs and Frequency of income shocks

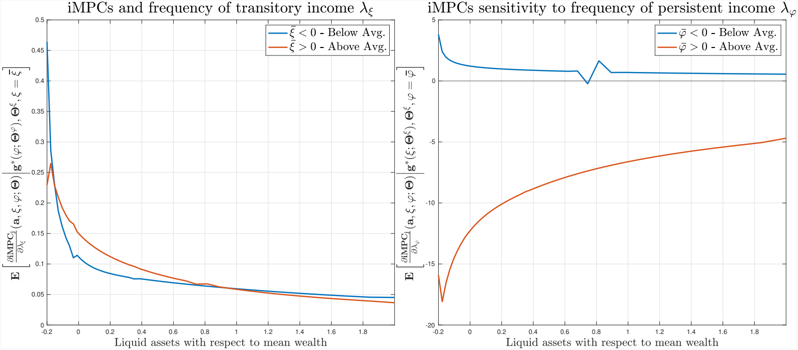

Figure 11: Panel (a) stands for the partial derivative of iMPCs with respect to the frequency of transitory shocks λ_ξ, evalued at a fixed persistent income value $\bar{\xi}$ and weighted by the stationary distribution of $g^*(\phi; \Theta^\varphi)$; while in Panel (b), the same but for λ_φ and weighted by the distribution $g^*(\xi; \Theta^\xi)$. The x-axis stands for the liquid wealth with respect to mean wealth of the distribution, $\mathbb{E}[a]$

Quarterly 500$ MPCs

Define consumption over a period τ as $\tilde{C}_{j,\tau}(a, z^P, z^T)$, such that:

$$\tilde{C}_{j,\tau}(a, z^P, z^T) = \mathbb{E}\left[\int_0^\tau c_j(a_t, z_t^P, z_t^T)dt \middle| a_0 = a, z_0^P = z^P, z_0^T = z^T\right]$$

The Quarterly MPC out of $x = 500\$$ transfer is defined as:

$$MPC_\tau^x = \frac{\tilde{C}_{j,\tau}(a + x, z^P, z^T) - \tilde{C}_{j,\tau}(a, z^P, z^T)}{x}$$

We compute $\tilde{C}_{j,\tau}(a, z^P, z^T)$ by the Feynman-Kac formula:

$$0 = c(a, z^P, z^T) + \mathcal{L}(a, z^P, z^T, 0)[\Gamma] + \partial_t \Gamma(a, z^P, z^T, 0)$$

where $\tilde{C}_{j,\tau}(a, z^P, z^T) = \Gamma(a, z^P, z^T, 0)$ Back

Mapping Assets to $ - Cross-country

Country	$\mathbb{E}[a]$	Avg. Net Personal Wealth	Asset to $	500$ in assets
Argentina	-	39,835 $	-	-
Brazil	15.57	50,071 $	3,216	0.16
Canada	-	266,053 $	-	-
Denmark	-	274,327 $	-	-
France	-	299,981 $	-	-
Germany	-	225,236 $	-	-
Italy	-	315,194 $	-	-
Mexico	-	71,199 $	-	-
Norway	-	192,022 $	-	-
Spain	-	290,060 $	-	-
Sweden	-	165,959 $	-	-
United States	19.54	351,262 $	17,976	0.03

Cross-country parameter estimates - Steady State

	Calibrated Steady State per country				
	ρ	∇_1	∇_2	τ	$\underline{a}$
Argentina	·	·	·	·	·
Brazil	0.0743	0.0033	0.0020	0.2170	-2.5414
Canada	·	·	·	·	·
Denmark	·	·	·	·	·
France	·	·	·	·	·
Germany	·	·	·	·	·
Italy	·	·	·	·	·
Mexico	·	·	·	·	·
Norway	·	·	·	·	·
Sweden	·	·	·	·	·
Spain	·	·	·	·	·
United States	0.0521	0.0065	0.0003	0.1962	-2.3044

