Monetary Policy and Household Net Worth

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Motivation

- Households' financial position key for propagation of economic shocks and policies (Mian et al., 2013; Schularick and Taylor, 2012).
- Important interplay between borrowing constraints and macro asymmetries in macro models (Eggertsson and Krugman, 2012; Guerrieri and Iacoviello, 2017).
- Policy relevance: large monetary policy interventions and large shifts in household net worth since Great Recession in the US and Europe.

This paper

- Does monetary policy effectiveness depend on the financial position of households in the US economy?

  1. Use a DSGE model to study the interrelation between household balance sheets, borrowing constraints and monetary policy.

  2. Test the model predictions on aggregate US data.

  $\rightarrow$ Provide guidance on which data to use to measure borrowing constraints.

Preview of results

- Main finding: monetary policy more effective when household net worth is low.
- Amplification effects in the responses of GDP and consumption: up to more than twice as large.

1. DSGE model implies
    - Monetary policy shocks have larger effects when borrowing constraints are binding.
    - Main determinant of binding constraint is the level of net worth.
2. Empirical analysis confirms model predictions
    - Strong and significant effects of monetary policy shocks when net worth is low.
    - Weak and mostly insignificant effects when net worth is high.

Outline

Model

Model overview (Guerrieri and Iacoviello, 2017)

- New Keynesian model with occasionally binding housing collateral constraint.
- Dual role of housing: utility & collateral.
- Production: firms and capital stock owned by patient households.
- Wage and price rigidities.
- Monetary policy follows Taylor rule subject to the ZLB.

Households

- Heterogeneous saving preferences generate borrowing and lending.

$$E_0 \sum_{t=0}^{\infty} z_t \left(\beta^i\right)^t \left(\Gamma_c^i \ln(c_t^i - \varepsilon_c c_{t-1}^i) + \Gamma_h^i j_t \ln(h_t^i - \varepsilon_h h_{t-1}^i) - \frac{1}{1+\eta}(n_t^i)^{1+\eta}\right)$$

for $i = \{P, I\}$ and $\beta^I < \beta^P$

- s.t. budget constraints and the collateral constraint

$$b_t \leq \gamma \frac{b_{t-1}}{\pi_t} + (1-\gamma) M q_t h_t^I,$$

where M is the maximum borrowing limit (LTV).

- Housing wealth is **occasionally** crucial for debt dynamics.

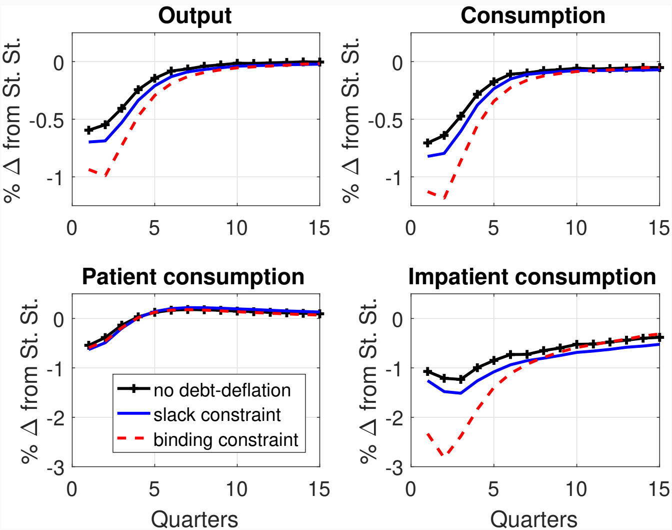
▸ Details

Model Estimation

- Data (1960q1-2018q1): consumption, price inflation, wage inflation, investment, house prices, FFR.
- Shocks: housing preference, investment specific, price markup, wage markup, consumption preference, monetary policy.
- Solution: OccBin (Guerrieri and Iacoviello, 2015).
  - model features 4 regimes; approximation around steady state.
- Bayesian estimation: deterministic filter (Guerrieri and Iacoviello, 2017).

▸ calibration ▸ priors-post ▸ filtering

A contractionary 100bp monetary policy shock



▸ amplification ▸ more

Determinants of borrowing constraints

- Question: How to measure borrowing constraints in the data?

- Answer: Estimate determinants of borrowing constraint.

