Distributive Effects of Banking Sector Losses

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Motivation: Unequal Effects of Bank Distress

- **disruptions in the banking sector** have significant real effects
  - transmission via interest rates, spreads, asset prices

- households exposed in **heterogeneous** ways
  - portfolio composition (e.g. borrowers vs. savers)
  - income sources (e.g. labor vs. financial)

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- households exposed in **heterogeneous** ways
  - portfolio composition (e.g. borrowers vs. savers)
  - income sources (e.g. labor vs. financial)
- understanding heterogeneous effects is a prerequisite for **policy design**
  - *Who benefits from government support to banks in crisis?*

Who bears the costs from banking sector losses?

This Paper

Quantitative **heterogeneous agent** model with a **banking sector**

- HHs: idiosyncratic risk, hold (liquid) deposits & (illiquid) capital (Kaplan and Violante, 2014)
- banks: leverage constraint, intermediate deposits/capital/loans (Gertler and Karadi, 2011)

$\Rightarrow$ micro-founded supply of deposits, explicit **liquidity transformation**

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Bank distress: simulate surprise decline in return on banks' assets

- **consumption response** decreases in income (in line with **empirical evidence**)
- **channels:** low-income respond to earnings & borrowing cost, high-income to asset returns
- welfare more unequal: high-income **gain** from lower asset prices & high returns

Related Literature and Contribution

- **financial recessions**
  Gertler and Kiyotaki (2010), Gertler and Karadi (2011), Jermann and Quadrini (2012), Brunnermeier and Sannikov (2014), He and Krishnamurthy (2019), Iacoviello (2015), Mendicino et al. (2020), Baron et al. (2021), ...

  $\Rightarrow$ **distributive effects**

- **inequality and aggregate shocks**
  Krusell and Smith (1998), Krueger et al. (2016), , Gornemann et al. (2016), Guerrieri and Lorenzoni (2017), Coibion et al. (2017), Kaplan et al. (2018), Bayer et al. (2019), Cloyne et al. (2020), Antunes et al. (2020), Glover et al. (2020), ...

  $\Rightarrow$ **isolate bank loss channel, endogenous transmission of financial shocks**

- **intermediation frictions and heterogeneous HHs**
  Fernández-Villaverde et al. (2019), Arslan et al. (2020), Lee et al. (2021), Schroth (2021), Ferrante and Gornemann (2021)

  $\Rightarrow$ **portfolio choice (liquid vs. illiquid assets), micro-founded demand for deposits**

A Heterogeneous Agent Economy with a Banking Sector

Model Setup: Households

- stochastic idiosyncratic **income**
  - (cyclical) labor income risk $w_t\gamma(z_t, Y_t)z_t$
  - dividend income div_t for top 1% ($z_t = z^*$)

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  - (cyclical) labor income risk $w_t \gamma(z_t, Y_t) z_t$
  - dividend income div_t for top 1% ($z_t = z^*$)
- save/borrow in (intermediated) **liquid** asset a_{t+1} at rate $r_t^{HH}(a_t, z_t)$
  - **deposit** rate if $a_t \geq 0$: $r_t^{HH}(a_t, z_t) = r_t^D$
  - **borrowing** rate if $a_t < 0$: $r_t^{HH}(a_t, z_t) = r_t^L + \tau(z_t)$

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  - **borrowing** rate if $a_t < 0$: $r_t^{HH}(a_t, z_t) = r_t^L + \tau(z_t)$
- save in **illiquid** asset k_{t+1} with stochastic utility cost of adjustment η_t

$$V_t(a_t, k_t, z_t, \eta_t) = \max \left[\underbrace{V_t^a(a_t, k_t, z_t) - \eta_t}_{\text{adjust}}, \underbrace{V_t^n(a_t, k_t, z_t)}_{\text{do not adjust}} \right]$$

Model Setup: Households

- non-adjusting household: $\mathbf{k_{t+1} = k_t}$

$$V_t^n(a_t, \mathbf{k_t}, z_t) = \max_{\substack{c_t \geq 0 \\ a_{t+1} \geq \underline{a}}} \left\{ u(c_t) + \beta \, \mathbb{E}_t V_{t+1}(a_{t+1}, \mathbf{k_t}, z_{t+1}, \eta_{t+1}) \right\}$$

$$s.t. \;\; c_t + a_{t+1} \leq (1 + r_t^{HH}(a_t, z_t))a_t + (r_t^K - \delta q_t)k_t + w_t \gamma(z_t, Y_t) z_t + \mathbb{I}_{z_t = z^*} div_t$$

- adjusting household: $\mathbf{k_{t+1} \geq 0}$

$$V_t^a(a_t, k_t, z_t) = \max_{\substack{c_t \geq 0 \\ a_{t+1} \geq \underline{a} \\ k_{t+1} \geq 0}} \left\{ u(c_t) + \beta \, \mathbb{E}_t V_{t+1}(a_{t+1}, \mathbf{k_{t+1}}, z_{t+1}, \eta_{t+1}) \right\}$$

$$s.t. \;\; c_t + a_{t+1} + q_t \mathbf{k_{t+1}} \leq (1 + r_t^{HH}(a_t, z_t))a_t + (r_t^K + (1 - \delta)q_t)k_t + w_t \gamma(z_t, Y_t) z_t + \mathbb{I}_{z = z^*} div_t$$

Model Setup: Banks

- following Gertler and Karadi (2011)
- bankers exit stochastically & distribute **equity** e_t with probability $\theta \Rightarrow$ dividend to HHs
- maximize expected payout by choosing deposits d_t, loans l_t, capital k_t^B
- subject to **incentive and balance sheet constraints**

$$
\begin{aligned}
v_t^B = \max_{k_t^b, l_t, d_t} \; & (1-\theta)\mathbb{E}_t \sum_{j=0}^{\infty} \theta^j \beta^{j+1} e_{t+j+1} \\
s.t. \;\; & q_t k_t^b + l_t = d_t + e_t \\
& e_t = (\xi_t^B r_t^K + (1-\delta) q_t) k_{t-1}^b + (1 + r_t^L) l_{t-1} - (1 + r_t^D) d_{t-1} \\
& v_t^B \geq \chi (q_t k_t^b + l_t)
\end{aligned}
$$

$\Rightarrow$ no arbitrage: $\mathbb{E}\frac{(\xi_t^B r_t^K + (1-\delta) q_t)}{q_{t-1}} - 1 = r_t^L$, binding incentive constraint: $r_t^D < r_t^L$

Model Setup: Supply

- **intermediate goods producer**

$$Y_t^I = A_t K_t^{\alpha} N_t^{1-\alpha} \qquad K_t = K_t^{HH} + \xi_t^B K_t^B$$

  - rent capital from households K_t^{HH} and banks K_t^B

  $\rightarrow$ wages w_t and rental rate r_t^K

- **retailers (monopolistic competition)**
  - sell differentiated intermediate good to final good's (Y_t) producer at a **markup** μ
    - + dividends $div_t^Y = \left(1 - \frac{1}{\mu}\right) Y_t \Rightarrow$ wealth inequality

- **capital producers**
  - convert final good into capital, subject to **adjustment cost**

  $\rightarrow$ fluctuations in asset price q_t

market clearing

Quantitative Results

Quantitative Exercise

1 calibrate steady state to **US data**

- size of commercial banks, households' balance sheet

Quantitative Exercise

1 calibrate steady state to **US data**

- size of commercial banks, households' balance sheet

2 simulate **surprise decline** in productivity of bank investments

- **bank losses ⇒ reduced intermediation ⇒ transmission to HH's**
- size and persistence match:
  - + drop of 12.43% in bank equity (**one standard deviation** of empirical returns)
  - + 12-quarter cumulative **aggregate** change in consumption of 4.67%