Table 4: Estimated set of parameters $\hat{\Omega}$ for each of the countries

Cross-country parameter estimates - Income Process

	Calibrated Income Process per country					
	Persistence		Frequency		Variance	
	β_{z^T}	β_{z^P}	λ_{z^P}	λ_{z^T}	σ_{z^P}	σ_{z^T}
Argentina	0.6948	0.0184	0.0101	0.1752	0.9840	1.8053
Brazil	0.7910	0.0019	0.0082	0.1776	1.1716	1.6927
Canada	.	.	.	.	.	.
Denmark	0.0136	0.5415	0.1901	0.0169	0.6973	0.9557
France	0.0245	0.9771	0.0666	0.0147	1.3584	0.8556
Germany	.	.	.	.	.	.
Italy	0.0145	0.2981	0.1685	0.0046	1.8668	0.4494
Mexico	0.7487	0.0018	0.0087	0.1792	1.1874	1.7951
Norway	.	.	.	.	.	.
Sweden	.	.	.	.	.	.
Spain	0.0266	0.4396	0.1076	0.0371	0.6503	0.7762
United States	0.0115	0.5005	0.1978	0.0170	0.8164	1.0257

Table 5: Estimated set of parameters $\hat{\Theta}$ for each of the countries

Back

Evolution of Wealth-Income distribution

HJB equation: Given the current prices and state of the economy, how individuals make their decisions? **Backward-looking equation**

$$\rho_j V_{t,j}(x) = \max_{c \geq 0} \left\{ u(c) + \mathcal{L}(x, c; t)[V_{t,j}] + \frac{\partial V_{t,j}}{\partial t} \right\}$$

KF equation: Given decisions of agents, how does the income-wealth distribution evolves in time? **Forward-looking equation**

$$\frac{\partial g_t}{\partial t}(x) = \mathcal{L}^*(x, \hat{c}_t(x); t)[V_{t,j}]$$

where $x = (a, z^P, z^T)$ are households' idiosyncratic states; $\mathcal{L}$ the infinitesimal generator and $\mathcal{L}^*$ its adjoint operator Back

Credit MPC distribution

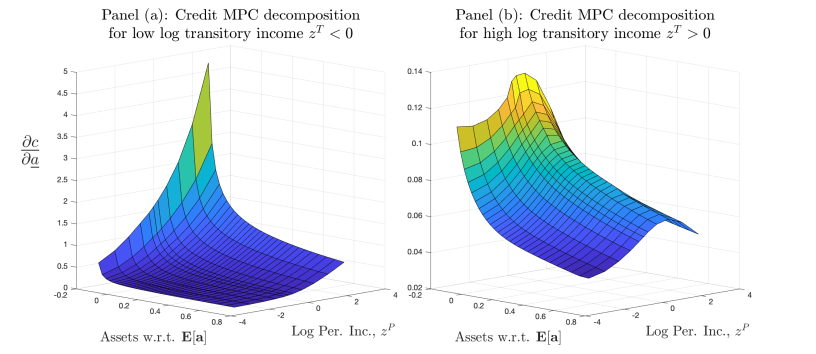

Figure 12: Distribution of Credit MPCs in the wealth $\times$ log permanent income plane for low ($z^T < 0$) and high ($z^T > 0$) transitory income

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Proposition 2

Proposition 2: Decomposing iMPCs (adapted Achdou et al, 2022)

As $a \to \underline{a}$, the iMPC of households' is asymptotically equivalent to:

$$iMPC_j(a, z^T, z^P) \sim r + \frac{1}{2}\sqrt{\frac{2\nu_j(z^T, z^P)}{a - \underline{a}}}$$

where $\nu_j(z^T, z^P)$ decomposes into its certainty and uncertain parts

$$\nu_{i,j}(z^T, z^P) = \underbrace{(\rho_j - r) \times IES \times \underline{c}(z^T, z^P)}_{\text{Certainty component}} + \underbrace{\frac{1}{u''(\underline{c}(z^T, z^P))}(\mathcal{A}u'(\underline{c}))}_{\text{Uncertainty component}}$$

where $\underline{c}(z) := c(z, \underline{a})$ and $\mathcal{A}$ is the infinitesimal generator

Back

Proposition 3

We observe Equilibrium outcome, but effect is a coupling of Partial and General Equilibrium effects. Can we dissect these?