- Approach:
  1. Use estimated DSGE model to simulate artificial time series.
  2. Estimate probit regressions for a slack constraint variable on different measures of "financial excess".

- Metric: predictive performance for binding/slack constraint.

details

Share of correctly predicted states of the borrowing constraint

Table 1: Prediction of binding collateral constraints

predictor candidate x_k	levels	growth rates	HP-cycle
net worth (impatient)	0.87	0.55	0.69
net worth (aggregate)	0.59	0.50	0.54
leverage (impatient)	0.83	0.54	0.65
leverage (aggregate)	0.56	0.55	0.57
credit	0.62	0.66	0.66
house prices	0.66	0.54	0.69
credit gaps	0.57	0.49	0.49

- The level of (impatient) net worth alone is very informative about the state of the borrowing constraint.
- Other variables have quantitatively much worse predictive performance.

$\rightarrow$ Monetary policy more effective when net worth is low.

▸ IRFs NW ▸ NW distribution

Empirical analysis

Estimation approach

- Local projections as proposed by Jordà (2005)

$$y_{t+h} = \tau t + I_{t-1}\left[\alpha_{A,h} + \psi_{A,h}(L)x_t + \boldsymbol{\beta_{A,h}} shock_t\right] + (1 - I_{t-1})\left[\alpha_{B,h} + \psi_{B,h}(L)x_t + \boldsymbol{\beta_{B,h}} shock_t\right] + \epsilon_{t+h}$$

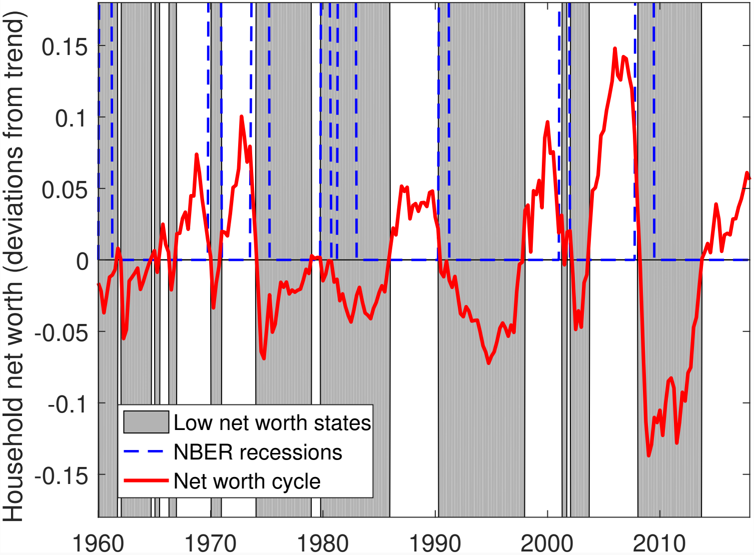
- Dummy I_t indicates the state $\{A, B\}$ of the economy
- $shock_t$ measures monetary policy shock
- $\boldsymbol{\beta_{A,h}}$, $\boldsymbol{\beta_{B,h}}$ provide state-dependent response of y_{t+h}

Data, definition, identification

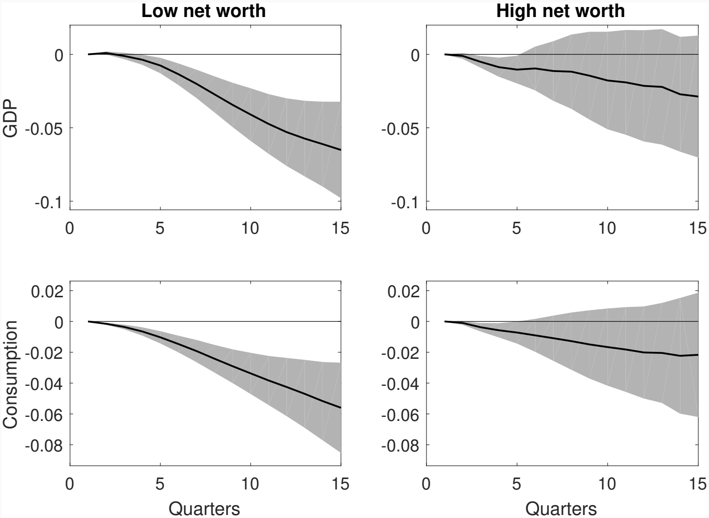
- Analysis based on quarterly US data (1960q1 2018q1)
- I_t: State of the household net worth cycle (high or low)
  - HP-filter smooth cycle ($\lambda = 100,000$)
- Monetary policy shock
  - State-dependent monetary policy rule, $r = f(I, y, p, n, s)$.
  - recursive identification: r reacts contemporaneously to y, p, n.
  - r measured by federal funds rate and shadow rate (Wu-Xia 2016) during the ZLB period.