Model Fit - Untargeted Moments

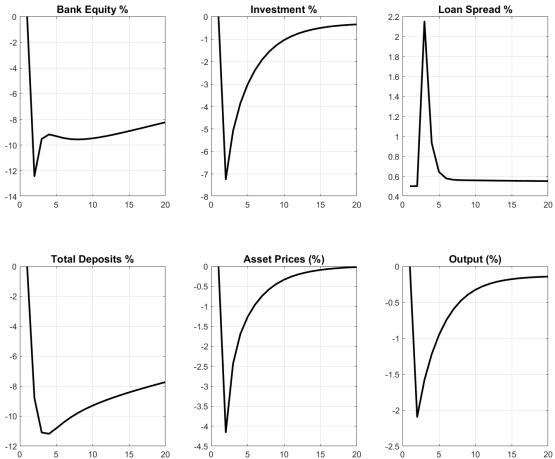
	Liquid/Deposits		**Total Net Worth**		**Total Income**		**NW (by Income)**		**Liq. (by Income)**	
	Model	Data	Model	Data	Model	Data	Model	Data	Model	Data
Q1	-3.5	-4.2	-0.1	-0.2	4.3	7.0	2.2	2.9	**2.2**	**2.2**
Q2	1.4	0.2	2.0	1.2	9.1	10.5	4.5	4.5	6.0	3.5
Q3	4.8	1.7	5.1	4.2	13.7	14.9	6.5	8.1	7.2	8.7
Q4	11.1	8.1	10.5	11.5	21.4	20.8	13.0	14.7	12.8	16.8
Q5	86.4	94.2	82.4	83.3	51.5	47.7	73.8	69.8	71.8	68.7

- Gini of net worth: 81.4 in the model vs. $\sim$ 80 in the data
- interest on consumer loans : 12.9% vs. 11.1%
- fraction of $a \leq 0$: 18.7% vs. 19.3%

$\Rightarrow$ model captures **realistic exposure** to banking sector losses

portfolio

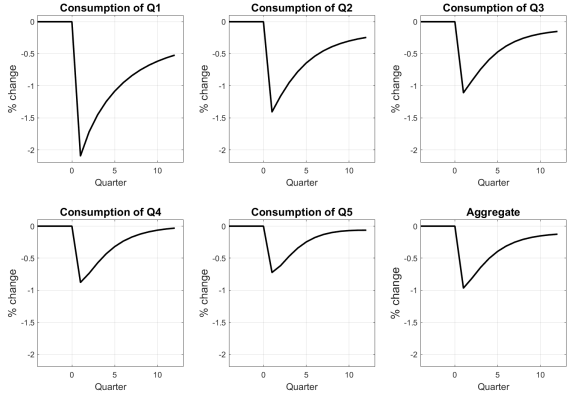
Aggregate Response to Shock



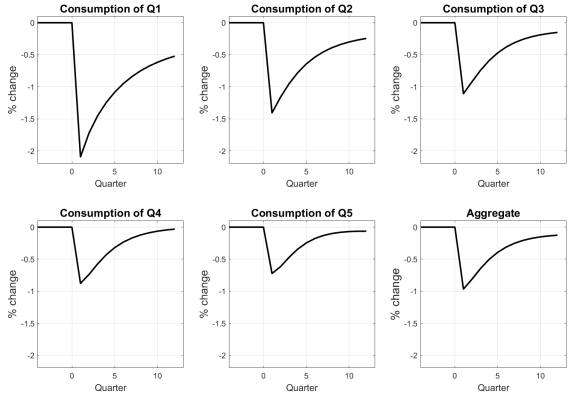
other

Results - Consumption Inequality

Consumption Inequality - Income Quintiles



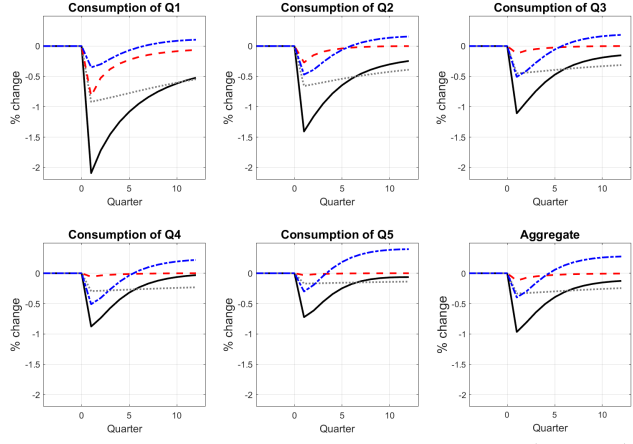
Consumption Inequality - Income Quintiles



⇒ HH's **consumption** responds to prices (**earnings, interest rates, returns...**)

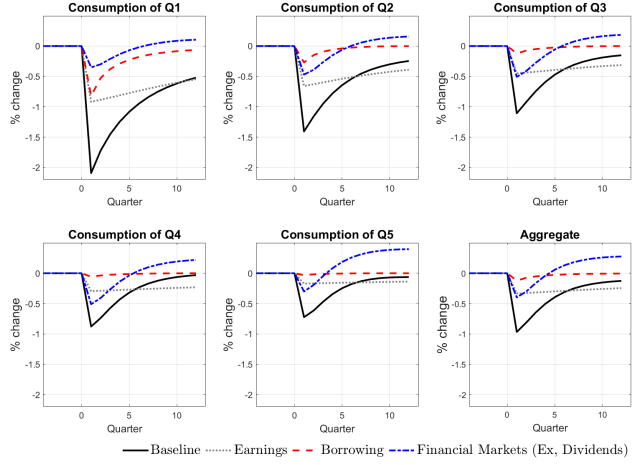
- decompose responses → transmission mechanisms

Consumption Inequality – Mechanisms



▸ prices ▸ earnings ▸ div ▸ fin

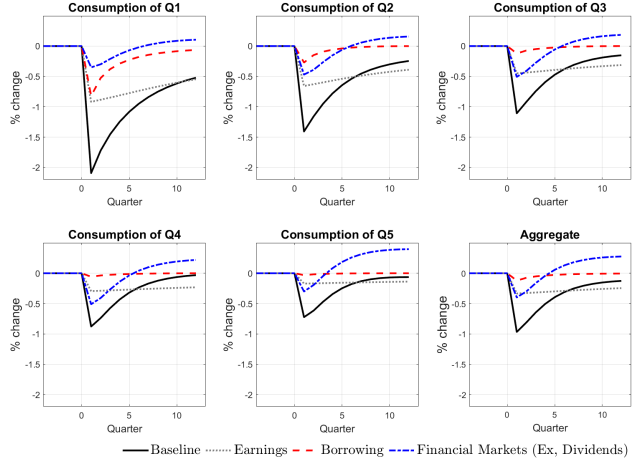
Consumption Inequality – Mechanisms



– ↑ borrowing cost → low income (more likely borrowers)

▸ prices ▸ earnings ▸ div ▸ fin

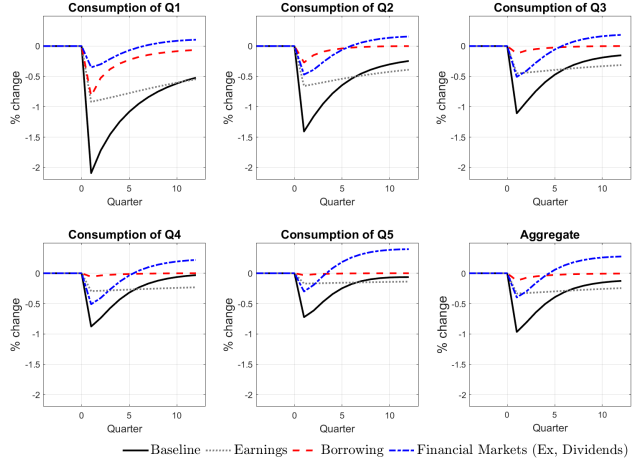
Consumption Inequality – Mechanisms



– ↓ earnings → decreasing importance (insurance, cyclicality)