Proposition 3 (adapted from Kaplan et al. (2018)):

Given a path of equilibrium objects $\{\Gamma_t\}_{t\geq 0} = \{\underline{a}_t, w_t, r_t, T_t\}_{t\geq 0}$, we decompose the consumption response to a credit deepening at t as:

$$dC_t = \underbrace{\int_t^{\infty} \frac{\partial C_t}{\partial \underline{a}_\tau} d\underline{a}_\tau d\tau}_{\text{Partial Equilibrium effect}} + \underbrace{\int_t^{\infty} \left(\frac{\partial C_t}{\partial r_\tau} dr_\tau + \frac{\partial C_t}{\partial w_\tau} dw_\tau + \frac{\partial C_t}{\partial T_\tau} dT_\tau \right) d\tau}_{\text{General equilibrium effects}}$$

Back

Cross-Country credit shock

- Employ a 50% increase to Household credit via borrowing constraint in the United States and Brazil
- Steady-State analysis of both countries to predict effects:

	$\mathbb{E}[MPC^{500\$}_{Qtr}]$	$\mathbb{E}[MPC^{500\$}_{Qtr} \mid a \leq 0]$	Indebted HHs	Gini	Eq. r^*_t	$\underline{a}$ in 2022 US$
Brazil	15.60	10.78	45.14 %	0.859	6.19 %	8.172
US	15.68	12.35	50.54 %	0.853	3.18 %	41.425

- Model implies similar overall inequality (Gini), but higher mass of indebted households because of the higher eq. r^*_t
- Credit expansion predictions: Credit “Boom & Bust” will be more amplified in the United States than in Brazil

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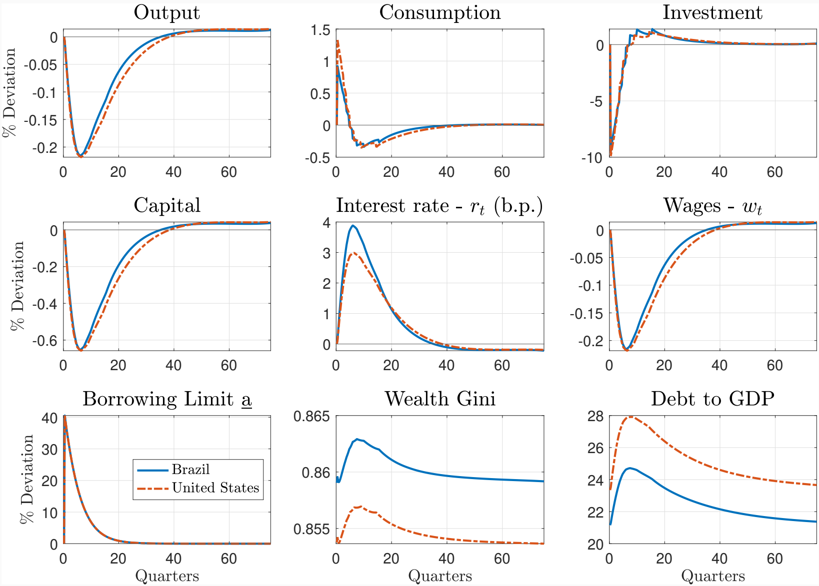
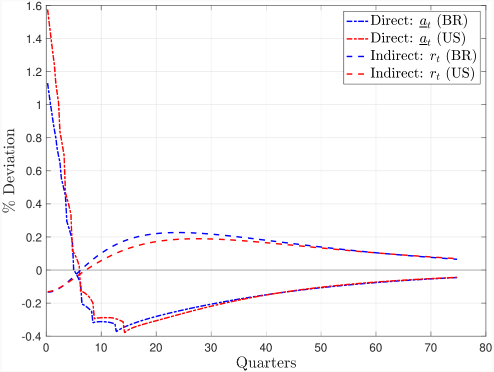
Cross-country credit expansion