▸ Details

States of the household net worth cycle



Baseline (cumulative) results: contractionary MP shock



‣ baseline ‣ more ‣ linear

Robustness

Baseline results robust to:

1. Excluding net worth, ordering of the variables (spread).
2. Alternative definition of state variable. Link
3. Different identification (Romer/Romer, long-term rate). Link
4. Sign of the monetary policy shock. Link
5. Changes in the sample. Link

Conclusion

Conclusion

- Standard New Keynesian model with financial frictions suggests monetary policy more effective when household net worth is low.
- Model predictions are supported when looking at US macro data.
- Household net worth plays an important role in understanding:
    - Household borrowing constraints.
    - The transmission of monetary policy to the economy.

Additional slides

Budget constraints and capital accumulation

- Budget constraints

$$c_t^P + q_t h_t^P + b_t + i_t = \frac{w_t^P n_t^P}{x_{w,t}^P} + q_t h_{t-1}^P + \frac{R_{t-1} b_{t-1}}{\pi_t} + rk_t k_{t-1} + div_t^P$$

$$c_t^I + q_t h_t^I + \frac{R_{t-1} b_{t-1}}{\pi_t} = \frac{w_t^I n_t^I}{x_{w,t}^I} + q_t h_{t-1}^I + b_t$$

- Capital accumulation

$$k_t = a_t \left(i_t - \phi \frac{(i_t - i_{t-1})^2}{\bar{i}_t} \right) + (1 - \delta) k_{t-1},$$

back

Wholesale firms

Wholesale firms produce intermediate goods y_t

$$\max \frac{y_t}{x_{p,t}} - w_t n_t - w_t^I n_t^I - rk_t k_{t-1}$$

subject to the production technology

$$y_t = n_t^{(1-\sigma)(1-\alpha)} n_t^{I\sigma(1-\alpha)} k_{t-1}^{\alpha},$$

where σ measures the labor income share of impatient households.

▸ back

Wholesale firms

Calvo-style wage rigidities rigidities imply the following linearized wage Phillips curves:

$$\ln(\omega_t/\bar{\pi}) = \beta E_t \ln(\omega_{t+1}/\bar{\pi}) - \varepsilon_w \ln(x_{w,t}/\bar{x}_w) + u_{w,t},$$

$$\ln(\omega_t^I/\bar{\pi}) = \beta^I E_t \ln(\omega_{t+1}^I/\bar{\pi}) - \varepsilon_w^I \ln(x_{w,t}^I/\bar{x}_w^I) + u_{w,t},$$

where $\varepsilon_w = (1-\theta_w)(1-\beta\theta_w)/\theta_w$, $\varepsilon_w^I = (1-\theta_w)(1-\beta^I\theta_w)/\theta_w$, $\omega_t = \frac{w_t \pi_t}{w_{t-1}}$, $\omega_t^I = \frac{w_t^I \pi_t}{w_{t-1}^I}$, and $u_{w,t}$ is a normally distributed i.i.d. wage markup shock.

▸ back

Deterministic filter

The solution has the form

$$X_t = P(X_{t-1}, \epsilon_t)X_{t-1} + D(X_{t-1}, \epsilon_t) + Q(X_{t-1}, \epsilon_t)\epsilon_t, \tag{1}$$

where X_t contains all the variables of the model and ϵ_t is the vector of innovations to the shock processes.