▸ prices ▸ earnings ▸ div ▸ fin

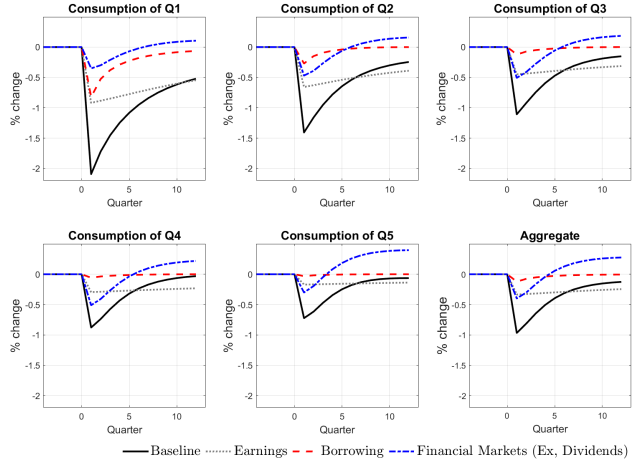
Consumption Inequality – Mechanisms



— returns on savings ↓ then ↑ → high income (future consumption)

▸ prices ▸ earnings ▸ div ▸ fin

Consumption Inequality – Mechanisms

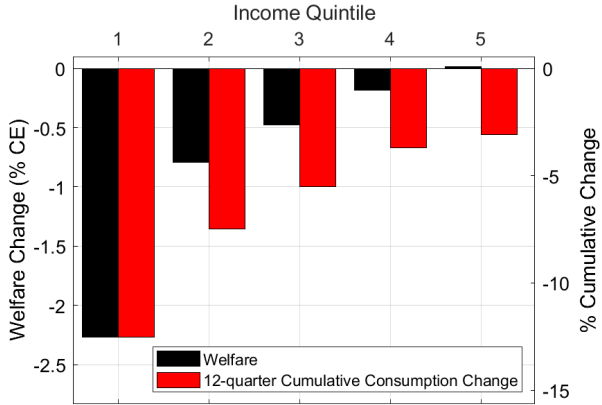


⇒ **heterogeneity** in response and transmission mechanisms

▸ prices ▸ earnings ▸ div ▸ fin

Results: Welfare Inequality

Welfare vs. Consumption



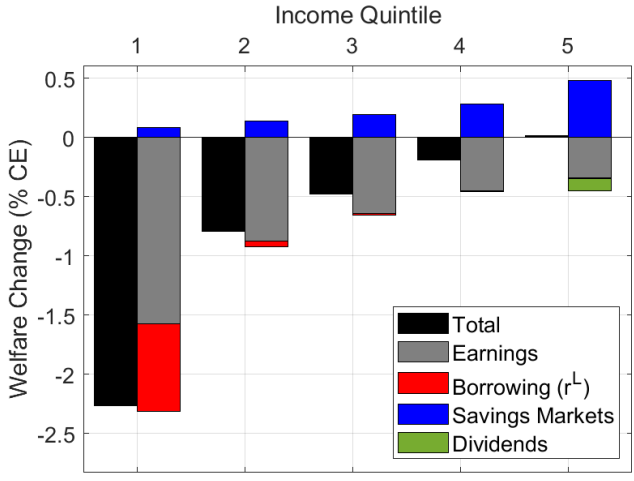
;

⇒ welfare impact **substantially more unequal** than (initial) consumption response

⇒ top quintile (marginally) **gains** from bank distress

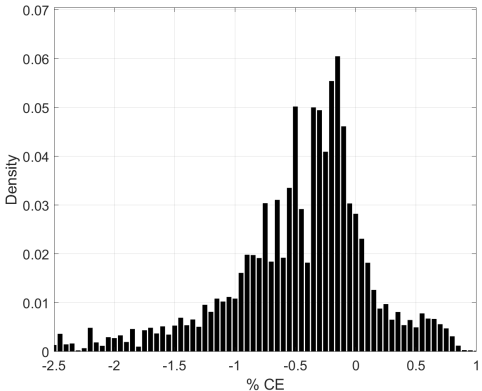
measure

Welfare - Mechanisms



capitalist fin NW fix r tab

Heterogeneity in Welfare



Distribution of Welfare Changes

- 14% of HHs are **better off**
  - income 61% larger than avg.
  - 4.5× **wealthier** than avg.
  - 4.4× more **liquid** wealth

▸ detail

Robustness to Alternative Specifications

Main conclusions are robust to:

- direct shock to **banks' equity**
  - equivalent change in banks' resources on impact
  - $\Rightarrow$ relatively larger role for asset returns and borrowing cost
- introduction of **New Keynesian** frictions
  - sticky wages, labor union as in Auclert et al. (2020), Taylor rule
  - $\Rightarrow$ relatively larger role for earnings

Empirical Evidence

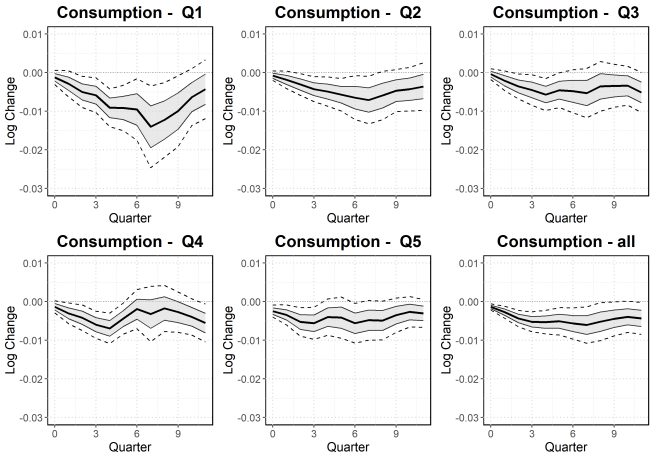
Data and Estimation

- Micro-data from Consumer Expenditure Survey (CEX), 1980-2018
  - **Consumption** $\equiv$ nondurables + durables + services
  - Averaged by **(total) income** quintile, quarterly series
- **Bank equity returns index** from Baron et al. (2021)
  - based on stock market prices and dividends
  - supplement with non-financial market returns (S&P 500 Industrials)
- **Quintile-level local projections** (similar to Baron et al. (2021)):

$$\overbrace{c_{i,t+h}}^{\text{log consumption}} = \alpha_i^h + \gamma_i^h(t+h) + \sum_{j=0}^{J} \overbrace{\beta_i^{h,j} r_{t-j}^{B}}^{\text{bank returns}} + \sum_{s=0}^{S} \overbrace{\delta_i^{h,s} r_{t-s}^{NF}}^{\text{NFC returns}} + \sum_{k=1}^{K} \lambda_i^{h,k} c_{i,t-k} + \epsilon_{i,t}^h$$

