The Transmission of Monetary Policy under the Microscope

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NBER Summer Institute, 9 July 2020

Motivation

- How does monetary policy affect household consumption?
- Recent advances in monetary economics

RANK $\rightarrow$ HANK

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  - Large consumption response of HHs with few liquid assets
  - MP works through general equilibrium ("indirect") effects
- But: Limited empirical evidence for these predictions

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  - Large consumption response of HHs with few liquid assets
  - MP works through general equilibrium ("indirect") effects
- But: Limited empirical evidence for these predictions
- This paper: provide detailed analysis of monetary transmission at the household level using Norwegian administrative data

Our findings

1. Responses across the liquid asset distribution
    - Low- but also high-liquidity HHs respond strongly
    - $r \uparrow \Rightarrow c_{\text{low liq.}} \downarrow$ and $c_{\text{high liq.}} \uparrow$
    - Most surprising: $\Delta c_{\text{high liq.}}$ is large

      $\rightarrow$ Sizable MPCs for high-liquidity HHs

      $\rightarrow$ Cash flow effects are important

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     $\rightarrow$ Sizable MPCs for high-liquidity HHs

     $\rightarrow$ Cash flow effects are important

2. Empirical decomposition into direct and indirect effects
   - Years 0-2: almost all direct
   - Years 3-5: about half indirect

     $\rightarrow$ Indirect effects of MP are large, albeit with a lag

Literature

- HANK models

  Kuester-Gornemann-Nakajima (2016), McKay-Nakamura-Steinsson (2016), McKay-Reis (2016), Guerrieri-Lorenzoni (2017), Debortoli-Gali (2018), Ravn- Sterk (2018), Bayer-Luetticke-Pham-Dao-Tjaden (2019), Kaplan-Moll-Violante (2018), Auclert (2019), Bilbiie (2019), Luetticke (2019), Auclert-Rognlie-Straub (2020)

- Monetary transmission using micro data

  La Cava-Hughson-Kaplan (2016), Di Maggio-et al (2017), Floden-Kilstrom-Sigurdsson-Vestman (2017), Coibion-Gorodnichenko-Kueng-Silvia (2017), Beraja-Fuster-Hurst-Vavra (2018), Berger-Milbradt-Tourre-Vavra (2018), Eichenbaum-Rebelo-Wong (2019), Wong (2019), Cloyne-Ferreira-Surico (2019)

Roadmap

1. Monetary Policy Identification
2. Administrative Data
3. Monetary Transmission at the Household Level
4. Direct and Indirect Effects of Monetary Policy
5. Conclusion

Monetary Policy Identification

Monetary policy identification

▸ Forecasts ▸ Historical Policy Rate

- Identification follows Romer-Romer (2004)

$$\begin{aligned}\Delta i_m = \alpha_1 + \alpha_2 i_{m,-1} + \sum_{k=0}^{1} \beta_k^{\pi} \pi_{m,t+k} + \sum_{k=0}^{1} \beta_k^{\Delta\pi} \Delta\pi_{m,t+k} \\ + \sum_{k=0}^{1} \beta_k^{y} y_{m,t+k} + \sum_{k=0}^{1} \beta_k^{\Delta y} \Delta y_{m,t+k} \\ + \gamma_1 ex_{m,-1} + \gamma_2 I_m^{IT} \cdot ex_{m,-1} + \epsilon_m^{MP}\end{aligned}$$

- i policy rate, y GDP growth forecast (mainland), π inflation forecast, ex exchange rate, and I indicator for pre-inflation targeting

Monetary policy identification

Variable	Constant	$i_{m,-1}$	π_m	y_m	$ex_{m,-1}$	$I_m^{IT} \cdot ex_{m,-1}$
	-0.50	-0.02*			0.02	0.06
	(0.22)	(0.09)			(0.95)	(0.34)
Current Year			0.06**	0.05		
			(0.04)	(0.37)		
Next Year			0.04	0.04		
			(0.44)	(0.62)		
ΔCurrent Year			0.02	0.27***		
			(0.28)	(0.00)		
ΔNext Year			0.11**	-0.04		
			(0.02)	(0.58)		
$N = 162$					Sample: 1994:M1-2018:M12	
$R^2 = 0.30$						

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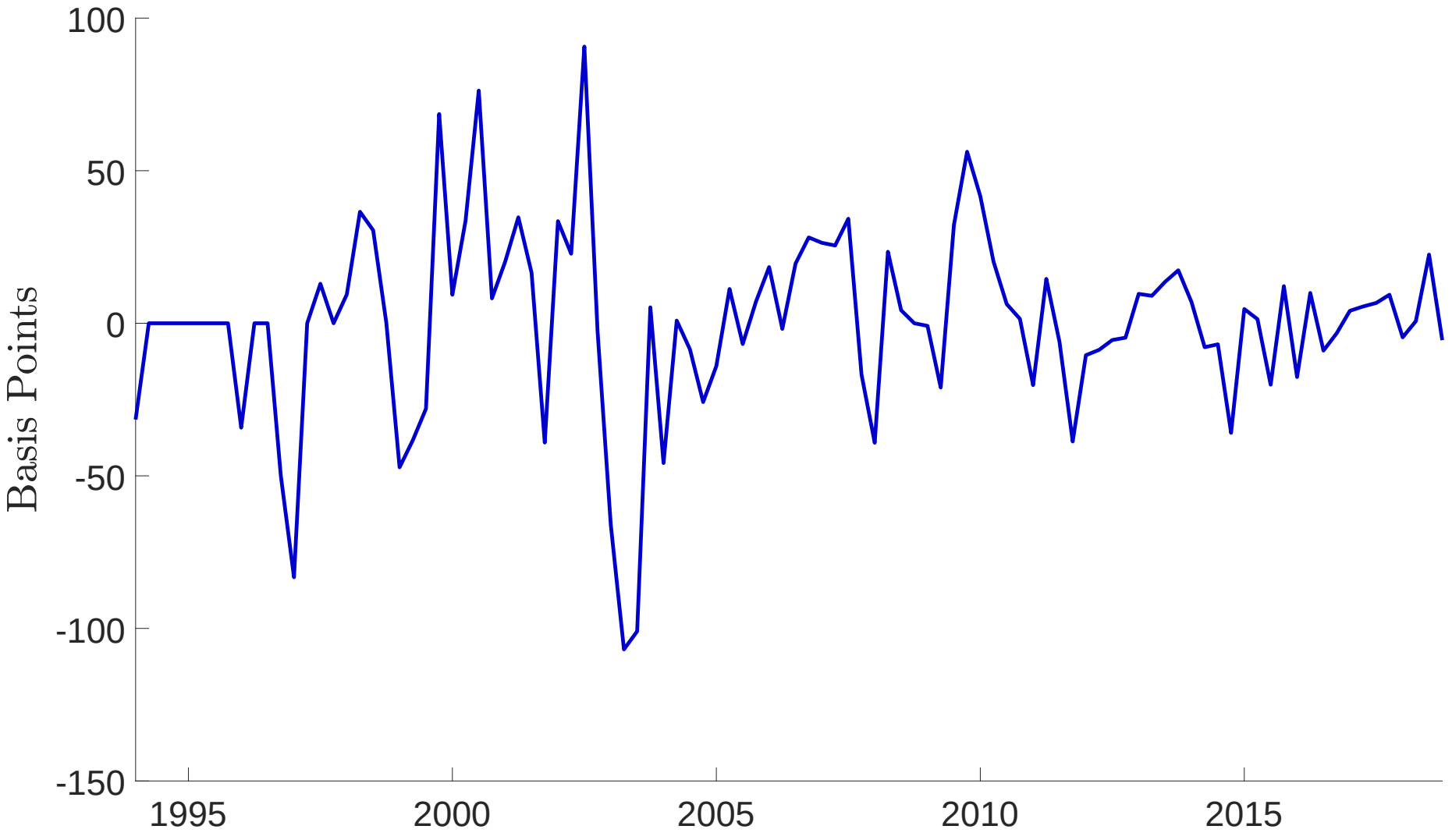
$N = 162$					Sample: 1994:M1-2018:M12	
$R^2 = 0.30$						

→ Aggregate residuals to monthly, quarterly, and annual frequency

Monetary policy shocks

▸ Monthly ▸ Annual ▸ Rate vs. shocks ▸ Predictability



Local projections

Based on shock series ϵ_t^{MP}, estimate local projections

$$y_{t+h} - y_{t-1} = \alpha^h + \beta^h \cdot \epsilon_t^{MP} + \gamma^h X_{t-1} + u_t^h$$

for outcome variable of interest y_t

- Impulse response horizons
  - h=0,1,...,20 for quarterly data
  - h=0,1,...,5 for annual data
- Newey-West standard errors
- X_{t-1}: controls (three lags of ϵ^{MP})

Macro responses

▸ Time aggregation ▸ Additional evidence & robustness

68% & 95% confidence bands

Macro responses

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Administrative Data

Administrative data

▸ Sample ▸ Summary statistics ▸ Comparison with NA ▸ Aggregated responses ▸ Inequality responses

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Sources

- Tax registry (income and wealth tax)
- Housing ownership and transactions
- Shareholder registry
- Longitudinal socio-economic database

Characteristics

- Third-party reported (employers, financial institutions)
- We aggregate information to household level
- Includes population of households in Norway ($\approx$ 1.9 million)
- Annual panel for 1996 to 2015 (20 years)

Consumption imputation

▸ Sample ▸ Summary statistics ▸ Comparison with NA ▸ Aggregated responses ▸ Inequality responses

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- Consumption expenditures imputed from budget identity

$$\text{Consumption } (C_t) = \text{Disposable Income } (Inc_t) - \text{Saving } (S_t)$$

$$Inc_t = \text{Labor inc}_t + \text{Net capital inc}_t + \text{Transfers}_t - \text{Taxes}_t + \text{Misc}_t$$

$$S_t = \Delta\text{Wealth}_t - \text{Capital gains}_t$$

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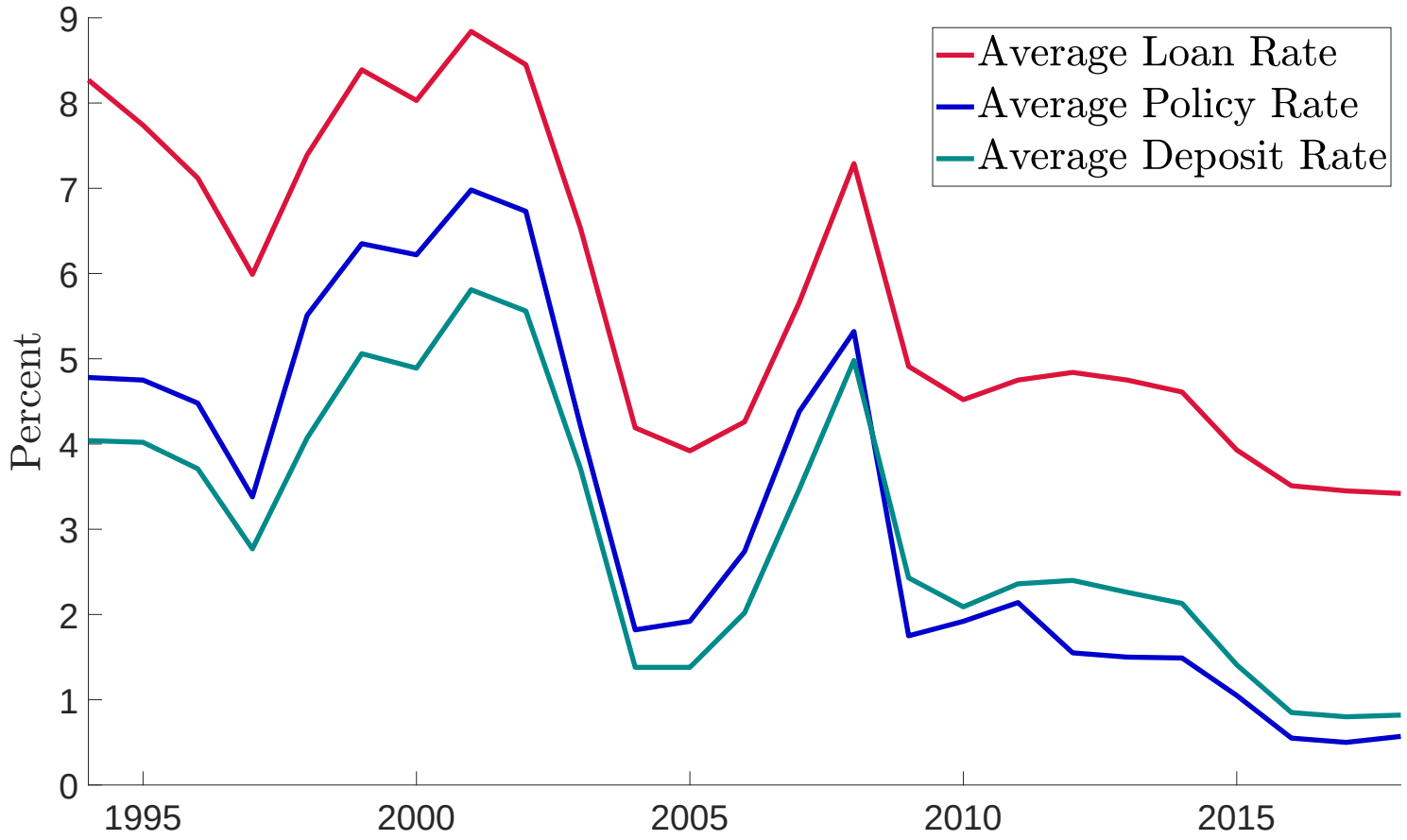
- Capital gains ▸ Details
  - Based on household-level housing & stock transaction data
  - All results robust to "no risky asset" sample

Interest rate pass-through



Monetary Transmission at the Household Level

Monetary Policy and Liquid Assets

Predictions from HANK models ▸ Details

- High-liquidity HHs: MPC small, intertemp. subs. dominate
- Low-liquidity HHs: MPC large, intertemp. subs. small

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Estimate impulse responses by liquid asset holdings