The model can be taken to the data with the following observation equation

$$Y_t = H_t P(X_{t-1}, \epsilon_t)X_{t-1} + H_t D(X_{t-1}, \epsilon_t) + H_t Q(X_{t-1}, \epsilon_t)\epsilon_t. \tag{2}$$

back

Calibrated parameters

	parameter	value
β	patient discount factor	0.995
α	capital share in production	0.3
δ	capital depreciation rate	0.025
$\bar{j}$	housing weight in utility	0.04
η	labor disutility	1
$\bar{x}_p$	price markup	1.2
$\bar{x}_w$	wage markup	1.2
$\bar{\pi}$	steady state inflation	1.0075
r_Y	weight of GDP in Taylor rule	0.1
M	steady state LTV limit	0.9
β^I	impatient discount factor	0.9922
γ	inertia, borrowing const.	0.6945

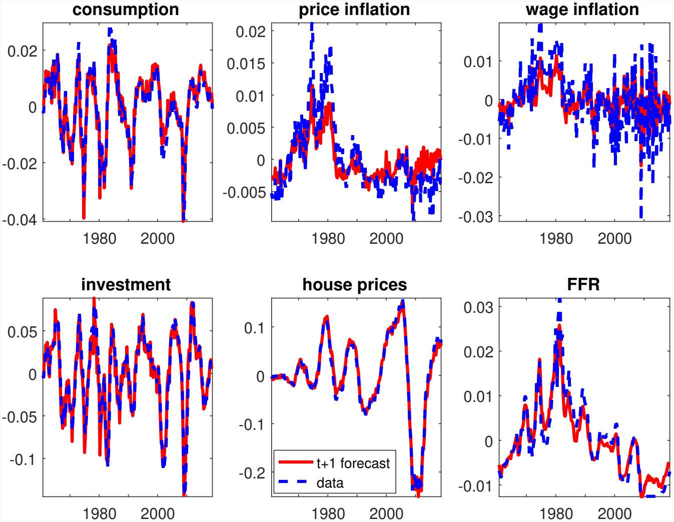
▸ back

Table 2: Estimated Parameters

	parameter	prior	posterior			
			mode	5%	median	95%
ε_c	habit in consumption	BETA 0.70(0.10)	0.4295	0.3804	0.4559	0.5270
ε_h	habit in housing	BETA 0.70(0.10)	0.9208	0.8888	0.9223	0.9415
ϕ	invest. adjustment cost	GAMMA 5.00(2.00)	11.0144	8.5145	11.2128	14.3330
σ	wage share impatient HH.	BETA 0.50(0.05)	0.4324	0.4046	0.4320	0.4705
r_π	Taylor Rule, inflation	NORMAL 1.50(0.10)	1.4427	1.3901	1.6175	1.7673
r_R	Taylor Rule, inertia	BETA 0.75(0.10)	0.2506	0.1419	0.2248	0.3284
θ_p	Calvo, prices	BETA 0.50(0.07)	0.9294	0.7960	0.8655	0.9374
θ_w	Calvo, wages	BETA 0.50(0.07)	0.9011	0.8764	0.8975	0.9154
ρ_J	AR(1) housing shock	BETA 0.75(0.10)	0.9876	0.9553	0.9763	0.9909
ρ_K	AR(1) investment shock	BETA 0.75(0.10)	0.5804	0.5289	0.5839	0.6373
ρ_R	AR(1) monetary shock	BETA 0.25(0.10)	0.4223	0.3371	0.4864	0.6035
ρ_Z	AR(1) preference shock	BETA 0.75(0.10)	0.8573	0.7559	0.8035	0.8675
σ_J	stdv. housing shock	INVGAMMA 0.01(1.00)	0.0470	0.0394	0.0686	0.0971
σ_K	stdv. investment shock	INVGAMMA 0.01(1.00)	0.0944	0.0702	0.0955	0.1222
σ_P	stdv. price markup shock	INVGAMMA 0.01(1.00)	0.0061	0.0059	0.0068	0.0078
σ_R	stdv. monetary shock	INVGAMMA 0.01(1.00)	0.0051	0.0048	0.0053	0.0058
σ_W	stdv. wage markup shock	INVGAMMA 0.01(1.00)	0.0084	0.0077	0.0084	0.0092
σ_Z	stdv. preference shock	INVGAMMA 0.01(1.00)	0.0154	0.0138	0.0155	0.0175