▸ stats ▸ event

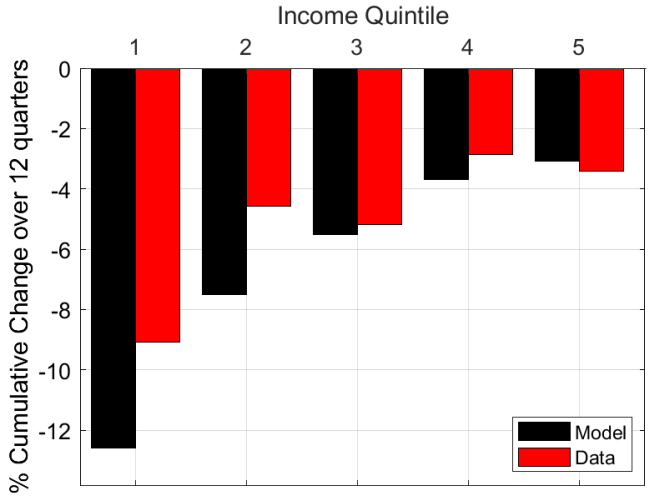
Consumption and Bank Returns



Response to a one-standard-deviation **decline** in bank equity returns

▸ mechanisms

Consumption: Model vs. Data



robust

Conclusion

Conclusion

- quantitative model with heterogeneous households, portfolio decisions, and banking sector
  - **low-income consumption** responds more to distress in the banking sector
  - **mechanisms** differ along the income distribution
    - + bottom: low insurance to earnings losses, borrowing rates
    - + top: **benefit** from asset prices, high future returns $\Rightarrow$ **portfolio composition** matters
  - welfare losses concentrated among **low-income**
- consumption response in line with empirical evidence

$\Rightarrow$ alleviating consequences of bank losses **supports low-income households**

Appendix

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Intermediate Goods Producer

- competitive markets
- Cobb-Douglas **production** function for intermediate good

$$Y_t^I = A_t K_t^{\alpha} N_t^{1-\alpha}$$

- $K_t = K_t^{HH} + \xi_t^B K_t^B \equiv$ **effective** units of capital
- input prices:

$$r_t^K = \frac{1}{\mu} \alpha A_t K_t^{\alpha-1} N_t^{1-\alpha}$$

$$w_t = \frac{1}{\mu} (1-\alpha) A_t K_t^{\alpha} N_t^{-\alpha}$$

back

Retailers and Final Goods Producer

- **monopolistic-competitive** retailers indexed by j:
  - purchase intermediate good, differentiate to y_{jt}
  - sell to final goods' producer
    - $Y_t = \left(\int_j y_{jt}^{\frac{1}{\mu}} dj \right)^{\mu}$
  - retailers pricing: **markup** μ over marginal cost
- retailers' dividends:

$$div_t^Y = \left(1 - \frac{1}{\mu}\right) Y_t$$

back

Capital Producers

- competitive markets
- convert final good into capital, subject to **adjustment cost**

$$\max_{K_t} \beta^t \sum_{t=0}^{\infty} \left((q_t - 1)K_t - \frac{\phi}{2} \left[\log \frac{K_t}{K_{t-1}} \right]^2 K_t \right)$$

back

Market Clearing

- demand and supply for effective capital units

$$K_t = \xi_t^B K_t^B + \overbrace{\int k_t(i)di}^{\equiv K_t^{HH}}$$

- deposits:

$$D_{t+1} = \int_{a_{t+1} \geq 0} a_{t+1}(i)di$$

- consumer loans:

$$L_{t+1} = \int_{a_{t+1} < 0} a_{t+1}(i)di$$

- investment:

$$I_t = (K_{t+1}^{HH} + K_{t+1}^B) - (1-\delta)(K_t^{HH} + K_t^B)$$

- final goods:

$$C_t + I_t + \frac{\phi_K}{2}\left(\frac{I_t}{K_{ss}} - \delta\right)^2 + \int \tau(z(i))a_{t+1}(i)di = Y_t$$

back

Calibration Strategy

1. **earnings process with Gaussian mixture**
   - match **higher-order** moments of after-tax earnings changes
   - capitalist state z^* (top 1%)
     + transitions from top labor productivity state
     + probabilities calibrated following Guvenen et al. (2021)
   - elasticities to aggregate income $\gamma(z, Y)$ calibrated to Guvenen et al. (2017)
2. **externally set parameters**
3. **internally calibrated parameters**
   - Commercial Banks' Balance Sheet (Fed H.8 2004)
     + Deposits, Assets
   - Households' Balance Sheet (SCF 2004)
     + Consumer Credit

back

Calibration - Earnings Risk

- Data: PSID from 1962 to 1992
  - After-tax household-level income (De Nardi et al. (2019))
- Step 1 - non-capitalists: $\log(z_t) = \rho \log(z_{t-1}) + \varepsilon_t$
  - ε_t drawn from mixture of normals
    - Match **higher-order** moments of the distribution of earnings changes
    - Discretize $z \in \{z_1, z_2 ..., z_N\}$
- Step 2 - add capitalist state z^*
  - $z_N \to z^*$ with probability ν^i
  - $z^* \to z_N$ with probability ν^o

back

Earnings Risk - Details

- AR1 Process, innovations from mixture of normals:

$$\log(z_t) = \rho \log(z_{t-1}) + \varepsilon_t,$$

$$\varepsilon_t \sim \begin{cases} \mathcal{N}(\mu_1, \sigma_1^2) \text{ with probability } p \\ \mathcal{N}(\mu_2, \sigma_2^2) \text{ with probability } 1-p \end{cases}$$

- $\rho = 0.963$, $\sigma_1 = 0.50$, $\sigma_2 = 0.01$, $p = 0.156$, $\mu_1 = -0.105$, and $\mu_2 = 0.019$.

Target	Model	Data
Cross Sectional Variance	0.57	0.57
Standard Deviation of Changes	0.33	0.33
Skewness of Changes	-0.99	-0.98
Kurtosis of Changes	10.5	10.3
P90-P10 of Changes	0.65	0.64

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Calibration - External Parameters

Parameter/Function	Value	Source
Utility Function	$u(c) = \frac{c^{1-\sigma}-1}{1-\sigma}$	CRRA
Risk Aversion	$\sigma = 2$	standard
Capital Share	$\alpha = 0.33$	standard
Borrowing limit	$\underline{a} = 1$	Kaplan et al. (2018)
P(Entering Capitalist State)	$\nu^i = 0.025$	1% of households
P(Quitting Capitalist State)	$\nu^o = 0.0625$	Guvenen et al. (2021)
Dispersion of Adjustment Cost	$\sigma_\eta = 10$	robust to other values
Markup	$\mu = 1.1$	standard
PB(Bank Survival)	$\theta = 0.972$	Gertler and Karadi (2011)

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Calibration - Internal Parameters

Target	Model	Data	Closest Parameter	Source
$\frac{K}{Y}$ Ratio	3	3	$\delta = 0.016$	Penn World Tables
Elasticity of q to I	0.58	0.58	$\phi_K = 115$	Gertler and Karadi (2011)
Deposit-to-output $\frac{D}{Y}$	0.40	0.40	$\chi = 0.271$	Fed H.8 2004
Liquid Asset Share Q1	2.2%	2.2%	slope of $\tau = -2.47$	SCF 2004
Bank investment-to-output $\frac{K^B}{Y}$	0.60	0.60	$\mu_\xi = 16.4$	Fed H.8 2004
Annual r^D	2%	2%	$\beta = 0.971$	annualized 3M Tbill rate
Annual spread $(r^L - r^D)$	2%	2%	$\omega = 0.0036$	Philippon (2015)

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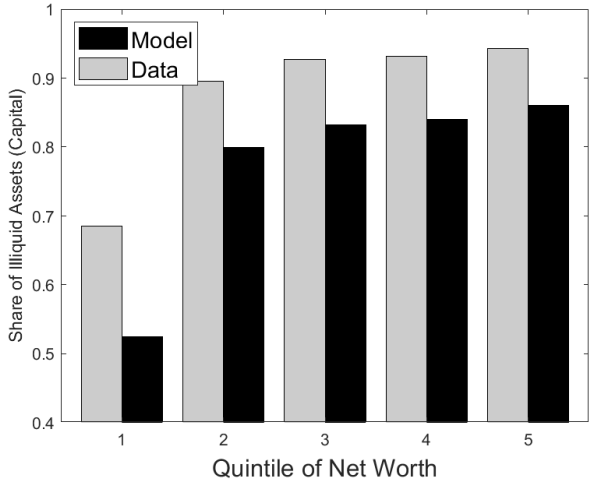
Households' Portfolio Composition