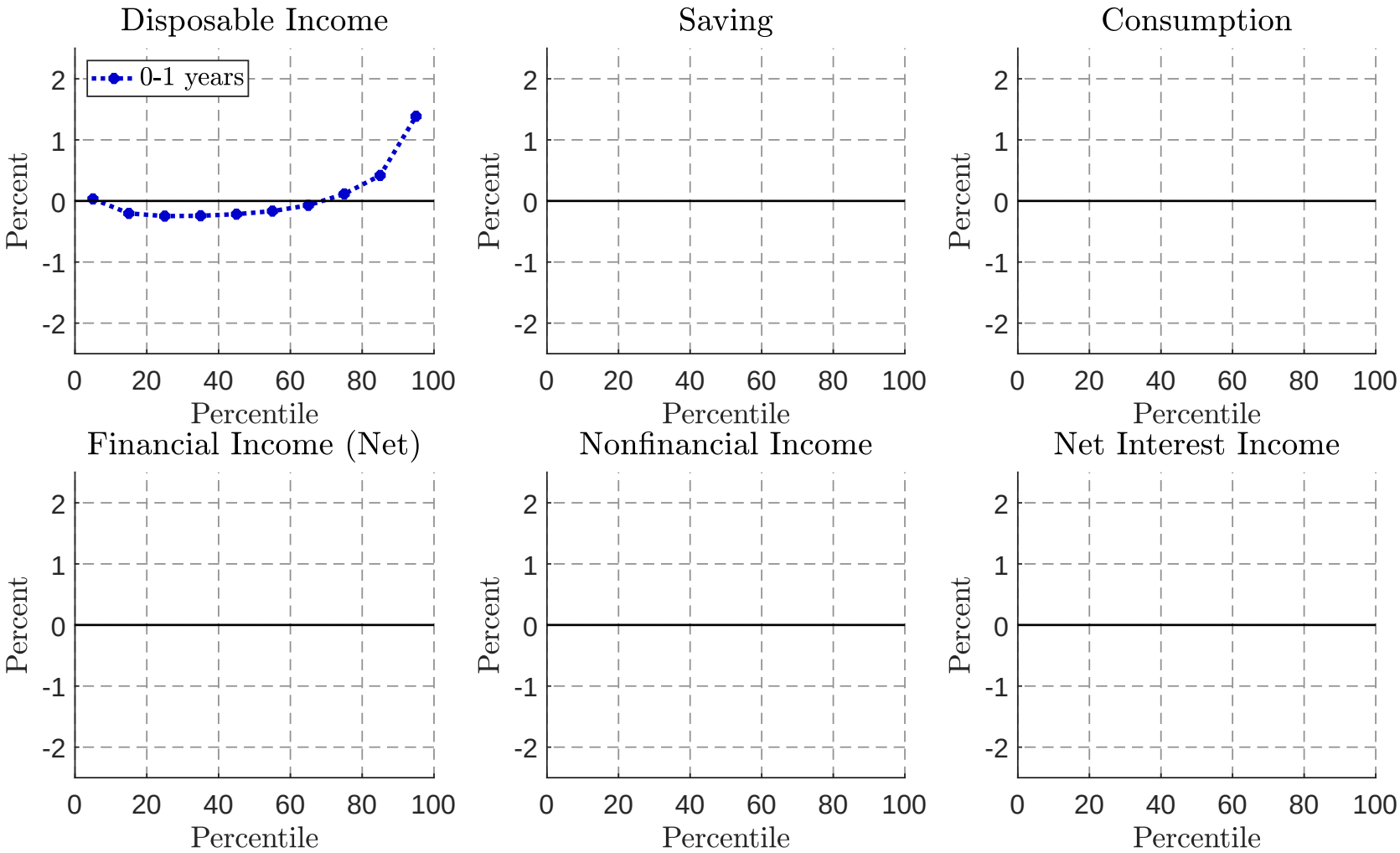
- Liquid assets = deposits + bonds + stocks + stock funds
- Divide HHs into groups $g = 1, 2, \ldots, 10$ by liquid assets in $t-1$

$$\frac{y_{i,t+h} - y_{i,t-1}}{inc_{i,t-1}} = \alpha_i^h + \beta_g^h \cdot \epsilon_t^{MP} + \gamma_g^h X_{i,t-1} + u_{i,t}^h \quad \forall i \in g$$

- $X_{i,t-1}$: Controls
  - Three lags of ϵ_t^{MP}
  - Two lags of dependent variable (h=0)
- Driscoll-Kraay standard errors

Responses by liquid assets

▸ Confidence bands ▸ Distributions



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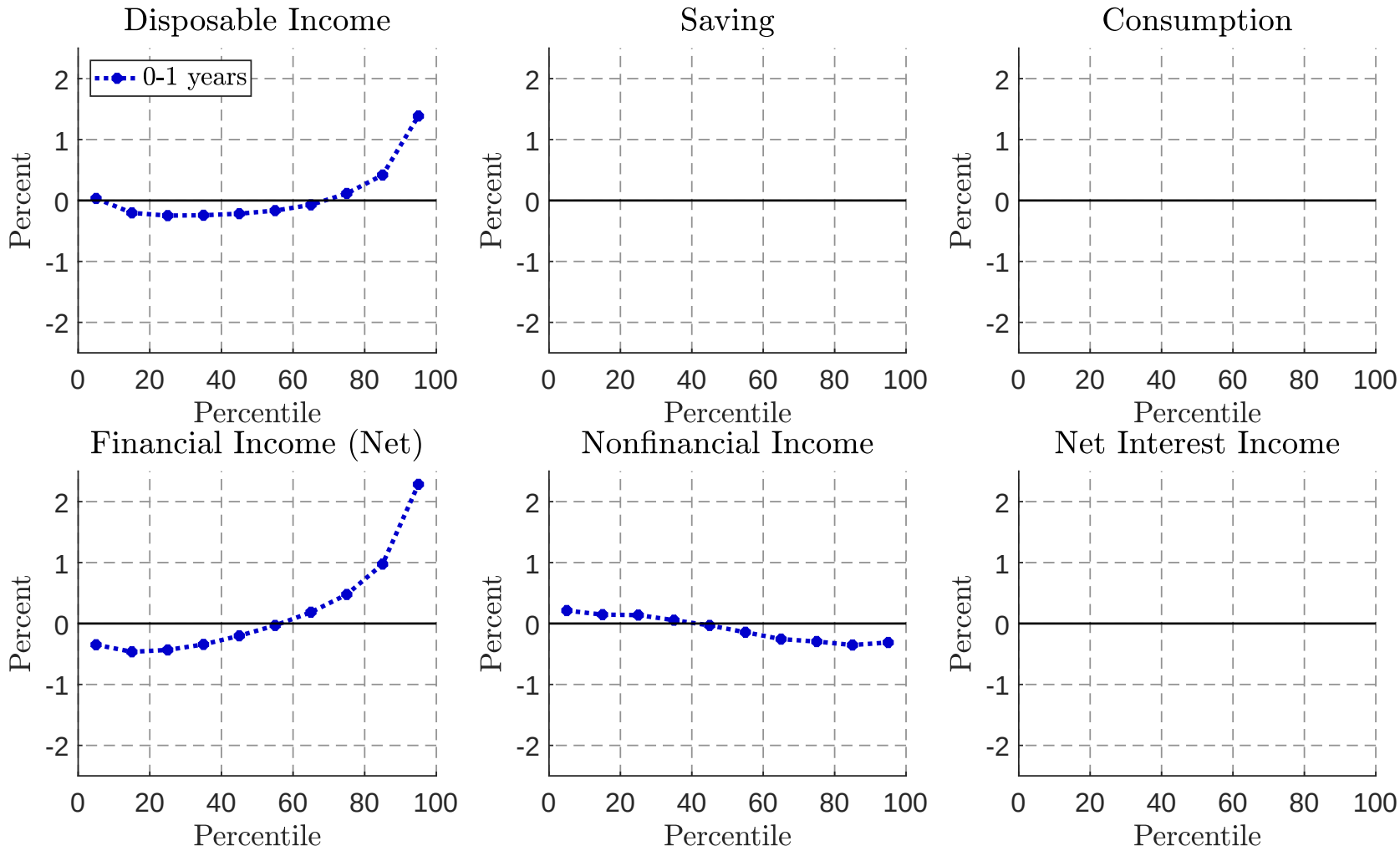

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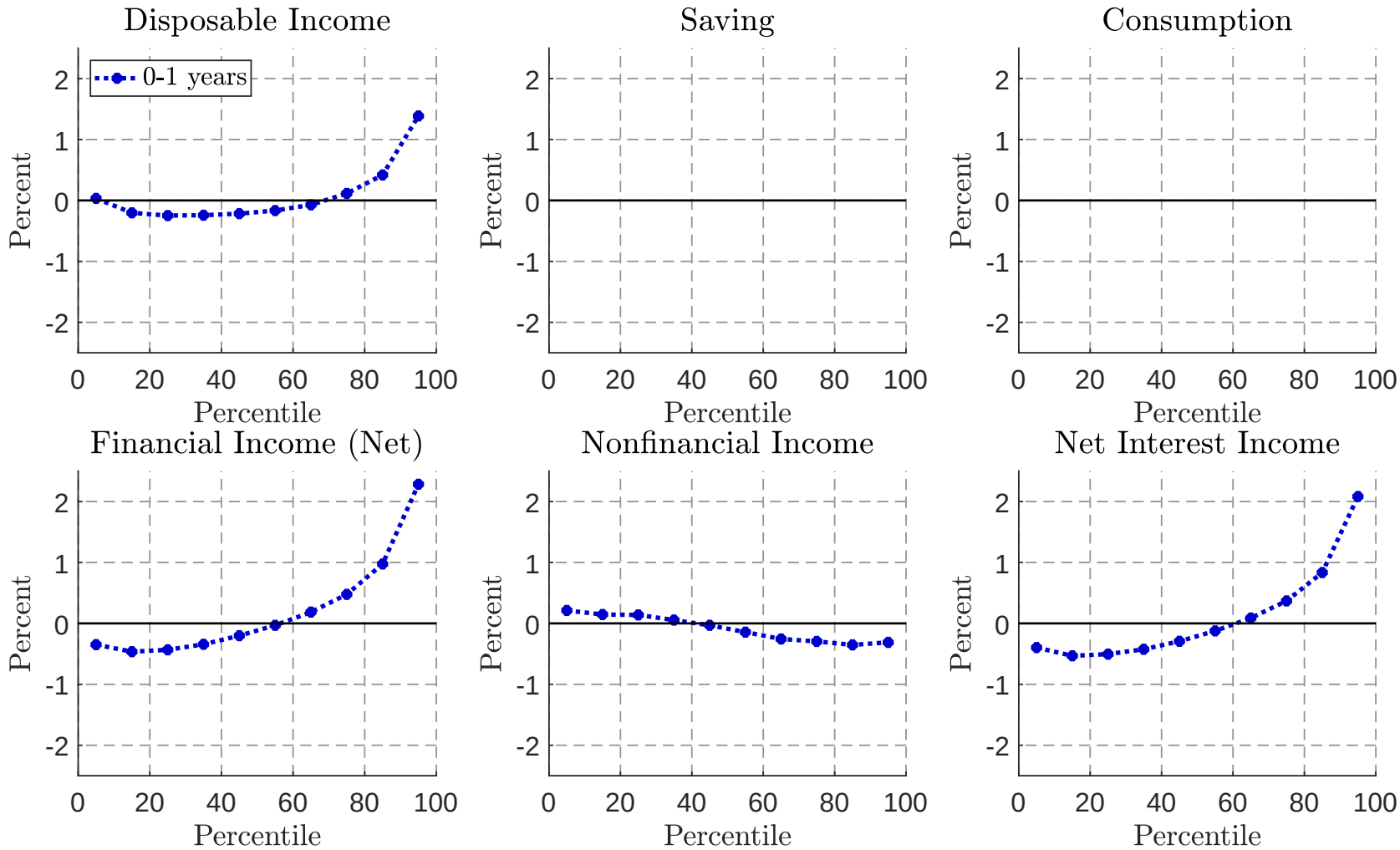

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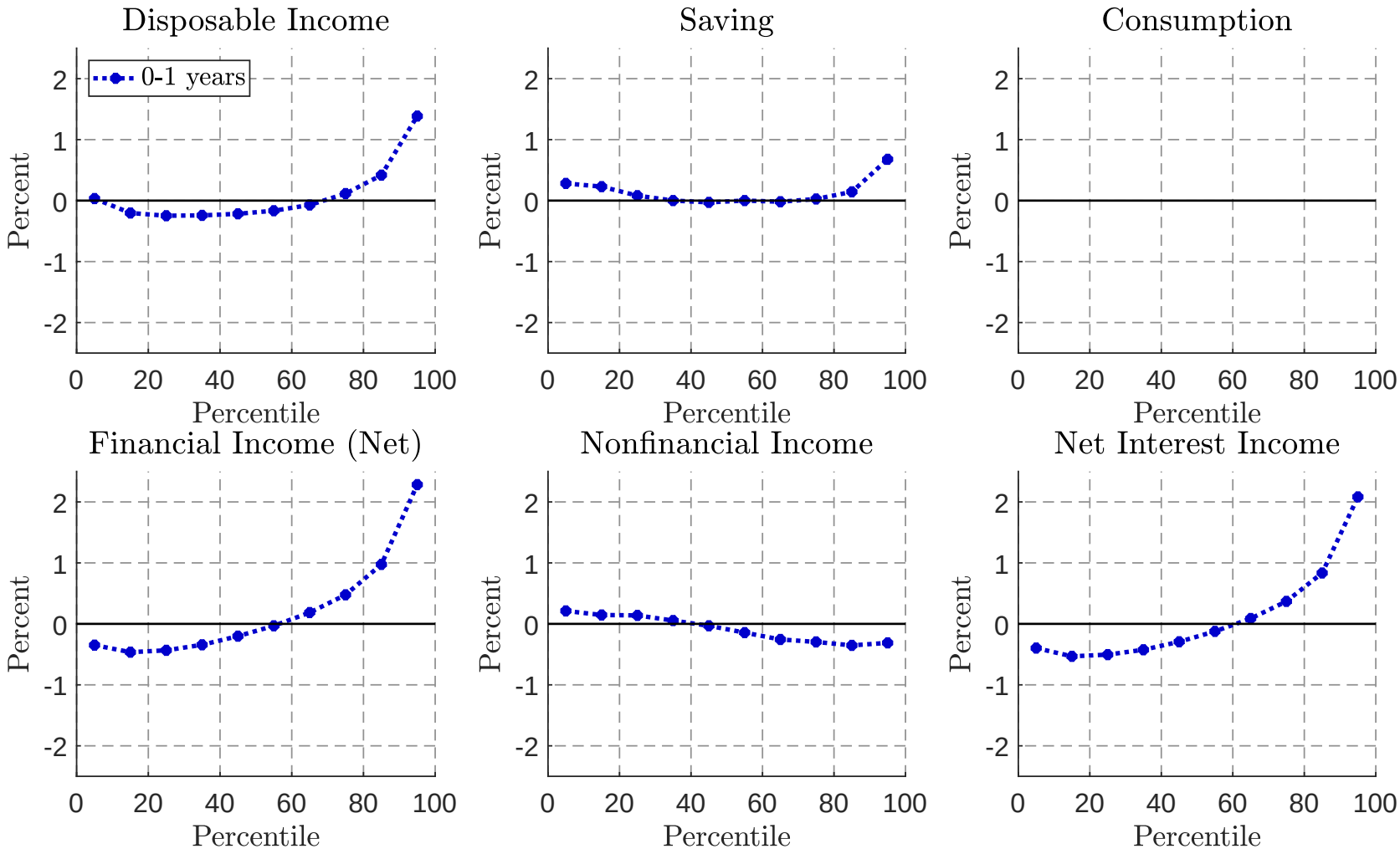