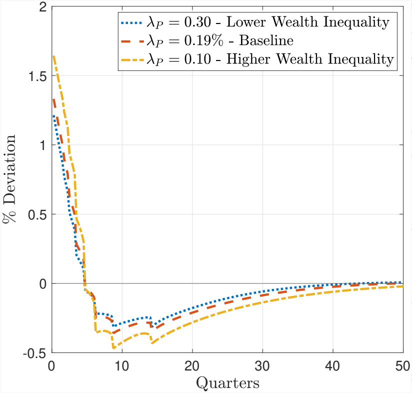
Decomposing Cross-Country Credit expansion

- Higher $\mathbb{E}[MPC^{500\$}_{Qtr} | a \leq 0]$ and share of indebted households in the US predicts higher PE effect in the short run
- However, wealth effects are higher in Brazil due to higher share of households with positive asset holdings. Thus, consumption rebounds faster in Brazil



Counterfactual: Idiosyncratic permanent income risk

Idiosyncratic Income risk (z^P): More permanent income shocks (higher λ_P) means higher incentive for precautionary savings, reducing wealth inequality



Elasticity and decomposition of consumption response to a credit shock						
	Arrival rate λ_P	1yr	3yr	5yr	10yr	20yr
Elasticity of C_t	0.100	0.330	0.051	-0.012	-0.021	-0.017
	0.197	0.240	0.035	-0.012	-0.013	-0.010
	0.300	0.206	0.027	-0.012	-0.010	-0.008
Contribution of each component (%)						
Direct Effect of $\underline{a}_t$	0.100	130	213	122	-237	-289
	0.197	127	208	35	-231	-276
	0.300	125	207	-7	-226	-265
Indirect Effect of r_t	0.100	-14	-26	118	265	329
	0.197	-14	-22	103	262	325
	0.300	-13	-18	92	260	319
Indirect Effect of $w_t + T_t$	0.100	-11	-82	-235	-134	-150
	0.197	-11	-82	-234	-134	-150
	0.300	-11	-85	-183	-136	-154

Full Dynamic relationship

- **Dynamic Specification**: Following Mian et al. (2017), we employ Local Projections (Jordà, 2003)
- Estimate IRF of consumption to HH debt shock up to 9 periods ahead:

$$c_{it+h-1} = \alpha_i^h + X_{it-1}\Gamma^h + \sum_{j=1}^{p} \beta_{\theta,j}^h d_{it-j}^{\theta} + \sum_{j=1}^{p} \beta_{F,j}^h d_{it-j}^{F} + \sum_{j=1}^{p} \delta_j^h c_{it-j} + \epsilon_{it+h-1}^h$$

α_i^h individual effects and X_{it-1} controls

- $d_{it-j}^{HH} * g_{it-j}^{W,I}$ captures the nonlinear effect of inequality given HH debt shock

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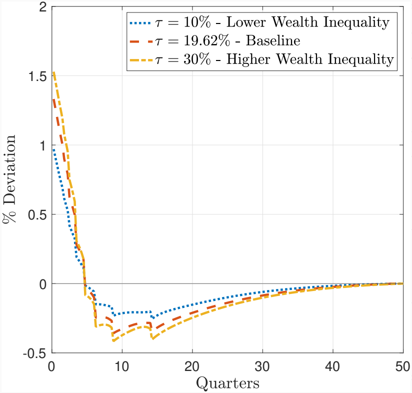
Counterfactual: Fiscal Policy

Taxes & transfers: A more progressive FP (higher τ & T) gives less incentives for precautionary savings, increasing wealth inequality