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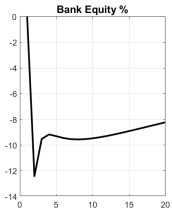
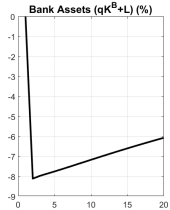
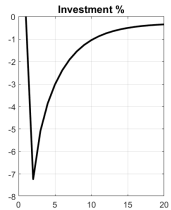
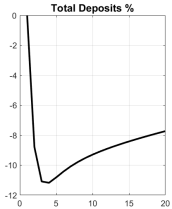
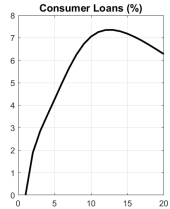
Equilibrium Aggregate Responses

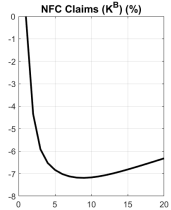












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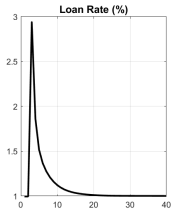
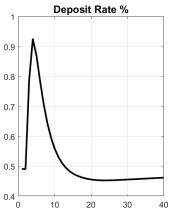
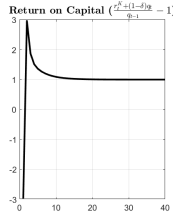
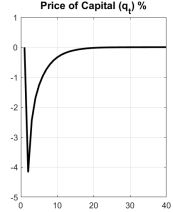
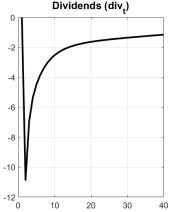
Equilibrium Price Responses

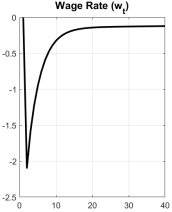












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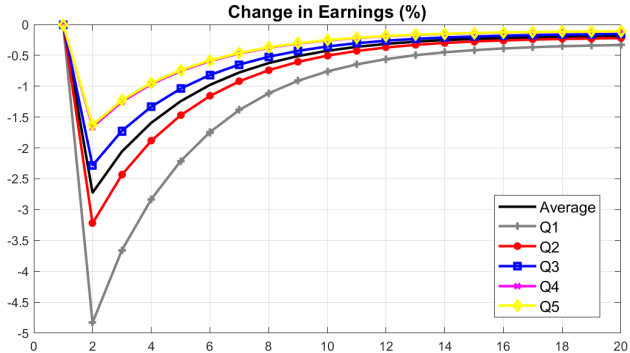
Earnings by Income Quintile



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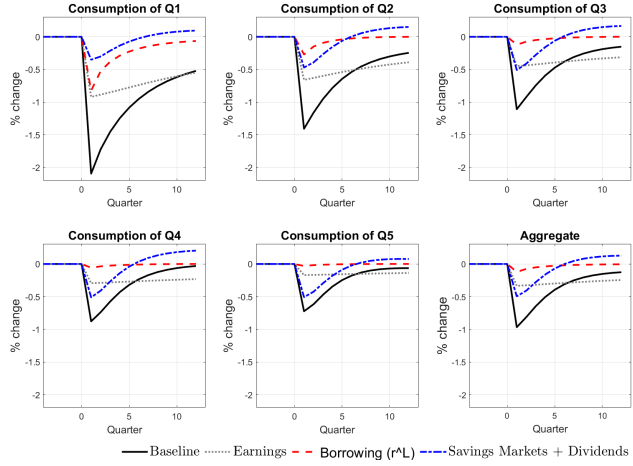
Consumption Inequality – Mechanisms



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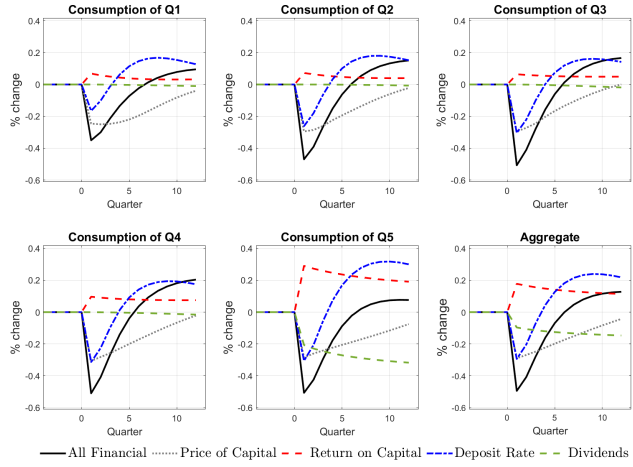
Consumption Inequality – Financial Channels



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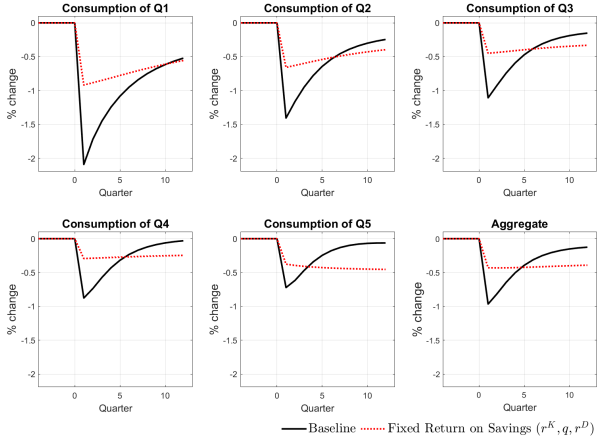
The Role of Returns to Savings



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Welfare Computation

$$CE(a,k,z) = 100 \times \left[\left(\frac{\tilde{V}_0(a,k,z) - V^{ss}(a,k,z)}{\mathbb{E}U} + 1 \right)^{\frac{1}{1-\sigma}} - 1 \right],$$

$$\mathbb{E}U = \mathbb{E} \sum_{t=0}^{\infty} \beta^t u(c_t^{ss}(a,k,z))$$

- **Interpretation:** what fraction of its consumption a household would be willing to (permanently) forgo to avoid the consequences of the shock and have the economy remain in steady state.

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Gainers and Losers

Characteristic	Welfare Losses	Welfare Gains
Avg. Liquid Assets	0.44	4.37
Avg. Capital Holdings	0.41	4.55
Avg. Total Income	0.90	1.61
Avg. Portfolio Liquidity	1.05	0.77
Avg. Dependence on Earnings	93.7	66.5

Gainers and Losers from Bank Losses

Note: *Dependence on labor income* refers to the average share of earnings in households' total income. With the exception of the last row, numbers are displayed as a multiple of economy-wide values.