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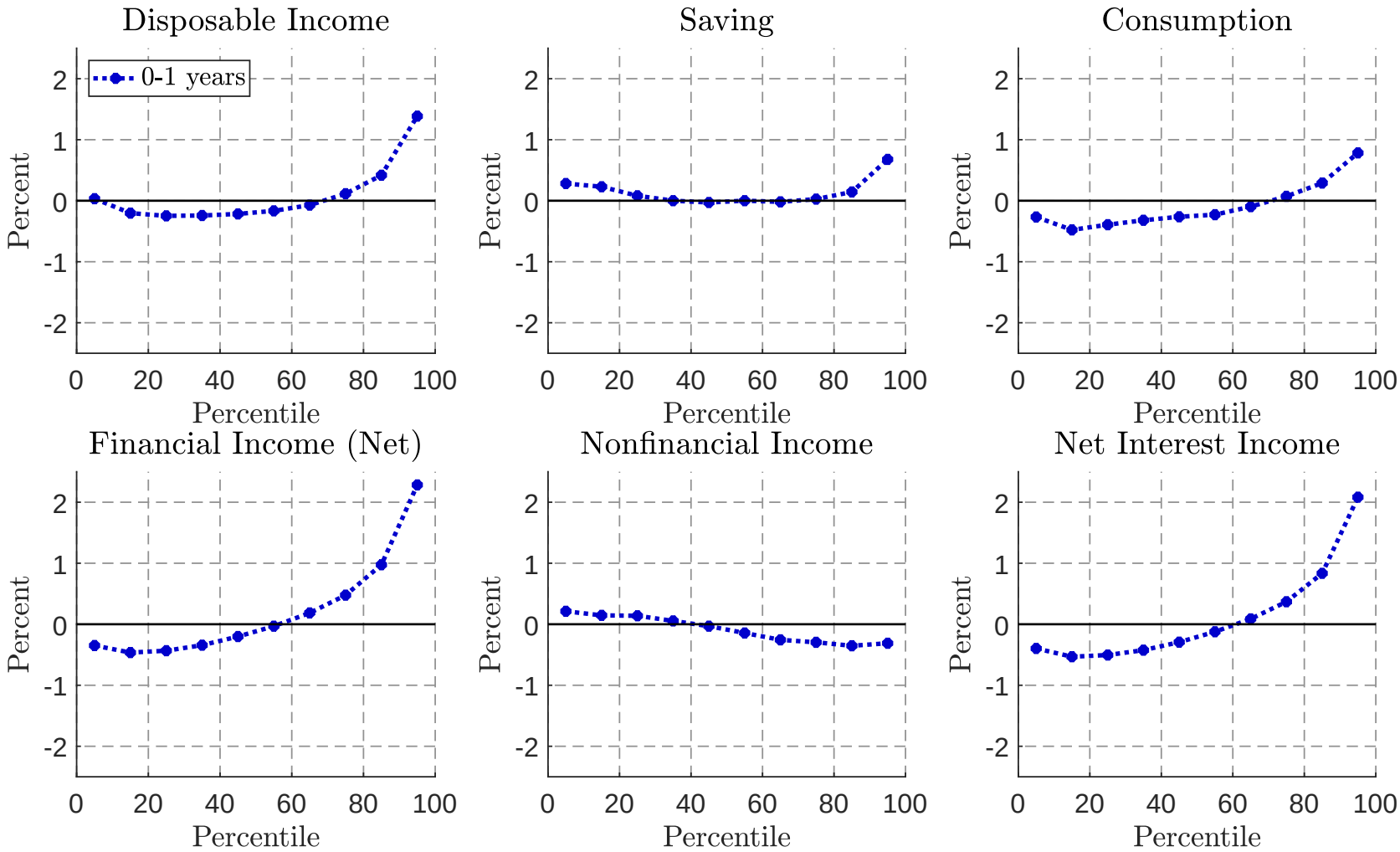

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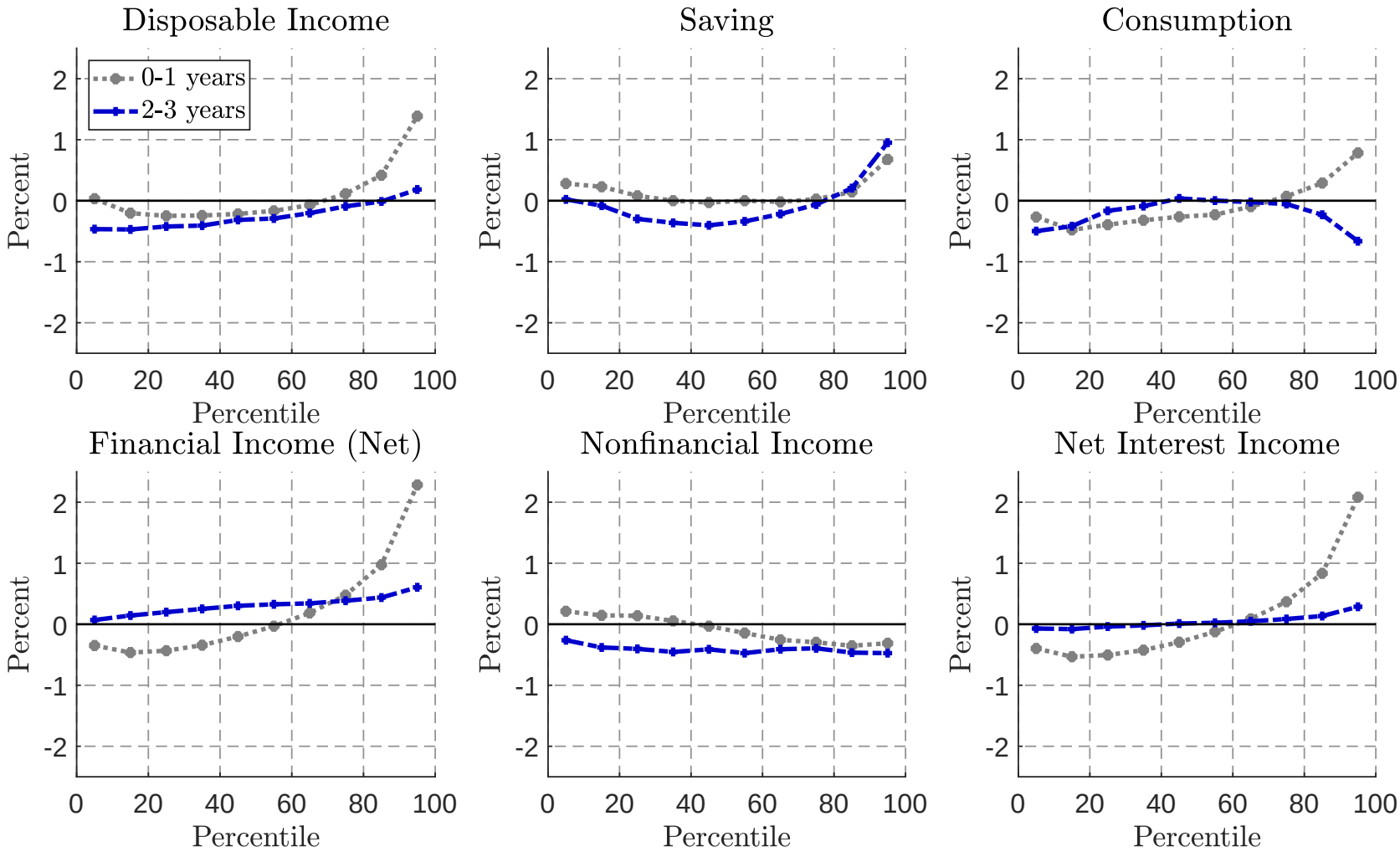

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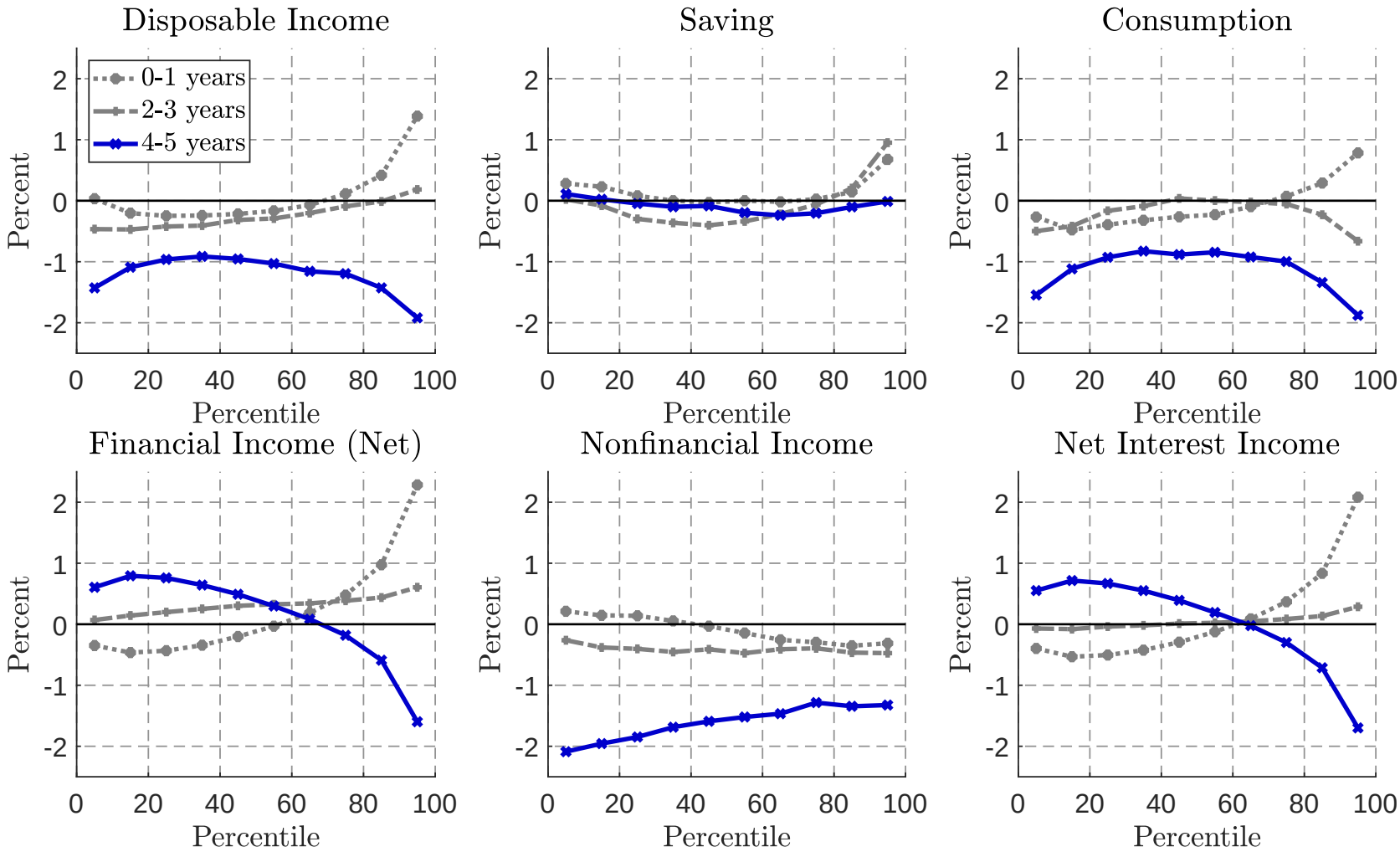

Additional Evidence & Robustness

- Wealth effects ▸ Details
- Planned durable purchases ▸ Persistence
- Correlation with age ▸ Details
- Correlation with income ▸ Details
- Which HHs drive aggregate response? ▸ Details ▸ Within top 10%
- Liquidity/Income distribution ▸ Details
- Consumption imputation ▸ Non-stockholders
- Additional evidence on MPCs ▸ Details

Responses by net interest rate exposure ▸ Confidence bands

- Net interest rate exposure = deposits - debt

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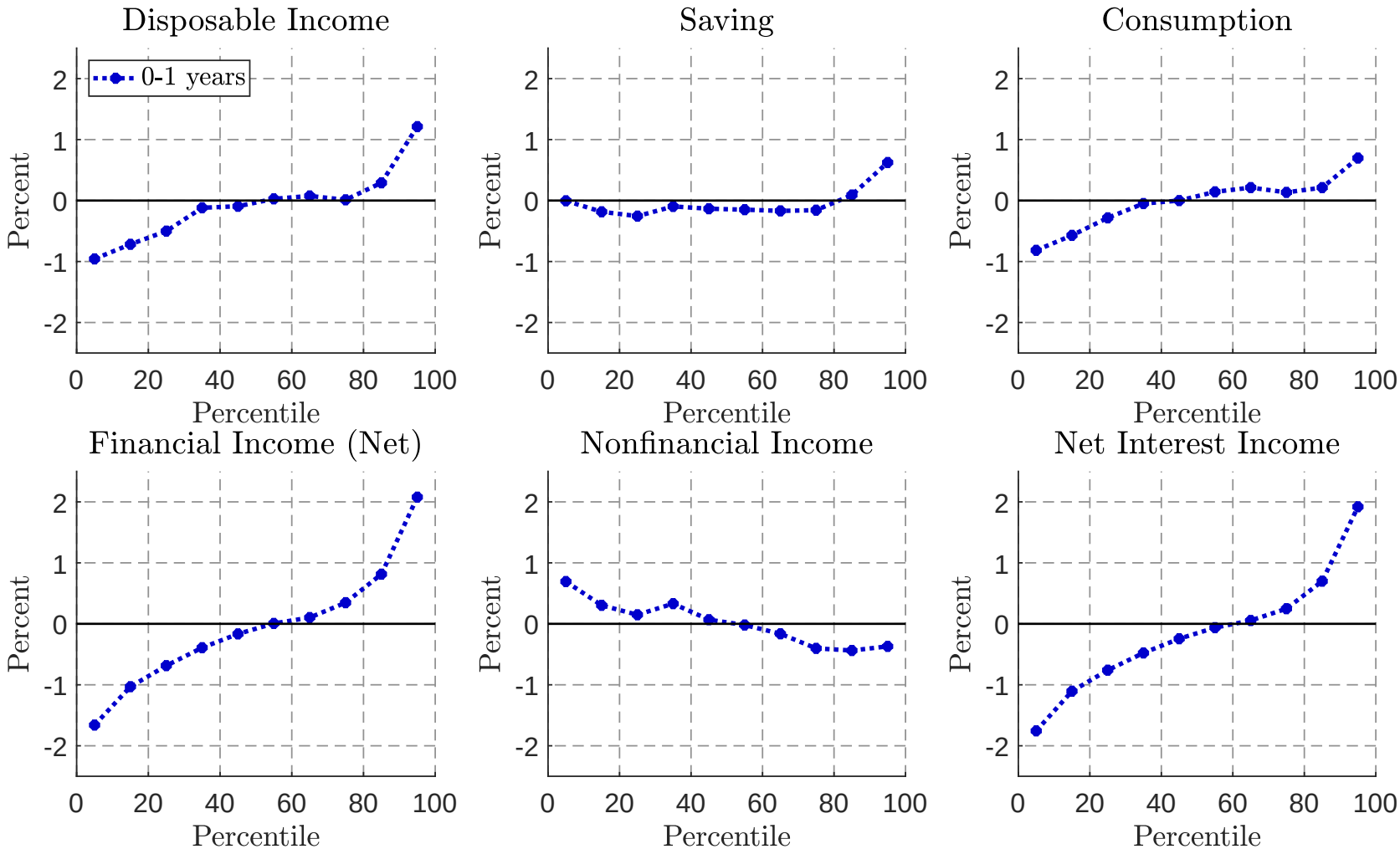