▸ back

Filtered variables and data



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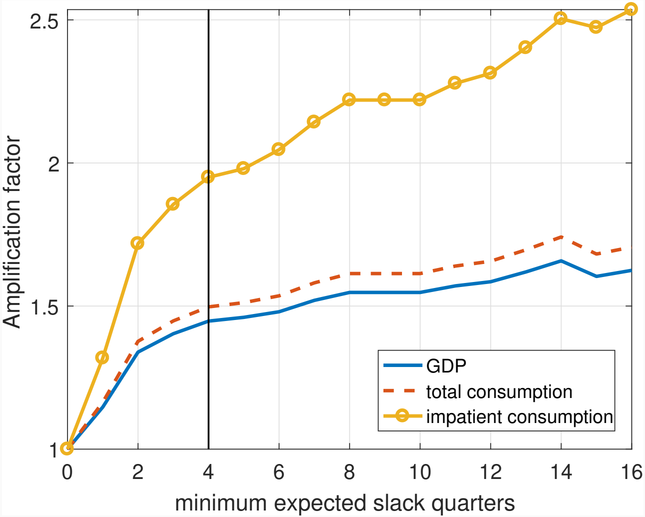
Amplification of max. response and expected slack duration



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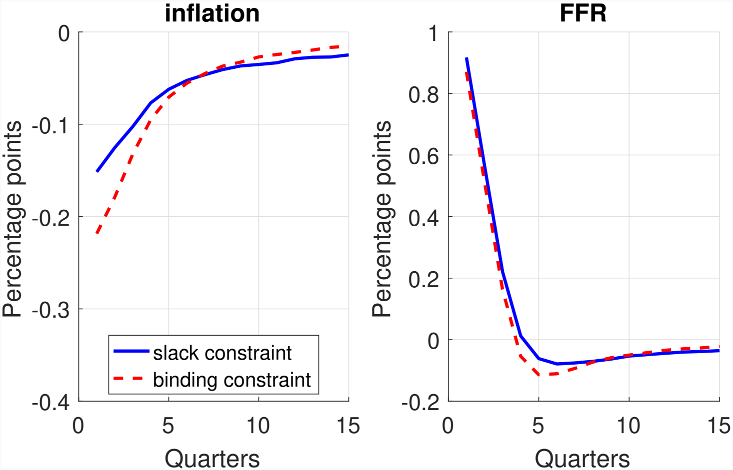
A contractionary 100bp monetary policy shock



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Determinants of borrowing constraints

Formally, we run regressions

$$\Pr(Y_t = 1 \mid X_{k,t}) = \Phi(X_{k,t}^T \beta_k), \quad k = 1 \dots K \tag{3}$$

where

$$Y_t = \begin{cases} 1 & \text{if LM>0} \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

- Φ is the CDF of a standard normal distribution.
- $X_{k,t}$ includes a constant and one of the predictor candidates $x_{k,t}$.
- $x_{k,t}$: net worth (aggregate and impatient), leverage (aggregate and impatient), credit, house prices, credit-to-gdp gaps (BIS).
- LM is the Lagrange multiplier on the borrowing constraint.

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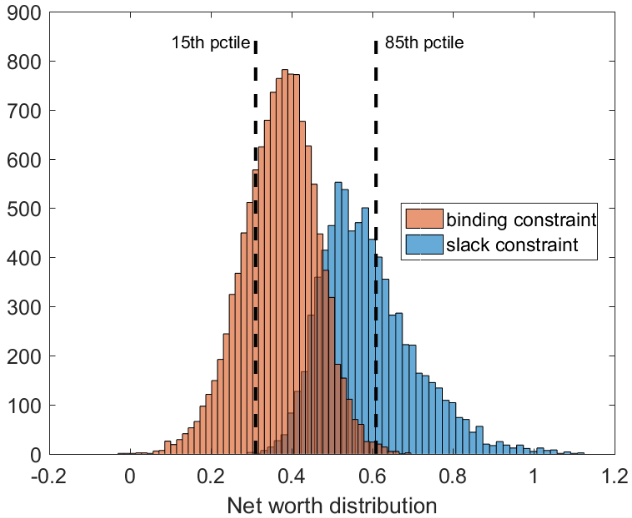
Net worth and borrowing constraints