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Welfare Changes

Change in (%) CE	Average	Workers	Capitalists	NW↑	NW↓
(1)	-0.737	-0.735	-0.944	-0.607	-0.796
by Income	Q1	Q2	Q3	Q4	Q5
(2)	-2.266	-0.794	-0.476	-0.186	0.017
by Net Worth	Q1	Q2	Q3	Q4	Q5
(3)	-2.443	-0.745	-0.415	-0.202	0.139
by Dep. on Labor Income	Q1	Q2	Q3	Q4	Q5
(4)	0.015	-0.297	-0.410	-0.638	-2.342

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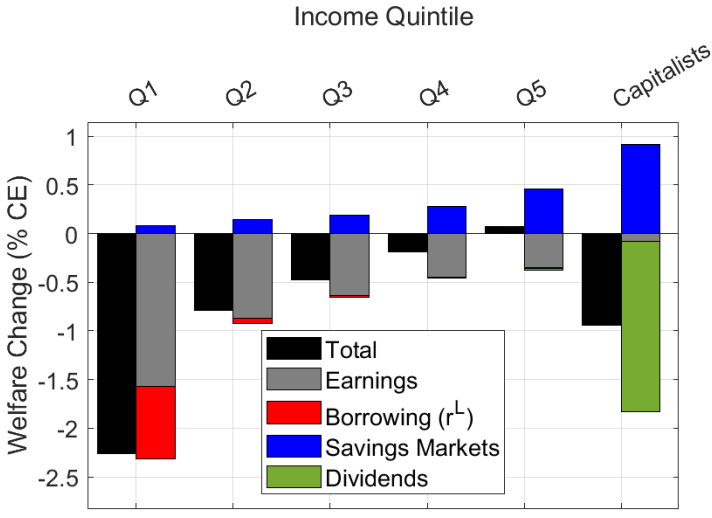
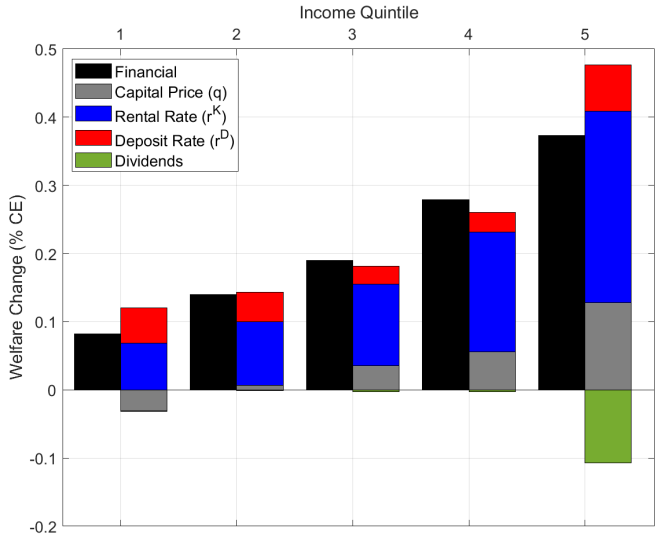
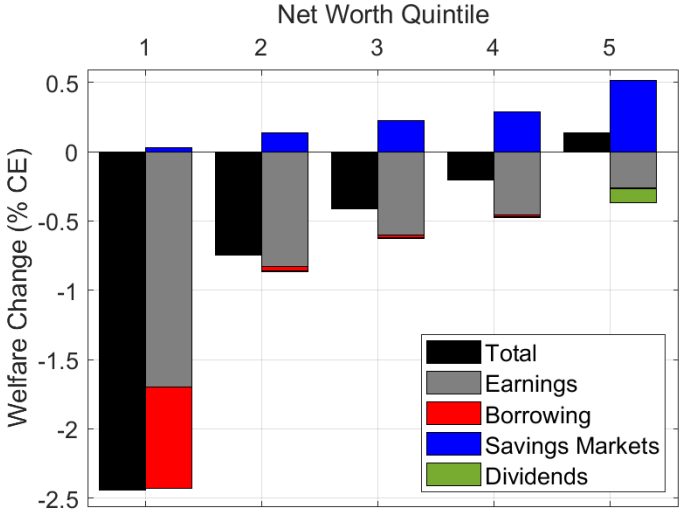
Welfare - Capitalist



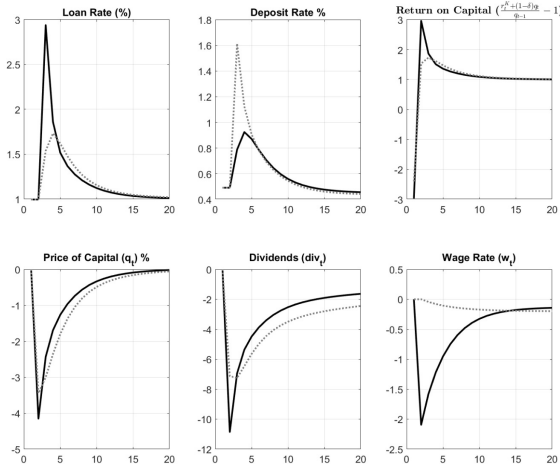
Welfare - Financial Channels



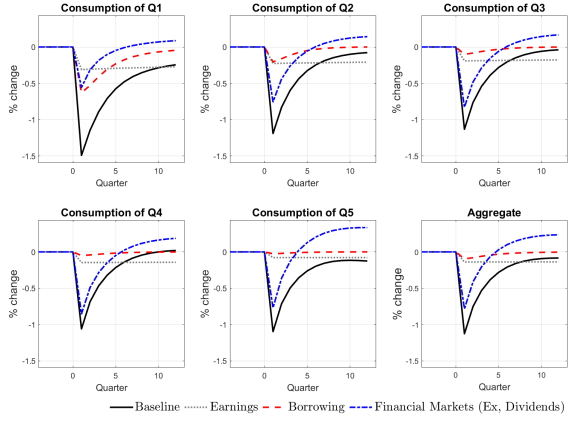
Welfare by Net Worth Quintile



BE: Prices


Loan Rate (%)
Deposit Rate %
Return on Capital $(\frac{r_t^k*(1-\delta)q_t}{q_{t-1}}-1)$
Price of Capital (q_t) %
Dividends (div_t)
Wage Rate (w_t)

BE: Consumption Dynamics



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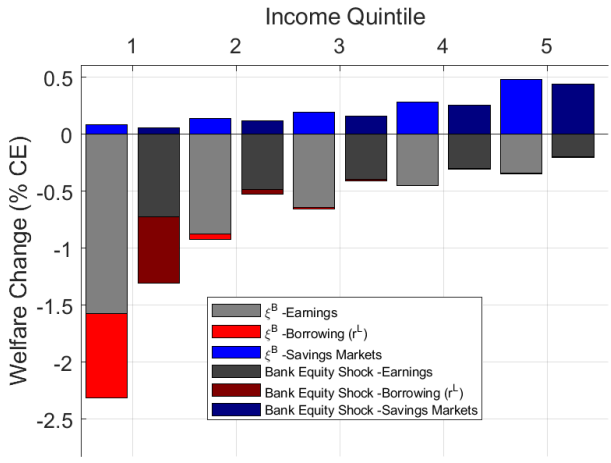
BE: Welfare



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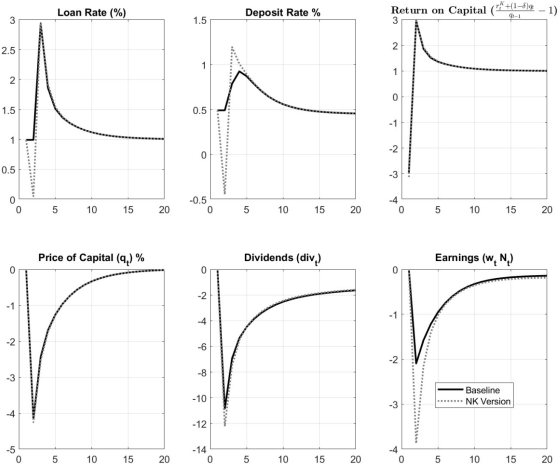
NK: Prices



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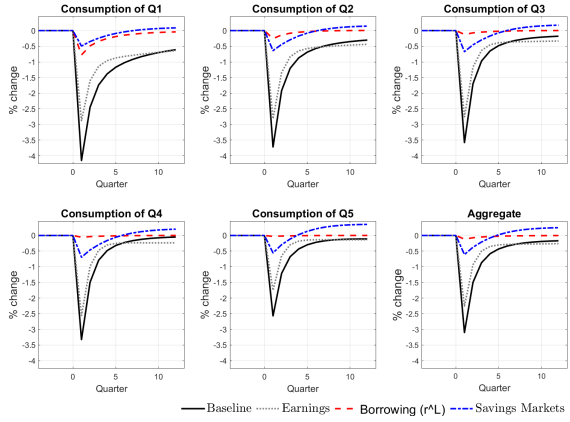
NK: Consumption Dynamics