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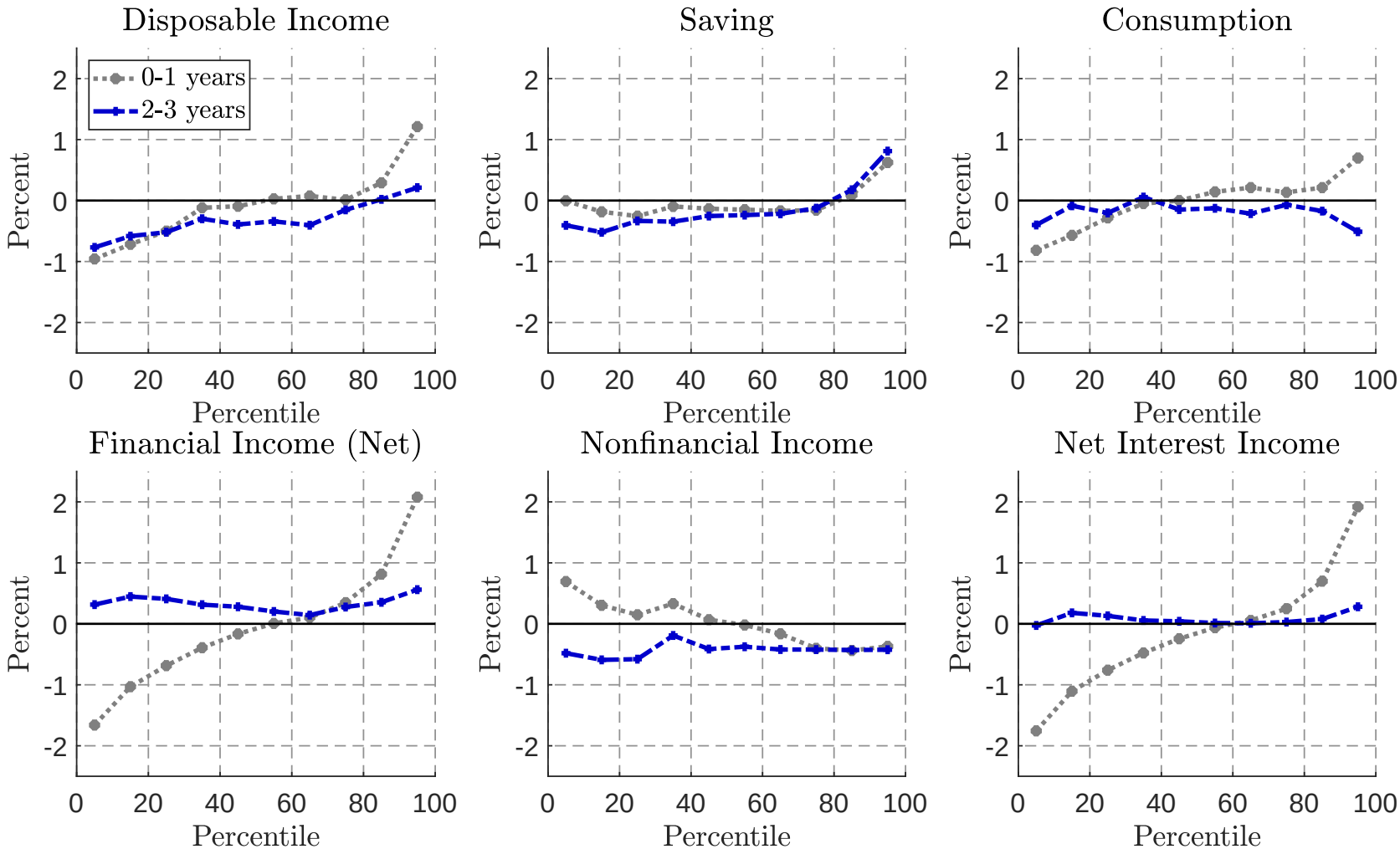

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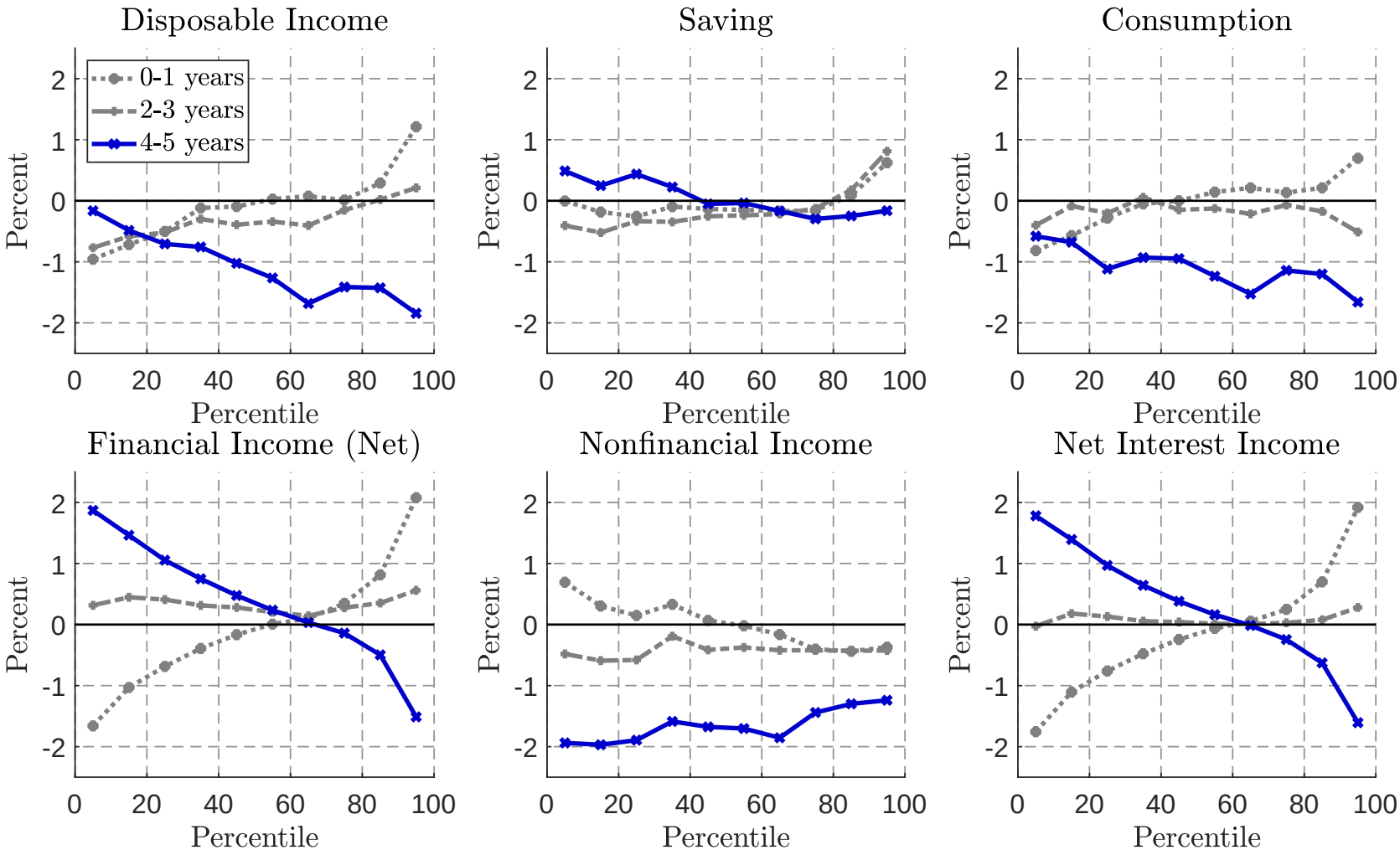


Direct and Indirect Effects of Monetary Policy

Direct and indirect effects

▸ MPCs ▸ Capital Gains ▸ By liquid assets

- Kaplan-Moll-Violante (2018) decomposition

$$dC_0 = \underbrace{\int_0^\infty \frac{\partial \mathcal{C}_0}{\partial r_t} dr_t dt}_{\text{direct}} + \underbrace{\int_0^\infty \frac{\partial \mathcal{C}_0}{\partial Y_t} dY_t dt}_{\text{indirect}}$$

- Empirical analogue (simplified notation)

$$\Delta^h C_{i,t-1} = \alpha_i^h + \beta^h \epsilon_t^{MP} + u_{i,t}^h$$
$$\Delta^h C_{i,t-1} = \tilde{\alpha}_i^h + \tilde{\beta}^h \epsilon_t^{MP} + \tilde{\gamma}^h \Delta^h Y_{i,t-1} + v_{i,t}^h$$

where

$$\beta^h = \underbrace{\tilde{\beta}^h}_{\text{direct}} + \underbrace{\tilde{\gamma}^h \times \delta^h}_{\text{indirect}}$$

δ^h is coefficient in projection of $\Delta^h Y_{i,t-1}$ on ϵ_t^{MP}

Direct and indirect effects

▸ MPCs ▸ Capital Gains ▸ By liquid assets

Empirical model:

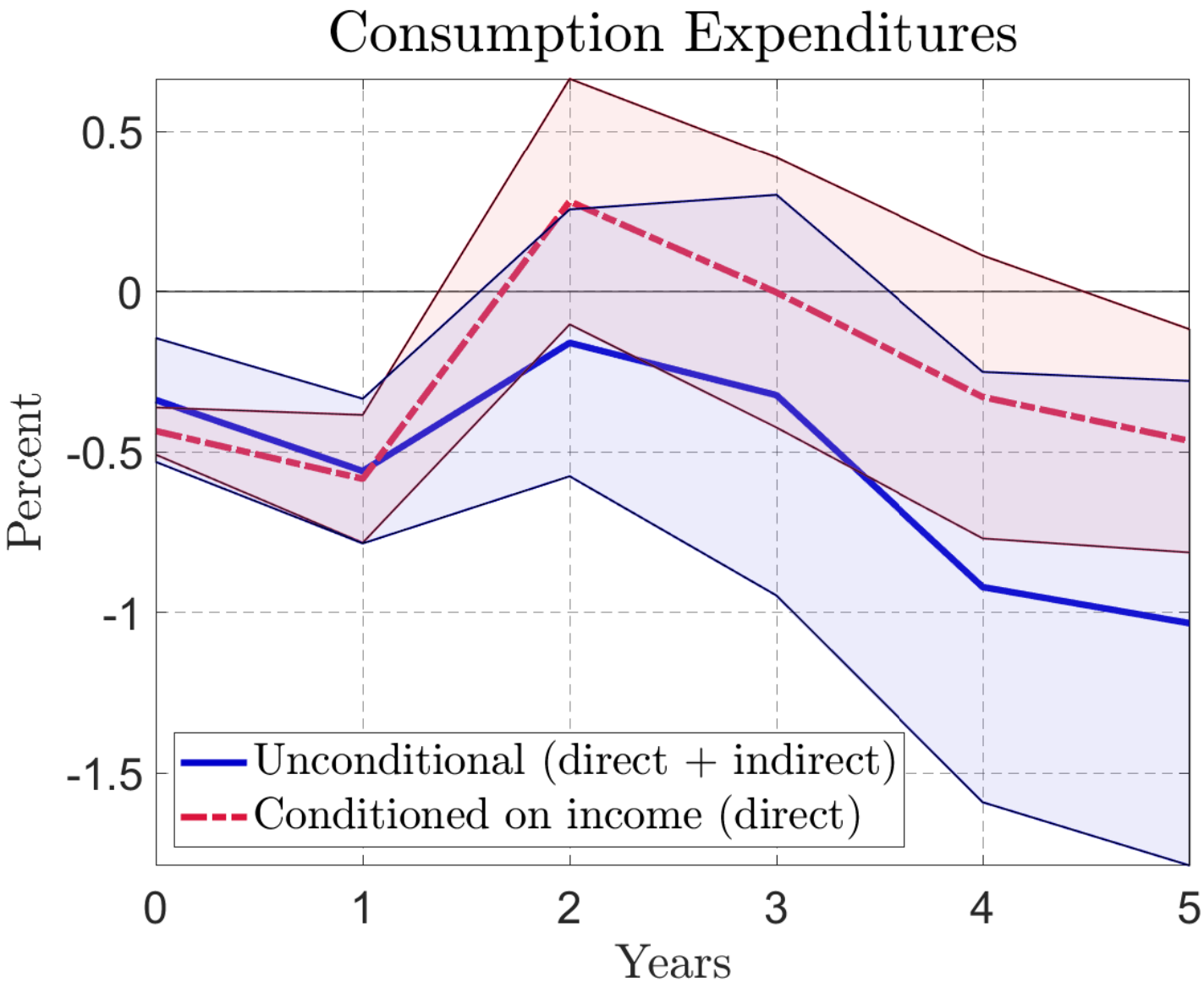
$$\frac{c_{i,t+h} - c_{i,t-1}}{\overline{c}_{t-1}} = \delta_i^h + \underbrace{\beta^h}_{\text{direct}} \epsilon_t^{MP} + \sum_{k=1}^{K} \sum_{m=0}^{h} \gamma_m^{h,k} \widetilde{y}_{i,t+m}^k + \mu^h X_{i,t-1} + u_{it}^h$$

where $\widetilde{y}_{i,t+m}^k$ is change in income k since $t-1$ relative to $\overline{c}_{t-1}$.