Elasticity and decomposition of consumption response to a credit shock						
	Tax rate τ	1yr	3yr	5yr	10yr	20yr
Elasticity of C_t	10%	0.166	0.026	-0.008	-0.009	-0.007
	19.46%	0.240	0.035	-0.012	-0.013	-0.010
	30%	0.283	0.040	-0.014	-0.016	-0.012
Contribution of each component (%)						
Direct Effect of $\underline{a}_t$	10%	125	196	33	-214	-251
	19.46%	127	208	35	-231	-276
	30%	128	216	40	-247	-300
Indirect Effect of r_t	10%	-13	-20	105	246	299
	19.46%	-14	-22	103	262	325
	30%	-15	-25	100	278	350
Indirect Effect of $w_t + T_t$	10%	-11	-74	-239	-133	-148
	19.46%	-11	-82	-234	-134	-150
	30%	-12	-87	-238	-134	-150

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Reduced Form

- Robustness exercise, employing 3-year windows to predict growth trends (as suggested by model)

$$\Delta_3 c_{it+k} = \alpha_i + \beta_{\theta,k}\Delta_3 d^{\theta}_{it-1} + \beta_{F,k}\Delta_3 d^{F}_{it-1} + X_{it-1}\Gamma_k + u_{it+k}$$

  α_i individual effects and X_{it-1} controls

- $d^{HH}_{it-j} * g_{it-j}$ captures the nonlinear effect of inequality on consumption growth trends

Reduced Form results

	Dependent variable: $\Delta_3 c_{it+k}, k = -1, 0, \ldots, 5$											
	$\Delta_3 c_{it-1} = c_{it-1} - c_{it-4}$				$\Delta_3 c_{it+2} = c_{it+2} - c_{it-1}$				$\Delta_3 c_{it+5} = c_{it+5} - c_{it+2}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\Delta_3 d^{HH}_{it-1}$	0.231**	0.254***		0.290	−0.067†	−0.061		−0.013	−0.117*	−0.130**		−0.067*
	(0.056)	(0.056)		(0.272)	(0.038)	(0.039)		(0.199)	(0.199)	(0.199)		(0.199)
$\Delta_3 d^{HH}_{it-1} * g_{it-4}$			0.783***	−0.092			−0.171	−0.129			−0.411**	−0.207
			(0.811)	(0.811)			(0.115)	(0.566)			(0.139)	(0.566)
$\Delta_3 d^{F}_{it-1}$	−0.007	−0.010	−0.003	−0.006	−0.037***	−0.038***	−0.039***	−0.039***	−0.021**	−0.020**	−0.021**	−0.020**
	(0.013)	(0.013)	(0.178)	(0.014)	(0.008)	(0.008)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)	(0.007)
g_{it-4}		0.058	0.085	0.097		0.071	0.071	0.070		−0.058	−0.053	−0.054
		(0.186)	(0.178)	(0.175)		(0.237)	(0.238)	(0.239)		(0.252)	(0.251)	(0.252)
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.030	0.043	0.049	0.047	0.029	0.033	0.039	0.018	0.023	0.027	0.029	0.019
Observations	1969	1880	1770	1770	1846	1772	1722	1722	1638	1581	1555	1555

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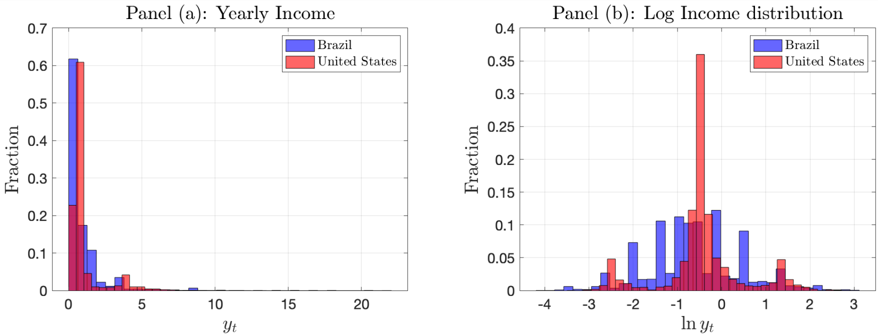
Calibrated Income Distribution



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