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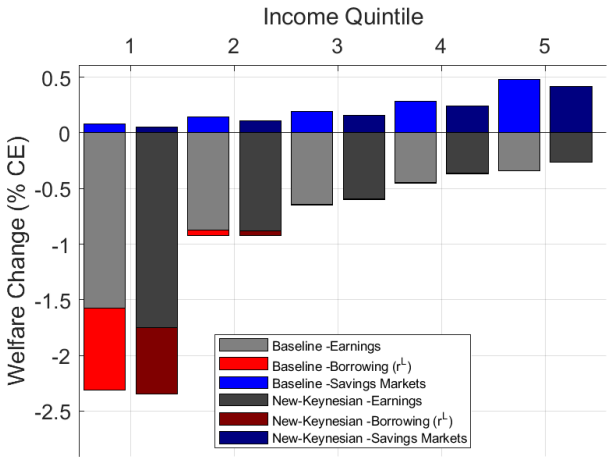
NK: Welfare



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Appendix - Empirical Analysis

Data Sources: Return Series

	r^B	r^N
Mean	0.0174	0.0197
Std	0.1229	0.0976
Min	-0.4666	-0.2988
P25	-0.0465	-0.0231
Median	0.0288	0.0347
P75	0.0943	0.0786
Max	0.2946	0.2069
Auto-corr.	0.0168	0.0371

Descriptive Statistics - Return Indices

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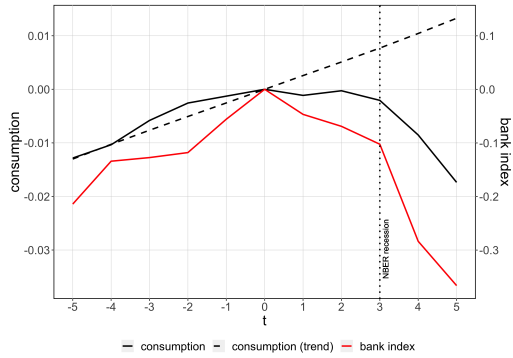
Event Studies - Consumption Dynamics

1990 Recession



2007 Recession

Notes: Dynamics of real aggregate consumption and bank equity return index around (a) Early 1990's recession and (b) the recession caused by the GFC. Bank equity declines begin at quarter $t = 0$. The dotted vertical line denotes the NBER recessions start dates (Q1 1990 and Q4 2007). The average consumption trend over the full sample is presented by the dashed line. Consumption and the bank idexes are normalized to 0 at $t = 0$. Lines represent changes relative to $t = 0$.

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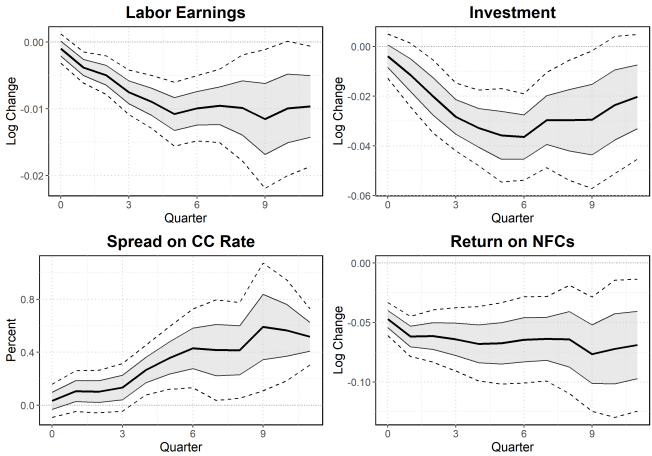
Transmission Channels



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Transmission Channels: Data Sources

- **Labor Earnings:** Aggregate wages and salaries disbursed, adjusted by the All Urban CPI.
- **Investment:** Real Gross Private Domestic Investment
- **Spread on Credit Card Rate:** difference of the average interest rate on credit cards and the 3-month T-bill rate.
  - We add the charge-off rate on credit card loans as a control in the local projection
- **Return on NFCs:** Dow Jones Industrial Index

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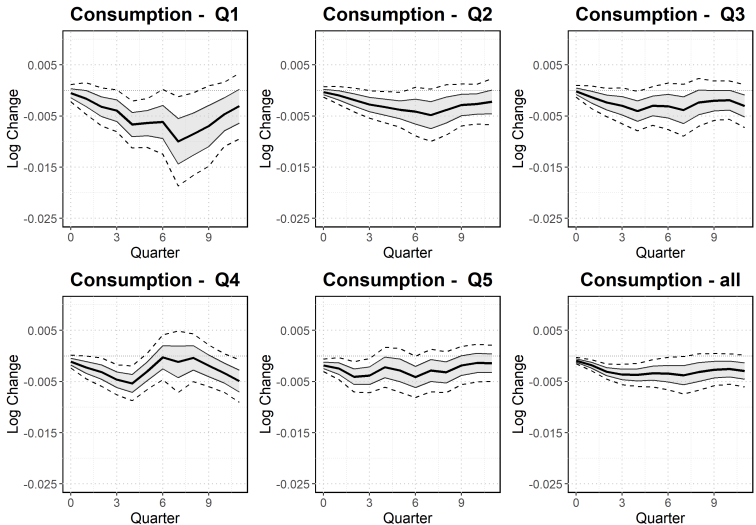
Robustness Checks

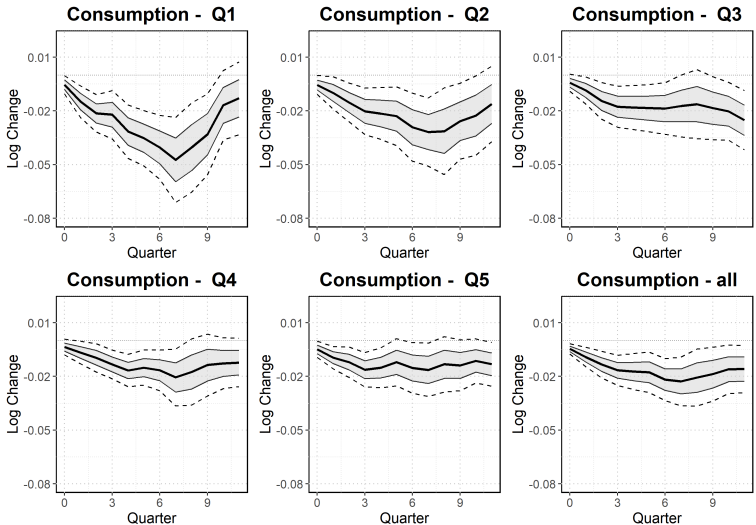
- Consumption categories ▸ non-durables ▸ durables
- Results not driven by mortgagors ▸ mortgagors ▸ non-mortgagors
- Lag criterion ▸ Aikaike
- Monthly analogue ▸ monthly
- Income adjusted by paid rent ▸ rent
- Positive vs. negative Returns ▸ below-median ▸ above-median

▸ back

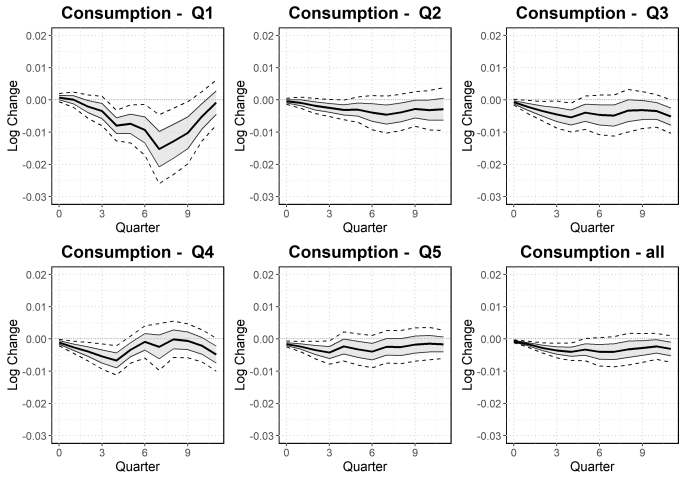
Consumption and Bank Returns: Nondurables