- In k: labor income, transfers, taxes, other income, dividends
- Not in k: interest income & expenses (direct + reverse causality)
- Not in k: future expected changes (included in theory)
- Not in k: capital gains and losses (robustness)

Direct and indirect effects

▸ MPCs ▸ Capital Gains ▸ By liquid assets



Direct and indirect effects - IV

Potential concerns

- Other shocks move consumption directly & through income
- Too high MPC: inc. variation is more persistent than MP shock

Solution

- Use lottery prizes to instrument for non-financial income
- 30,000 unique lottery winners (Fagereng, Holm, Natvik, 2020)

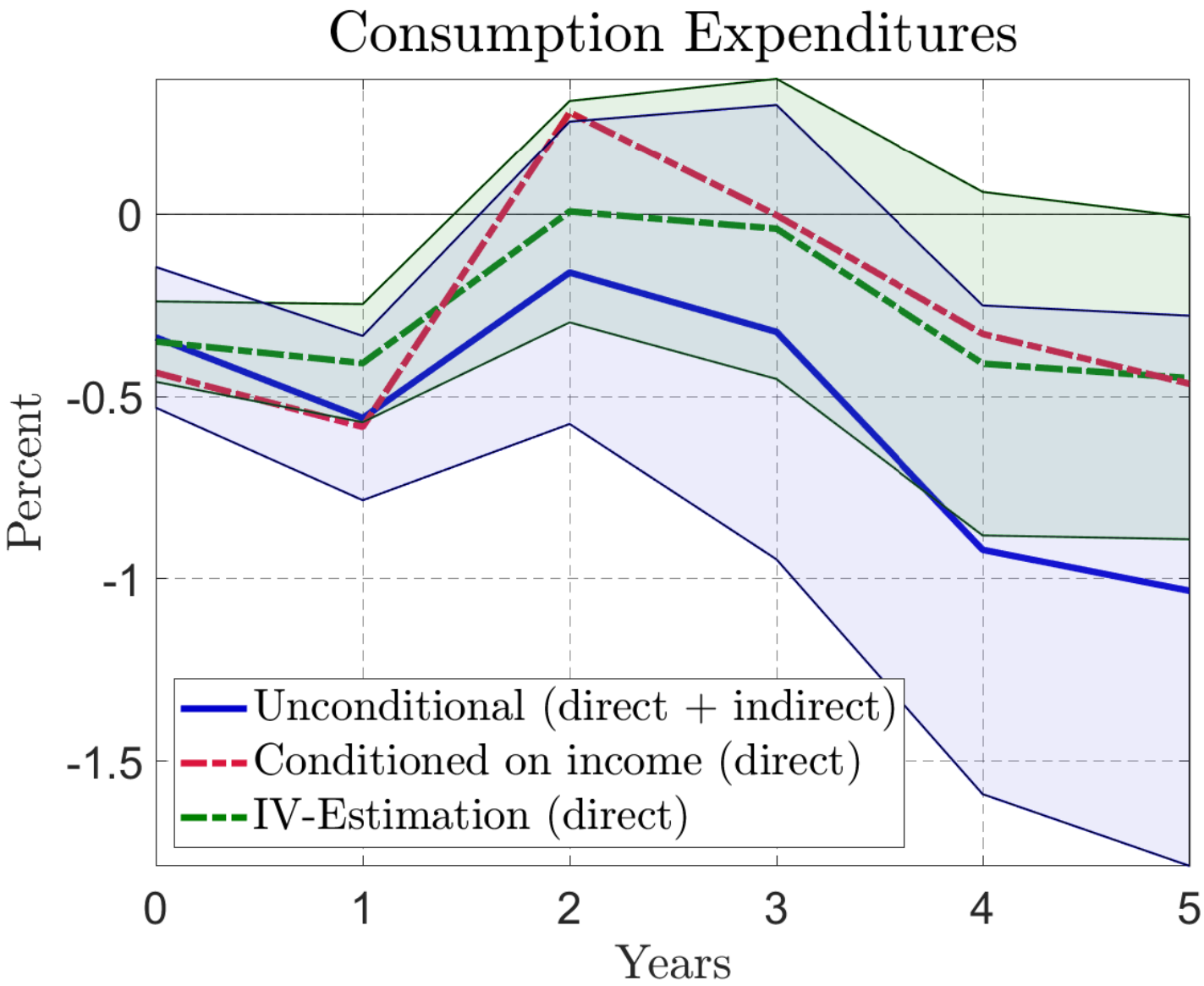
1st-stage

$$\widetilde{y}_{i,t+h} = \delta_i^h + \delta_1^h \text{lottery}_{i,t+h} + \delta_2^h \epsilon_t^{MP} + \delta_3^h X_{i,t-1} + \widetilde{u}_{i,t}^h$$

2nd-stage

$$\frac{c_{i,t+h} - c_{i,t-1}}{\overline{c}_{t-1}} = \delta_i^h + \beta^h \epsilon_t^{MP} + \sum_{m=0}^{h} \gamma_m^h \widehat{\widetilde{y}}_{i,t+m} + \mu^h X_{i,t-1} + u_{i,t}^h$$

Direct and indirect effects - IV



Conclusion

Conclusion

1. We identify monetary policy shocks for Norway and find "text-book" aggregate responses
   - ... based on macro aggregates
   - ... based on micro data

2. Monetary policy affects consumption through income
   - Cash-flow effects are important
   - Deposit-rich households are 'large' and increase consumption with higher interest rates $\rightarrow$ dampened initial aggregate impact of monetary policy

3. Indirect effects of MP are large, albeit with a lag
   - Year 0-2: mostly direct
   - Year 3-5: about half indirect

APPENDIX

Forecasts

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Collected data on:

1. Historical Monetary Policy Meetings
2. Norges Bank Forecasts ($\sim$4 per year)
   - until 2006: "Inflation Reports"
   - since 2007: "Monetary Policy Reports"
3. Consensus Forecasts (monthly)

Correlations: Norges Bank vs. Consensus Mean (1994:M1-2018:M12)

	y_t	y_{t+1}	π_t	π_{t+1}
Correlations	0.95	0.80	0.93	0.69

Forecasts

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To assign forecasts to the policy meetings (162 in total), we use the following rule:

1. If available, use Norges Bank forecasts that are either
    - directly prepared for a policy meeting (51)
    - the same month before the meeting (5)
    - or in the month before the meeting (32)
2. For any remaining meetings, we use the Consensus forecasts that are
    - conducted in the same month before the meeting (4)
    - or in the month before the meeting (70)

Hence, for 88 meetings we use the Norges Bank forecasts, and the Consensus forecasts for the remaining 74 meetings.

Historical policy rate (sight deposit rate)

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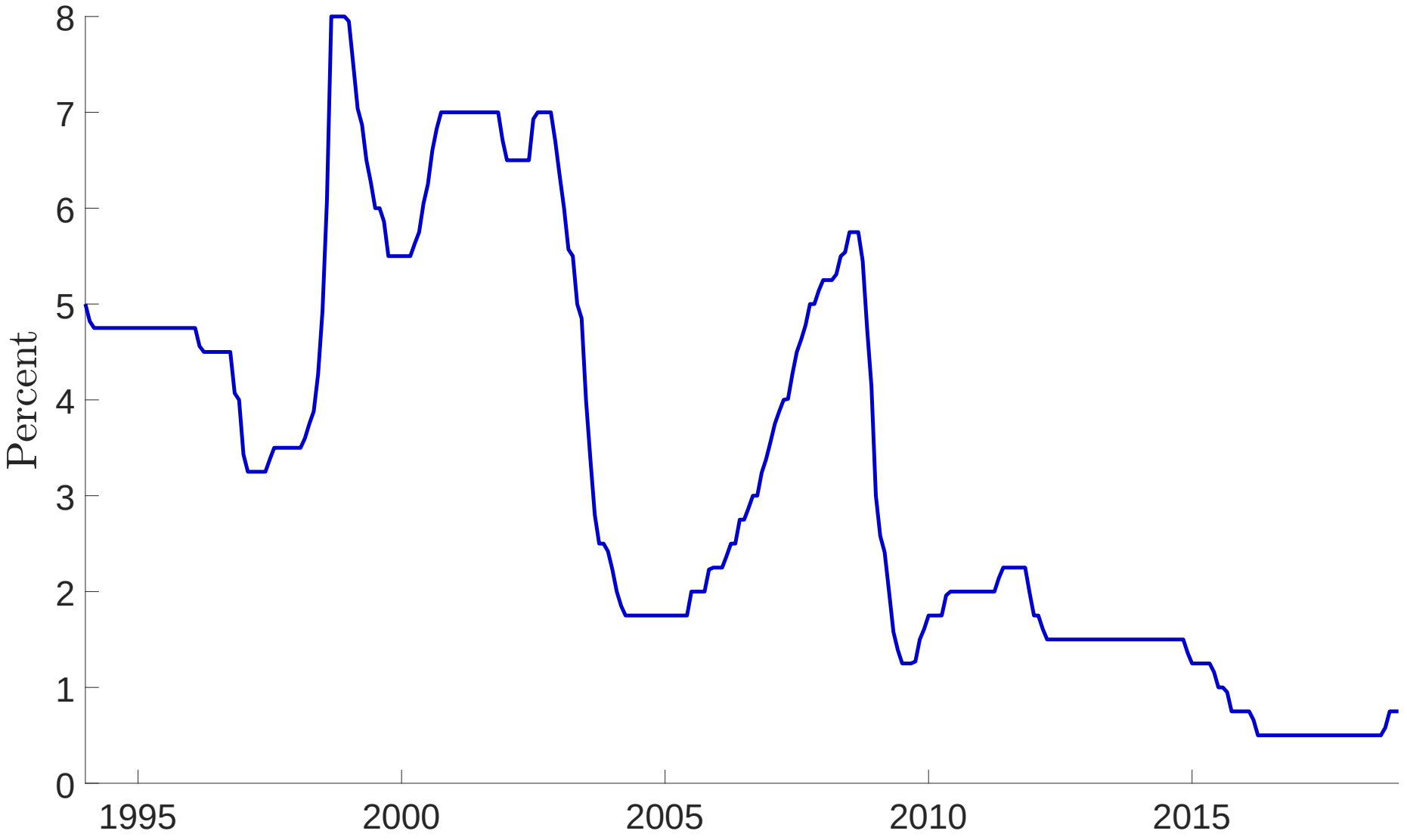

MP shocks monthly

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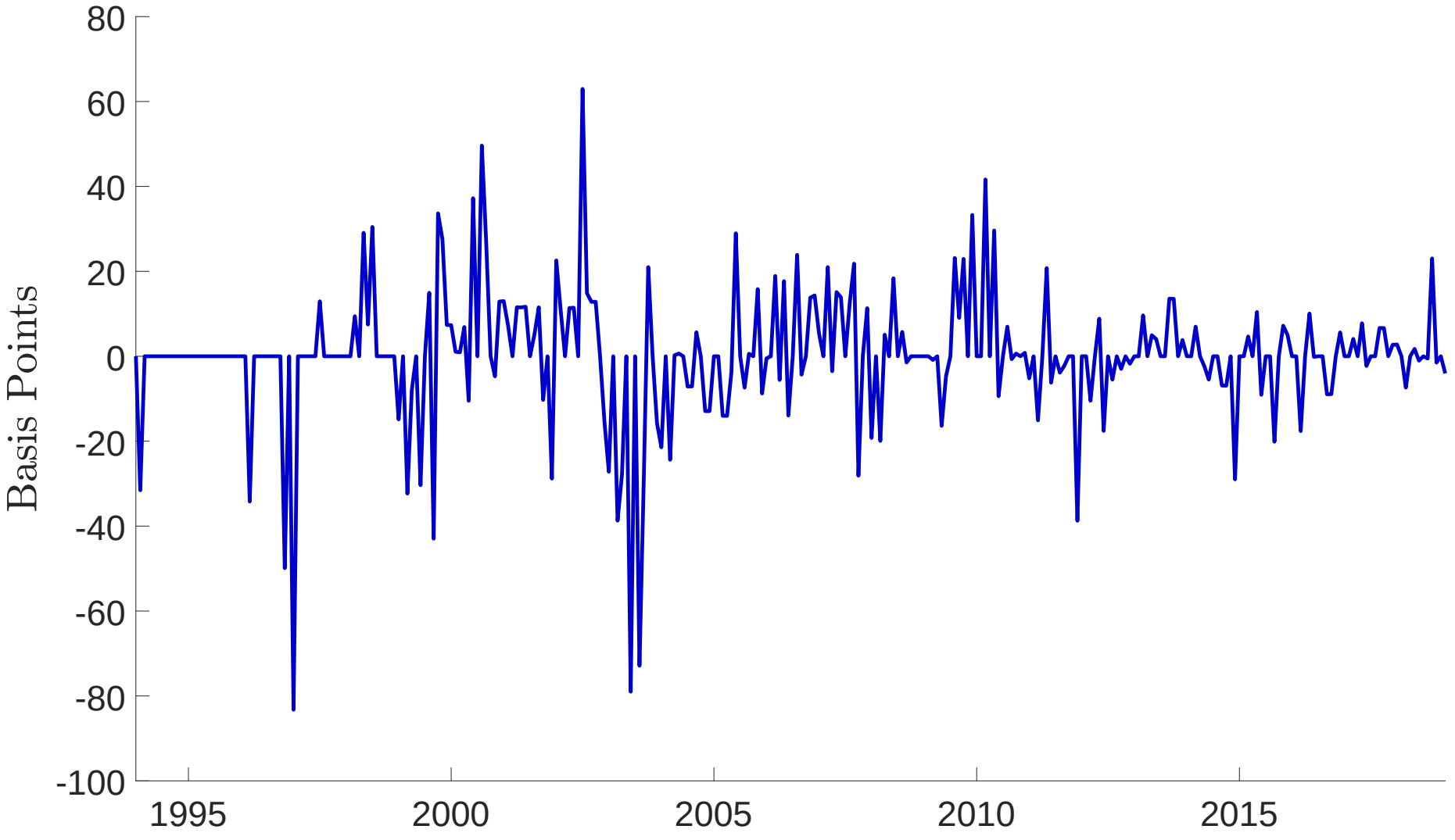