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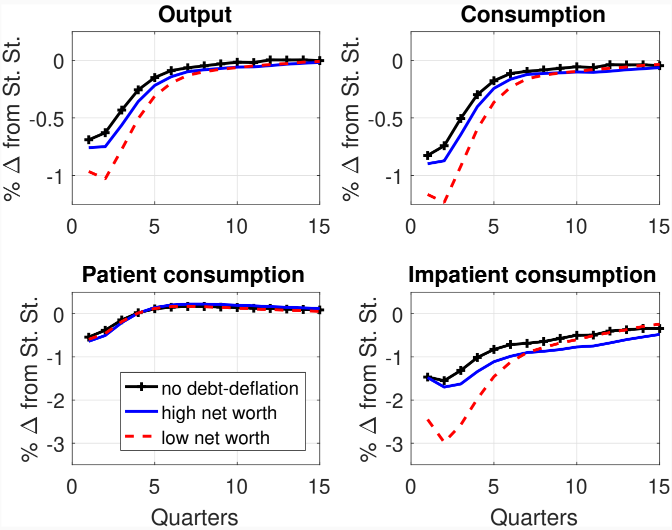
Net worth and monetary policy



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Estimation approach

Define the structural IRF of y_t to $shock_t$ at horizon h as

$$IRF(h, shock_t) = E(y_{t+h}|shock_t = \delta) - E(y_{t+h}|shock_t = 0)$$

This can be computed with regressions

$$\begin{aligned} y_{t+h} = \tau t + I_{t-1}\left[\alpha_{A,h} + \psi_{A,h}(L)x_t + \boldsymbol{\beta_{A,h}} shock_t\right] \\ + (1 - I_{t-1})\left[\alpha_{B,h} + \psi_{B,h}(L)x_t + \boldsymbol{\beta_{B,h}} shock_t\right] + \epsilon_{t+h} \end{aligned}$$

where $h = 1, \ldots, H$ and

$$shock_t = r_t - E(r_t|\omega_{kt})$$

$$\begin{aligned} \omega_{kt} = (r_{t-1}, r_{t-2}, y_t, y_{t-1}, y_{t-2}, p_t, p_{t-1}, p_{t-2}, \\ n_t, n_{t-1}, n_{t-2}, s_{t-1}, s_{t-2}) \end{aligned}$$

x_t additionally includes 2 lags of y_t.

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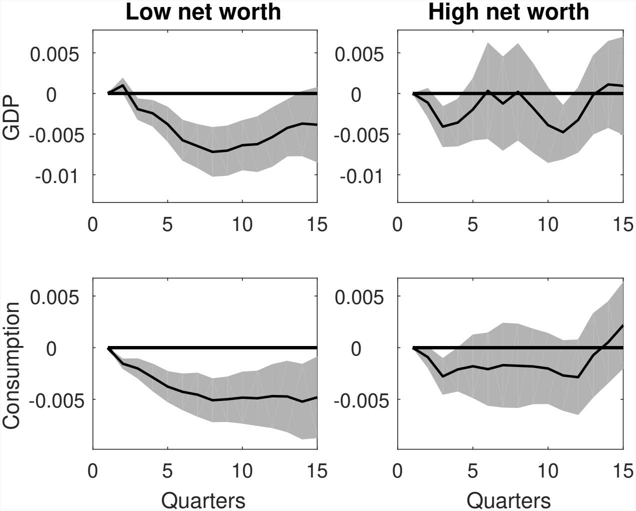
Baseline results: contractionary MP shock



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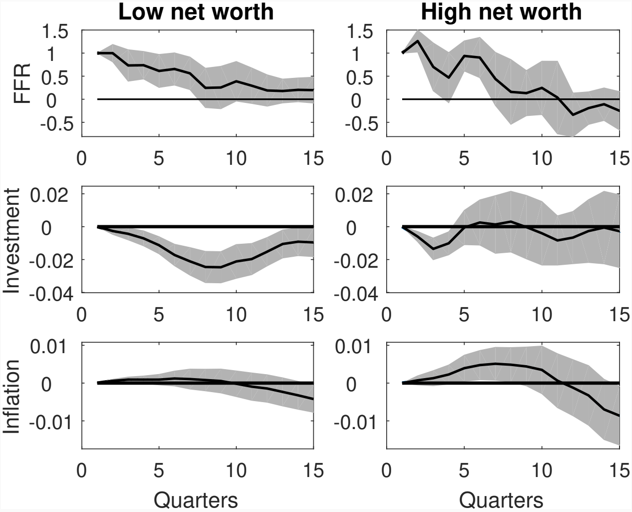
Baseline results: contractionary MP shock