Consumption and Bank Returns: Durables



Consumption and Bank Returns: Lag Selection



- For any combination of i/h lag selection according to AIC

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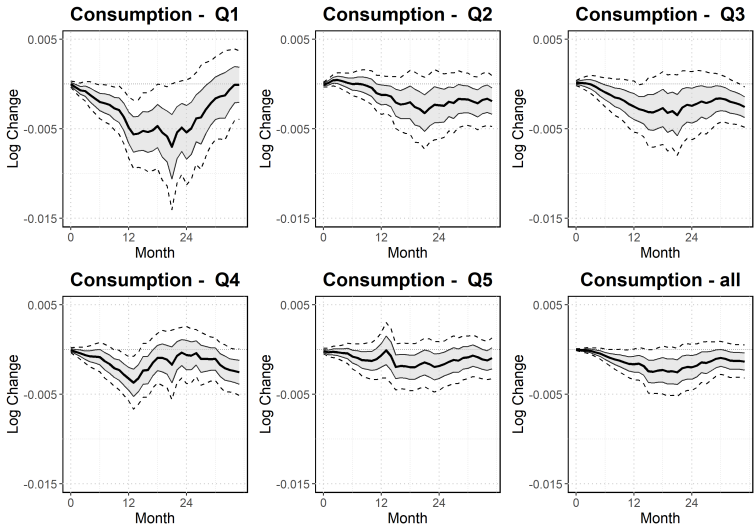
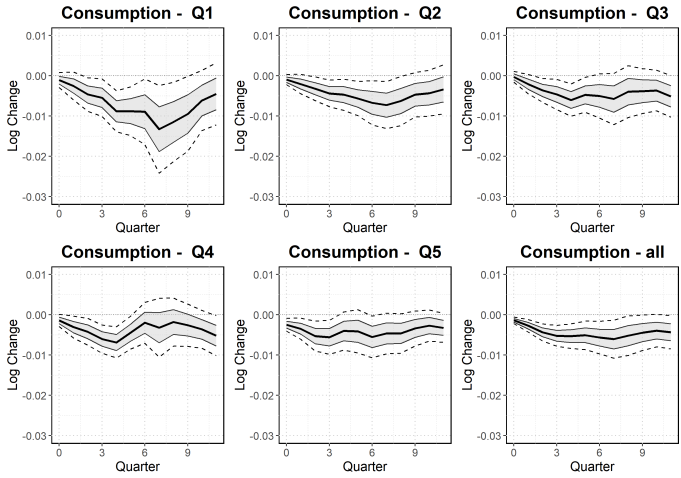
Consumption and Bank Returns: Monthly



Consumption and Bank Returns: Rent



- after-tax income adjusted by rent paid before sorting quintiles

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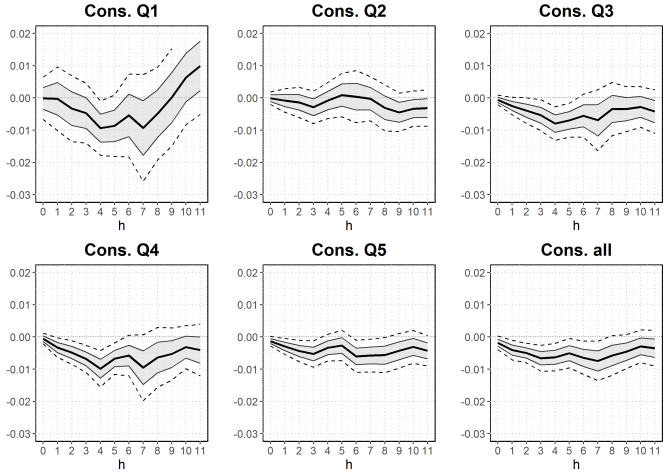
Consumption and Bank Returns: Mortgagors



- selected sample: only mortgagors

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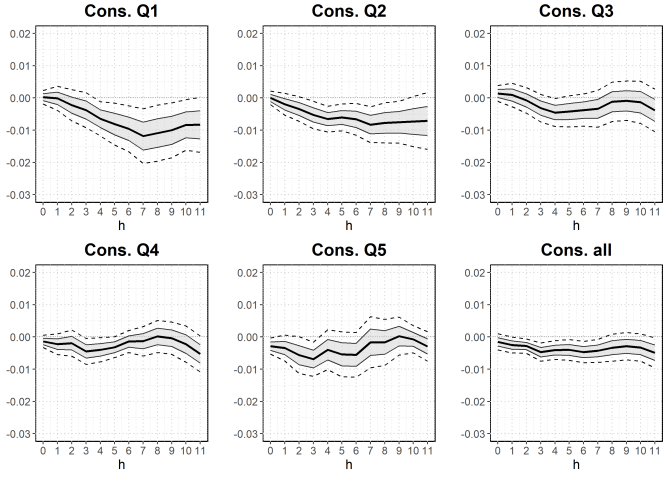
Non-Mortgagors



- selected sample: renters and homeowners

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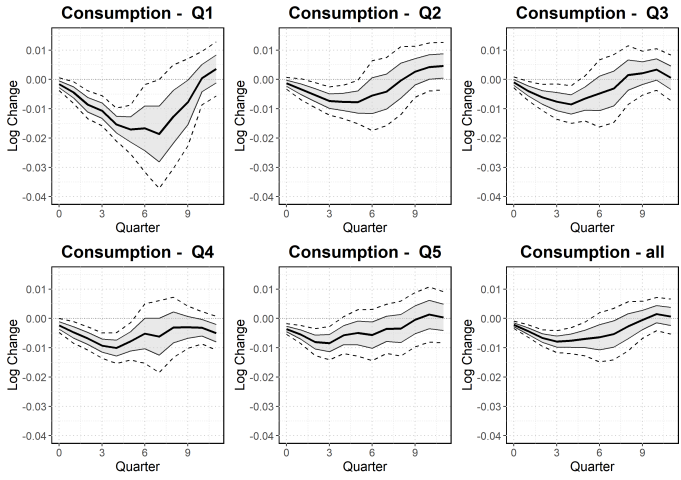
Below-median Returns



- interaction with dummy for below-median returns

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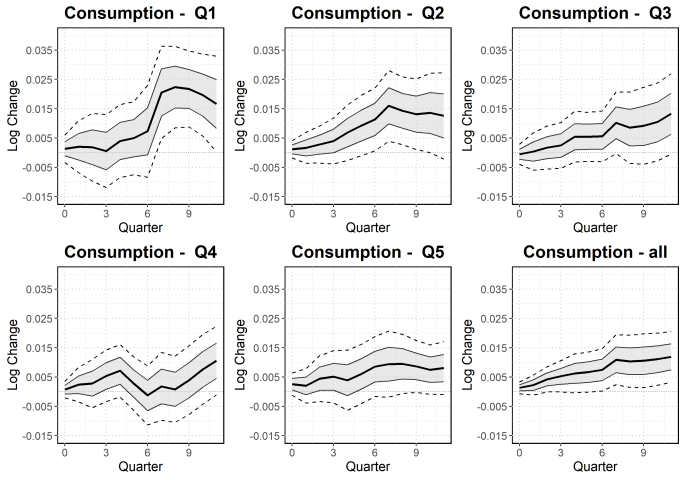
Above-median Returns



- interaction with dummy for above-median returns

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