MP shocks annual

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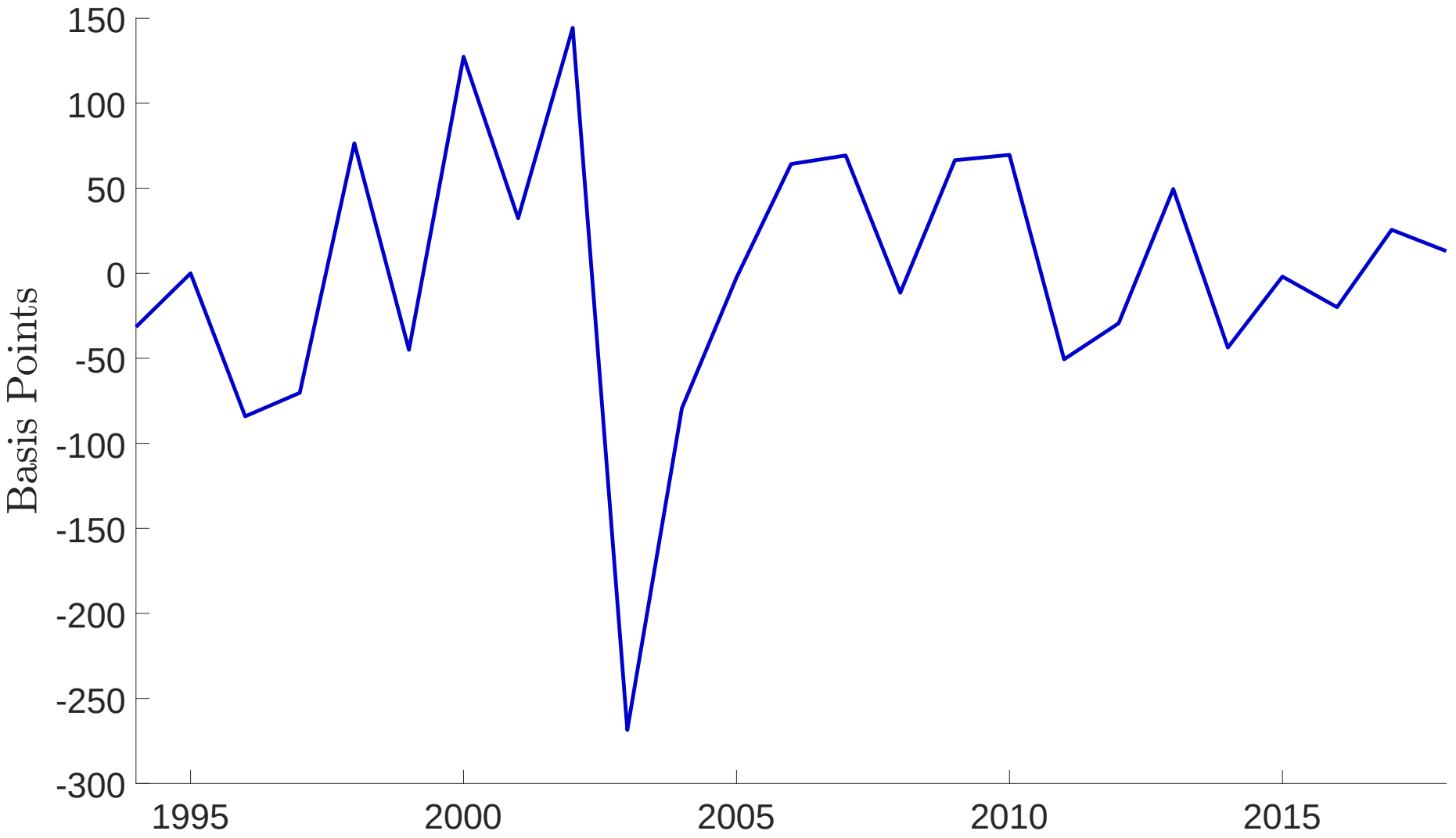

Rate changes vs. MP shocks

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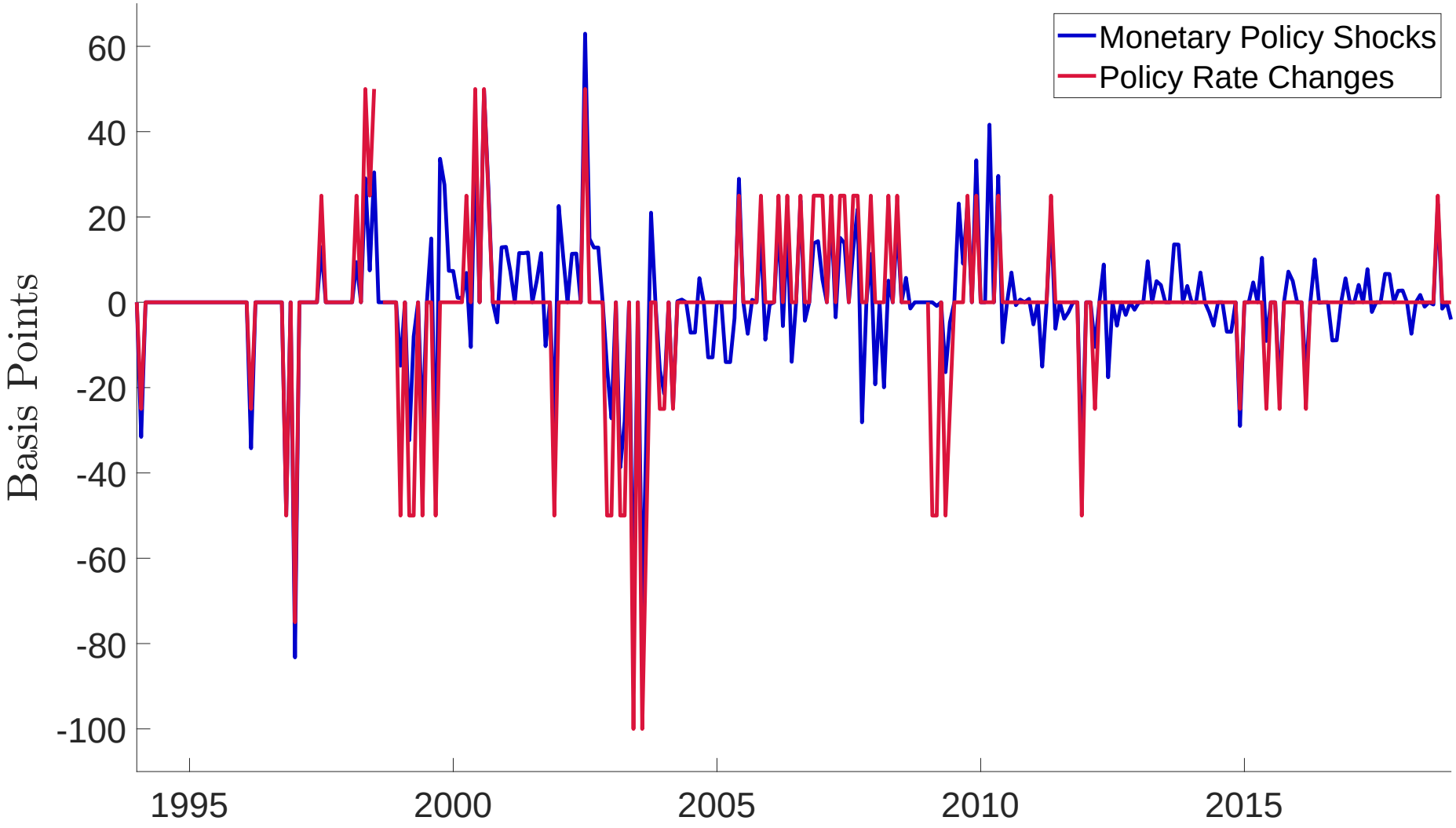

Predictability of MP shocks

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Table 3: **Predictability of Monthly Monetary Policy Shocks.**

	3 Lags		6 Lags		9 Lags	
Variables	F-statistic	P-value	F-statistic	P-value	F-statistic	P-value
Unemployment Rate	0.90	0.44	0.83	0.55	0.60	0.80
CPI-AEL Inflation	1.15	0.33	1.42	0.21	1.36	0.21
Industrial Production	0.25	0.86	0.25	0.96	0.27	0.98
All of the above	0.84	0.58	0.86	0.63	0.73	0.84

Notes: The dependent variable is the monthly series of monetary policy shocks. The regressors are three, six, or nine lagged values of the change in the unemployment rate, monthly CPI-AEL inflation, the monthly growth rate of industrial production, or a joint regression with all three variables. The table reports F-statistics and the associated p-values given the null hypothesis that all coefficients are zero.

Time aggregation

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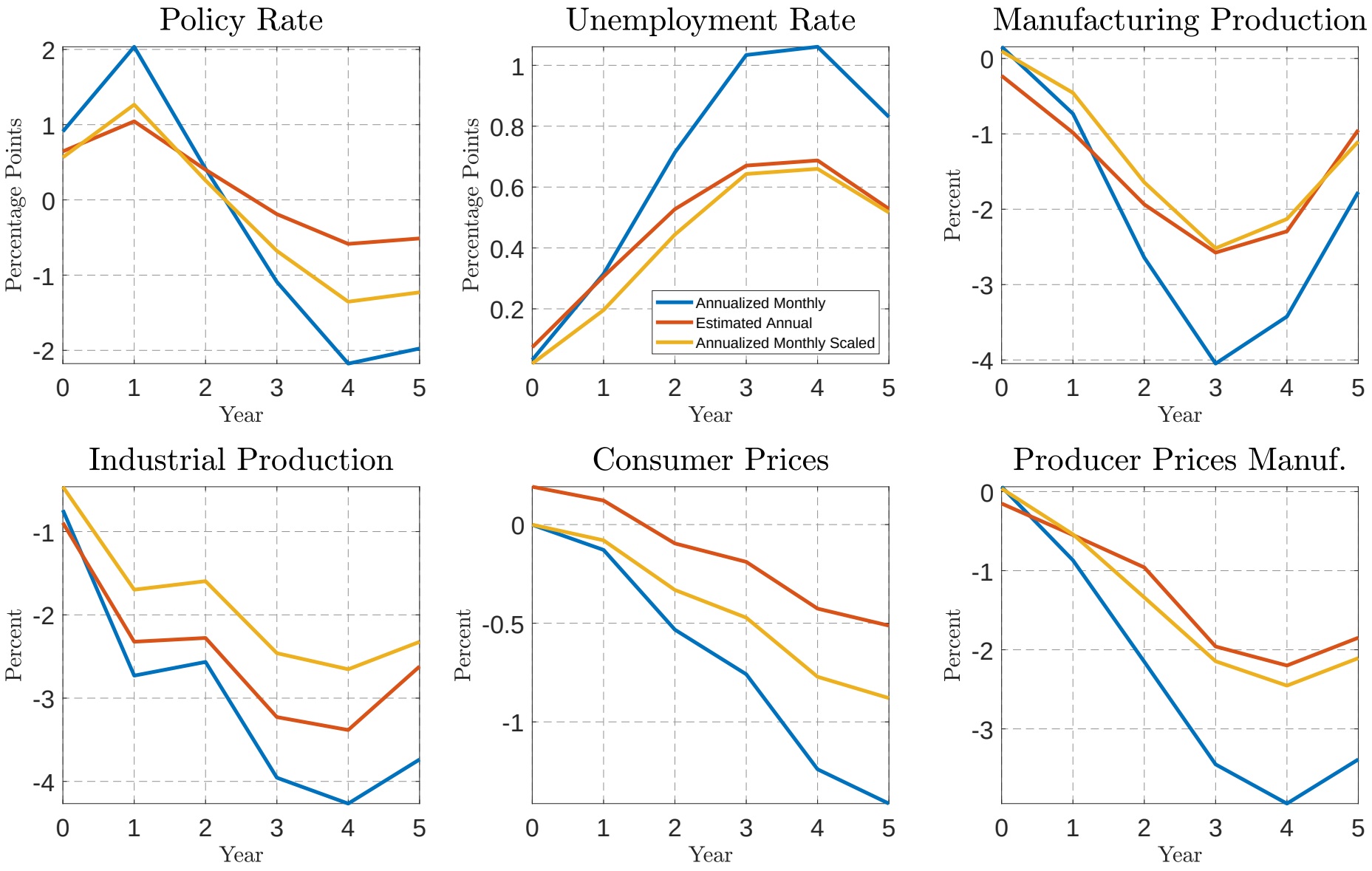

Additional evidence & robustness ▸ Back

- Additional responses ▸ Details
- Monetary tightenings & easings ▸ Details
- Comparison with U.S. data ▸ Details
- Only Consensus forecasts ▸ Details
- Only rate changes ▸ Details
- Lag length ▸ Details
- Timing of shocks ▸ Details
- Alternative samples ▸ Details

Additional Responses - Monthly

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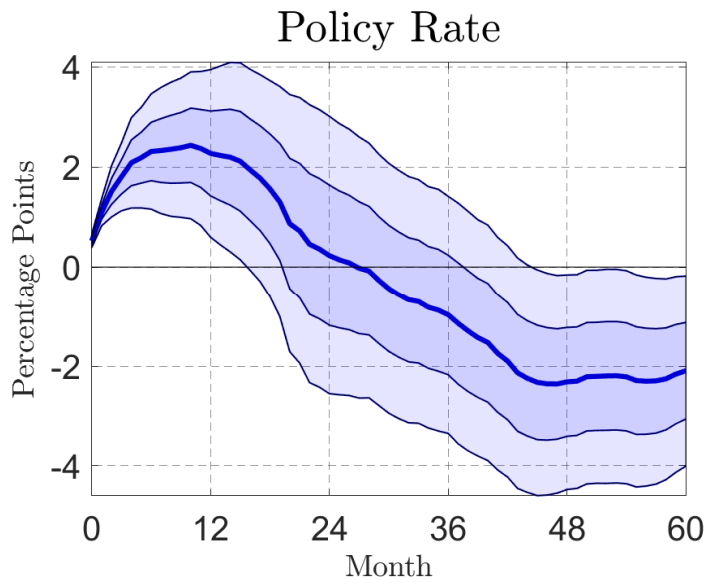