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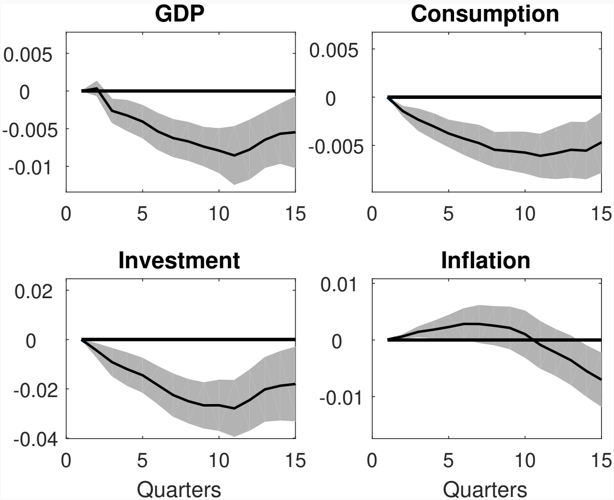
Linear model: contractionary MP shock



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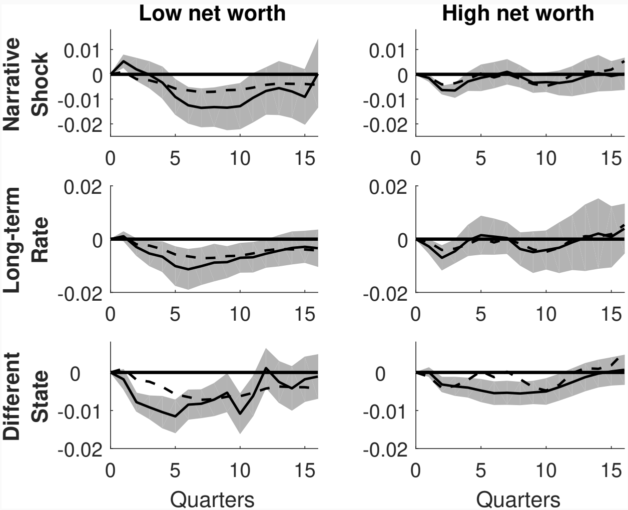
Alternative identification and state definition: GDP



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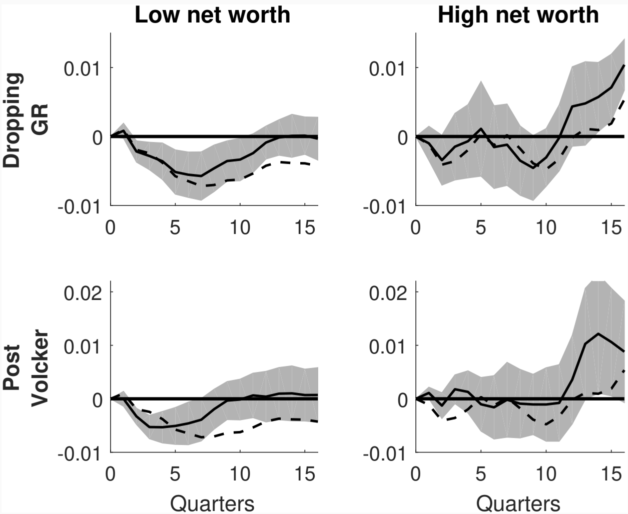
Alternative samples: GDP



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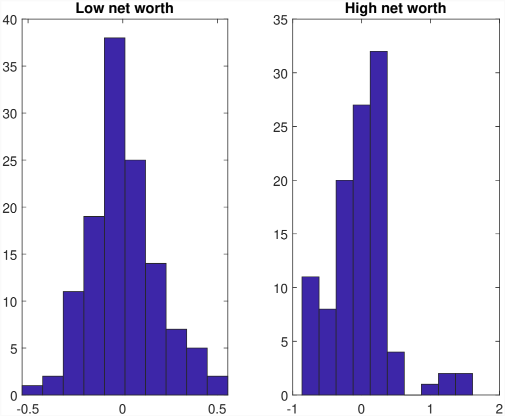
Sign of monetary policy shocks



Notes: Monetary policy shocks during a high household net worth state: 50% positive and 50% negative. Monetary policy shocks during a low household net worth: 46% positive and 54% negative. 52% of the positive shocks happened during a low household net worth state, while 55% of the negative shocks occurred during a low net worth state.

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