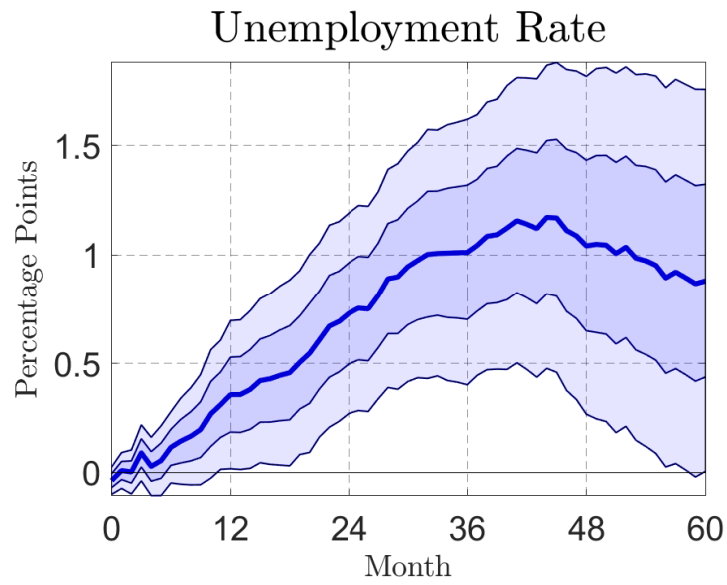

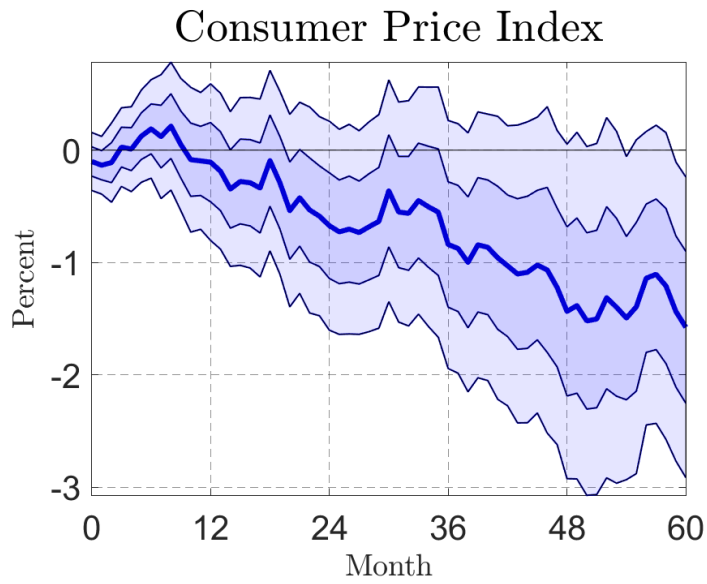

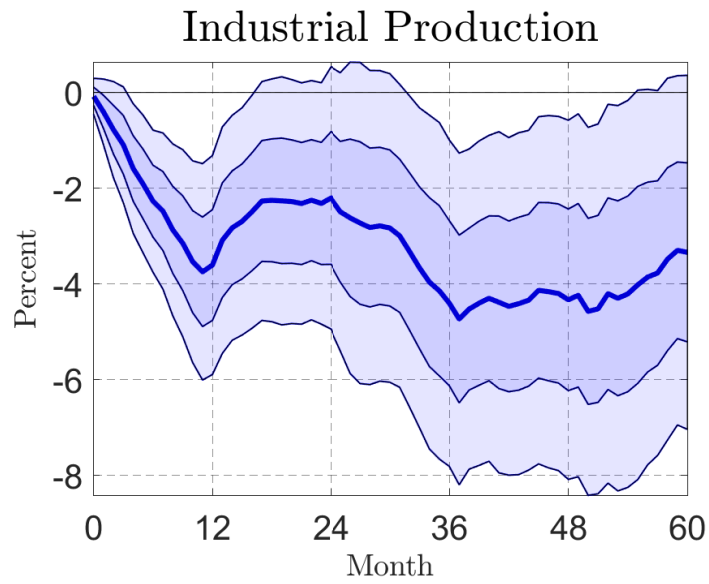

Additional Responses - Monthly

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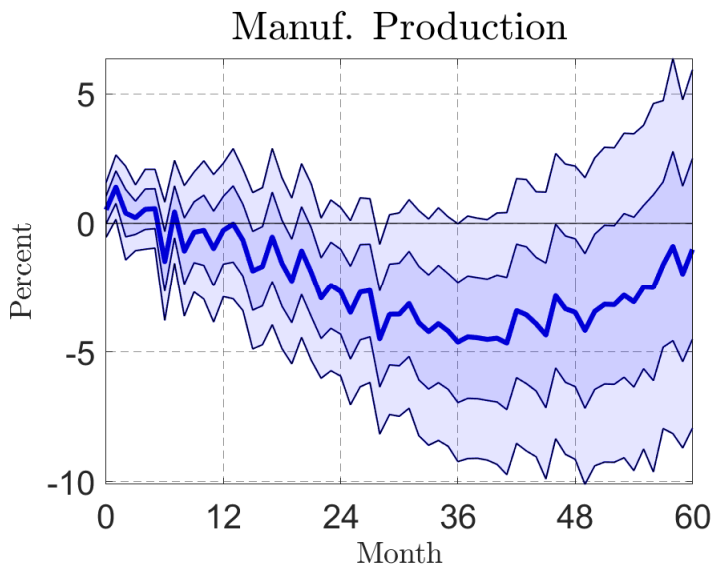

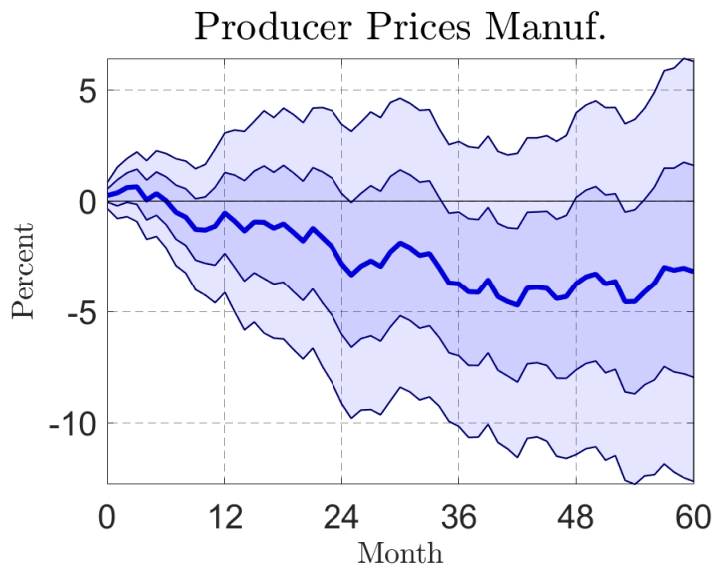

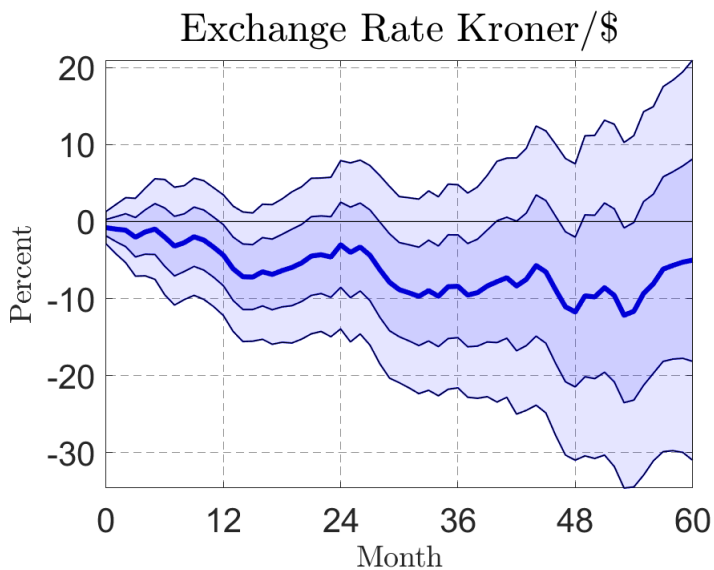

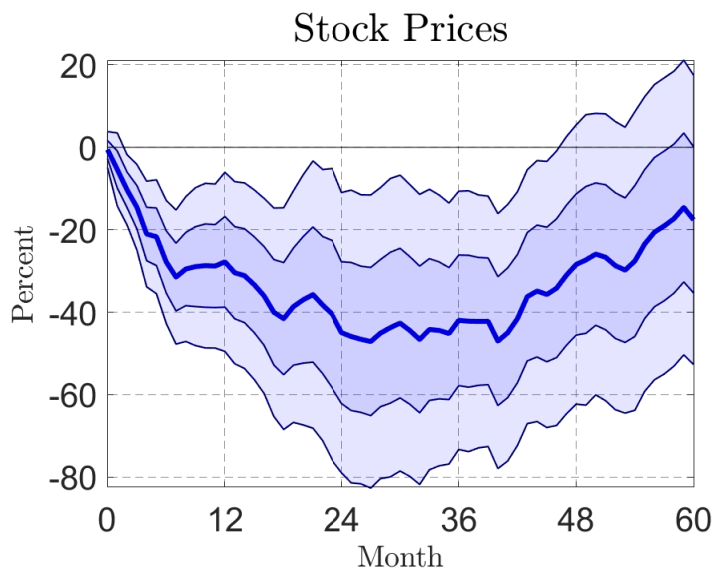

Additional Responses - Quarterly

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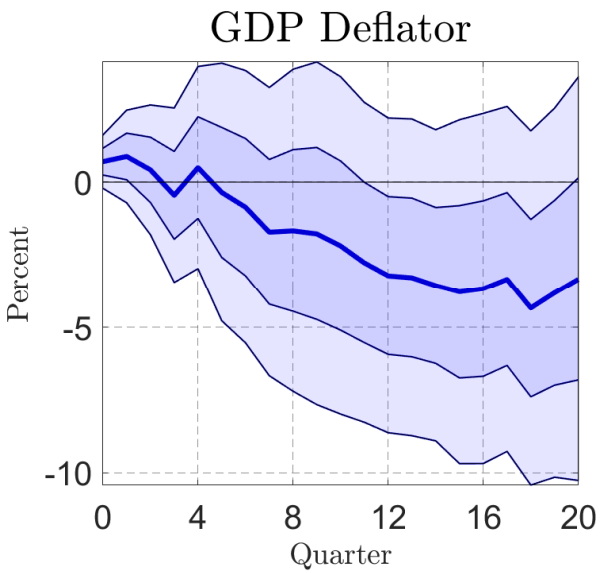
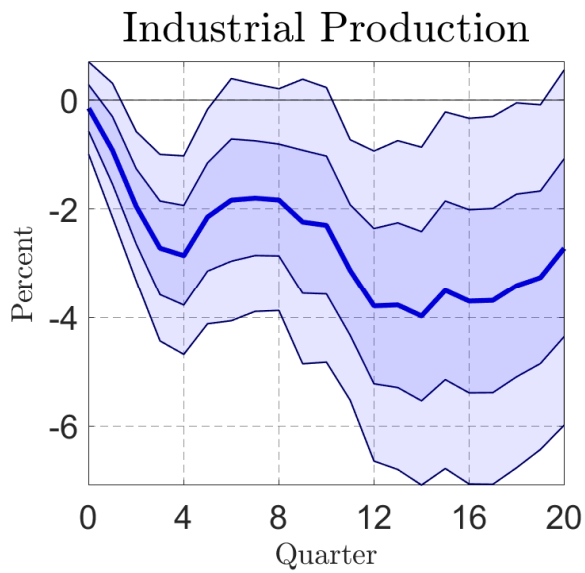
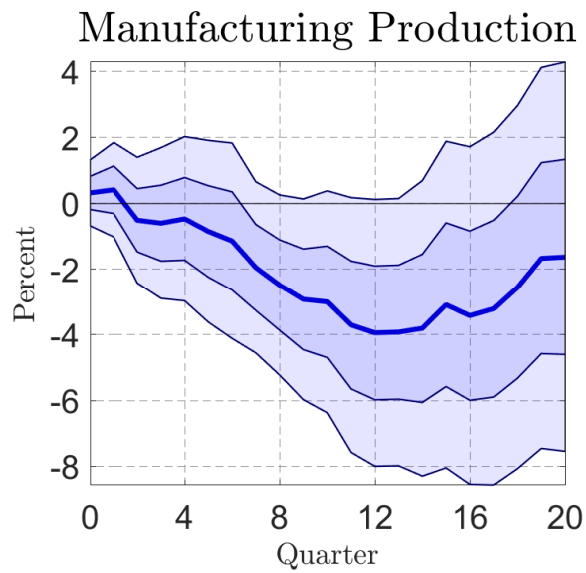
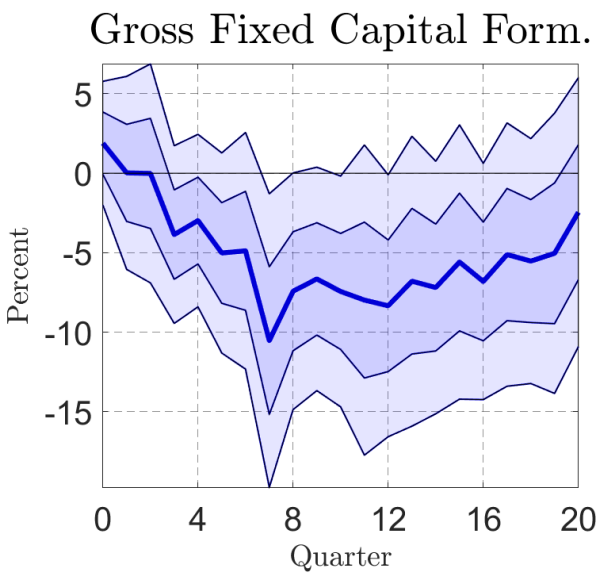
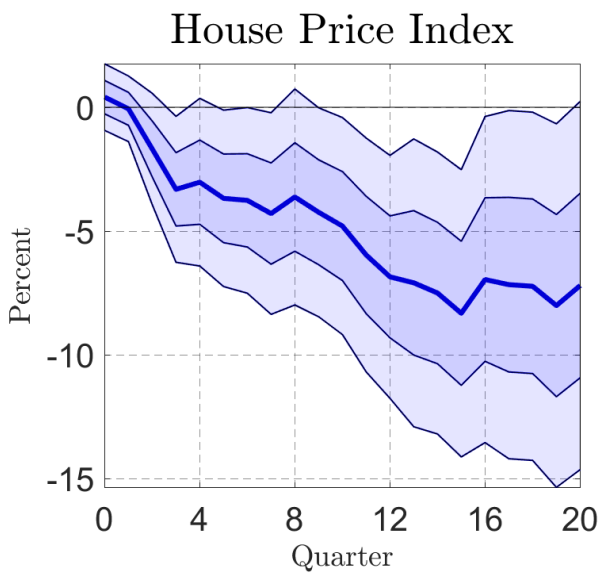
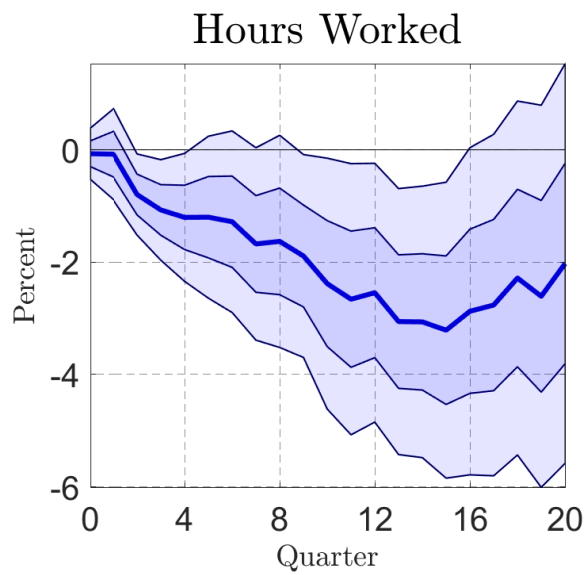






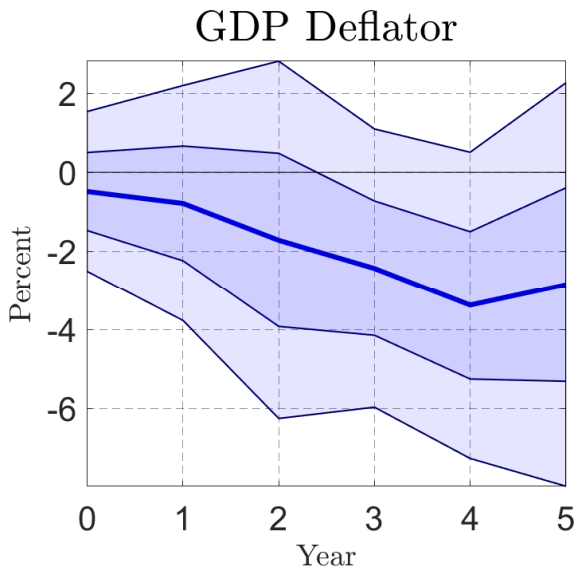


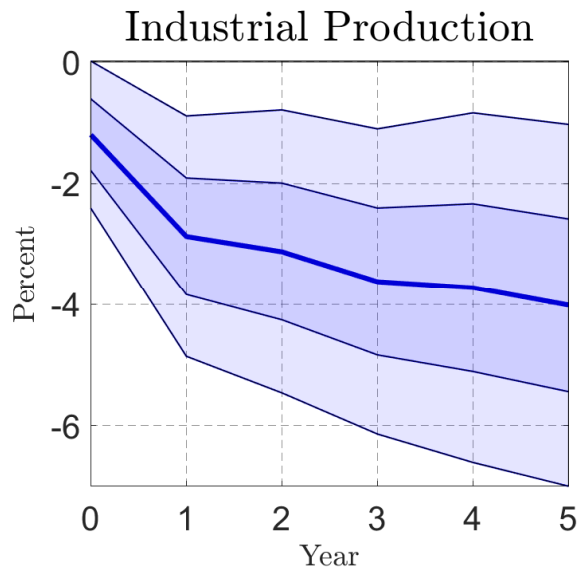


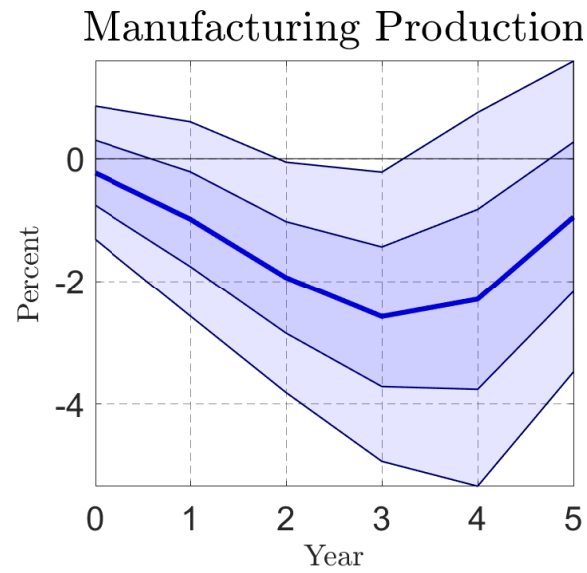


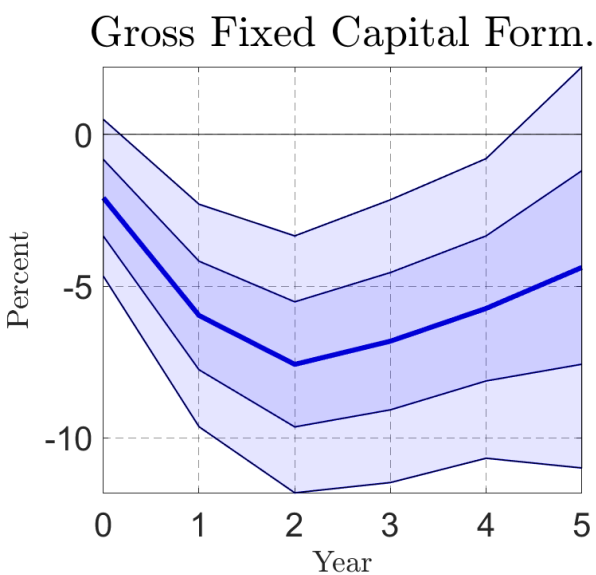
Additional Responses - Annual

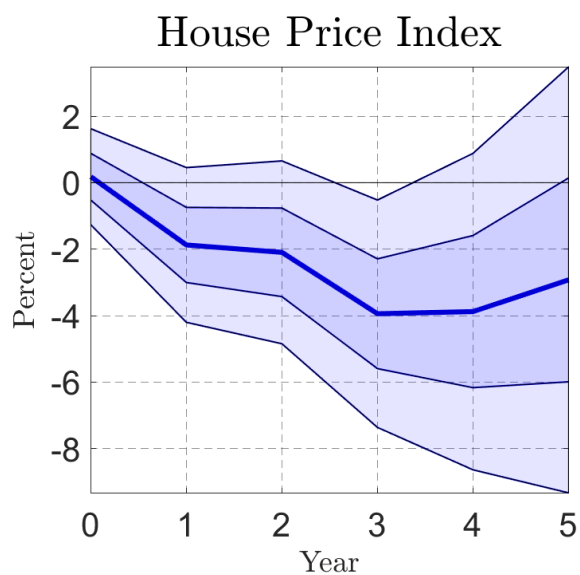
Back

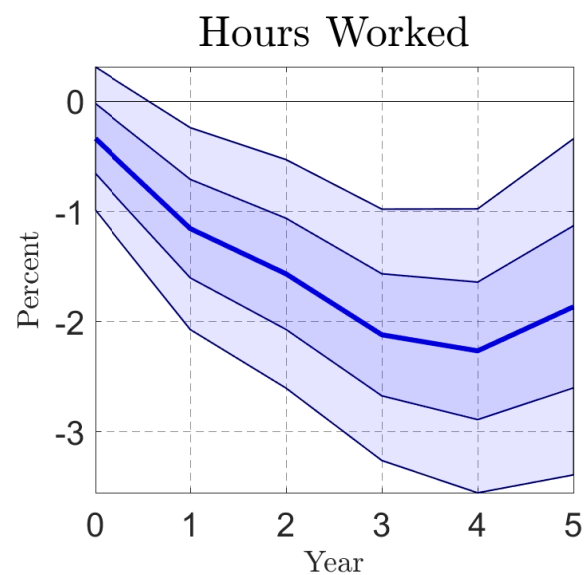






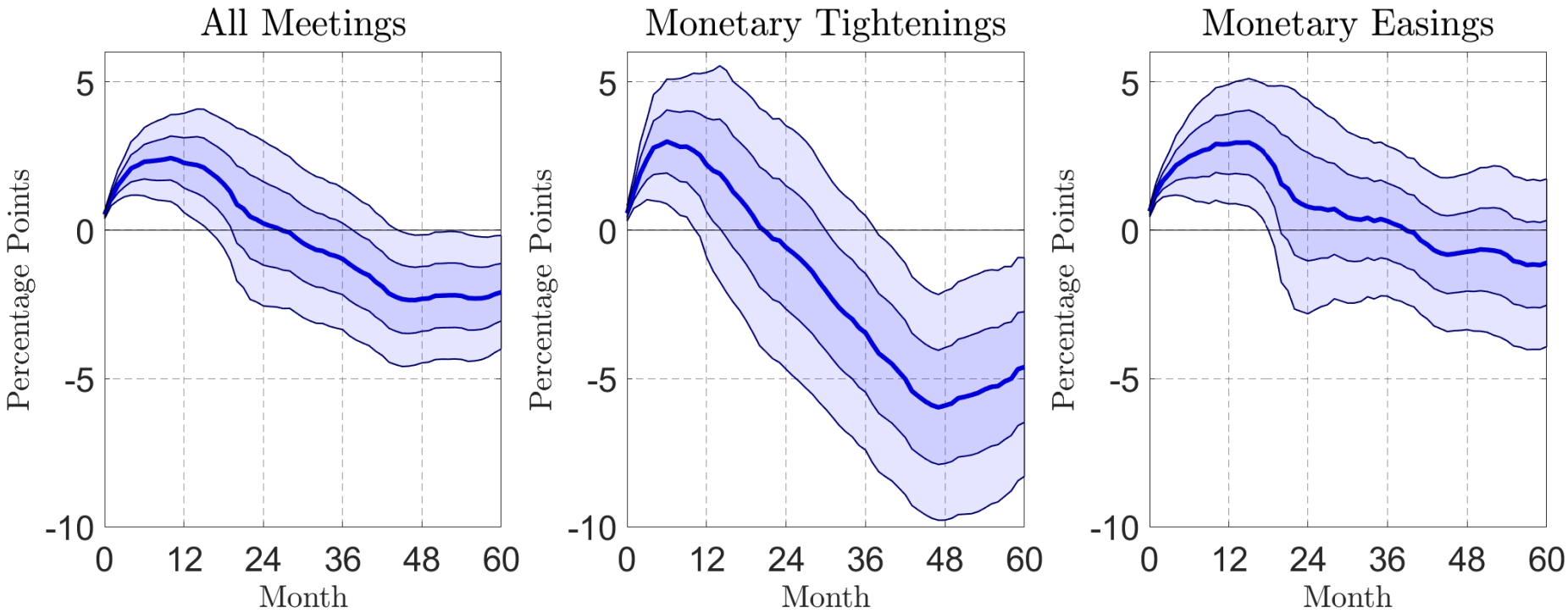






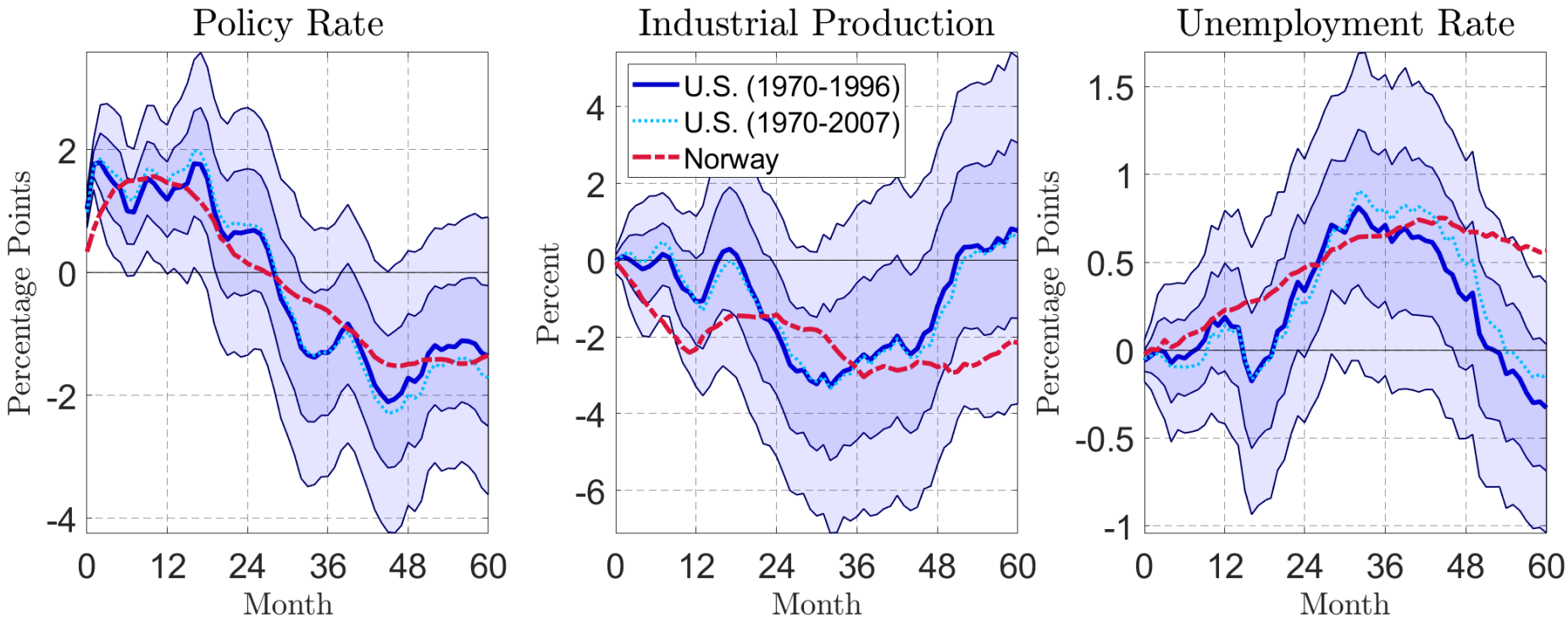
Monetary tightenings & easings

Back



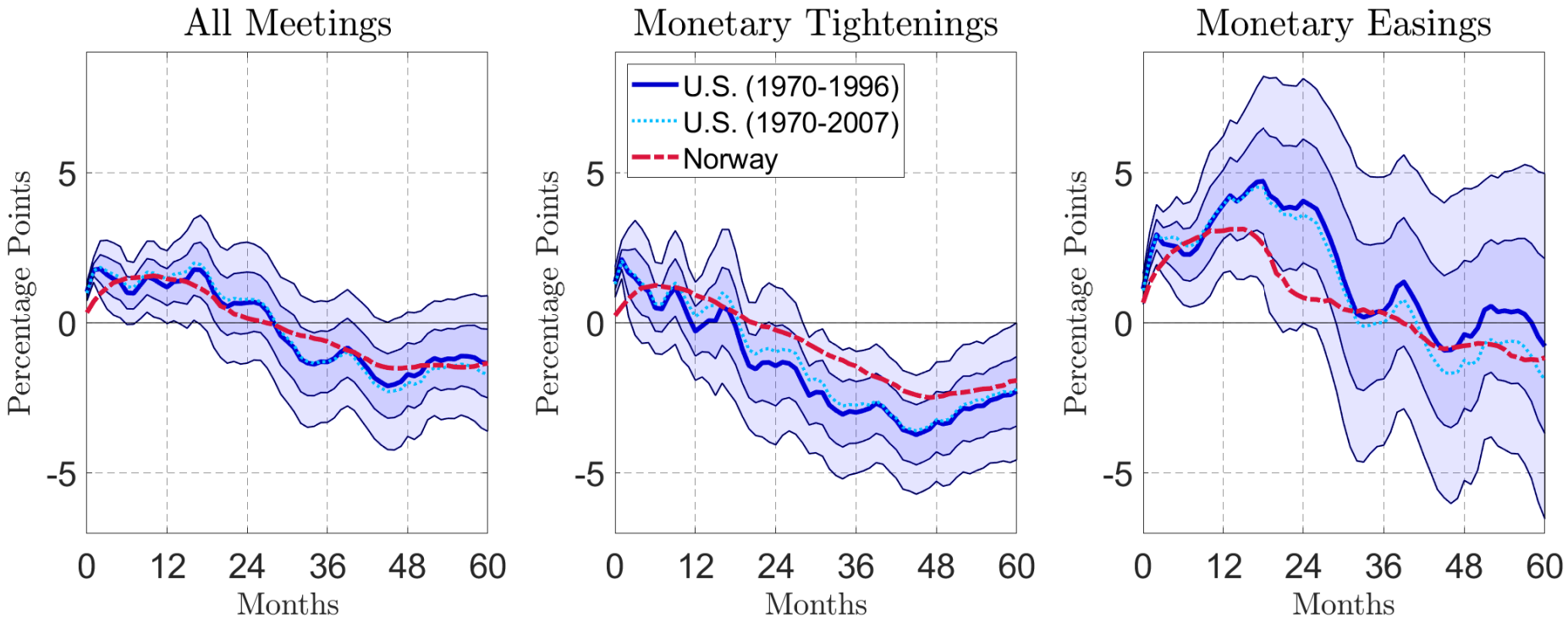
Comparison with U.S. data

Back



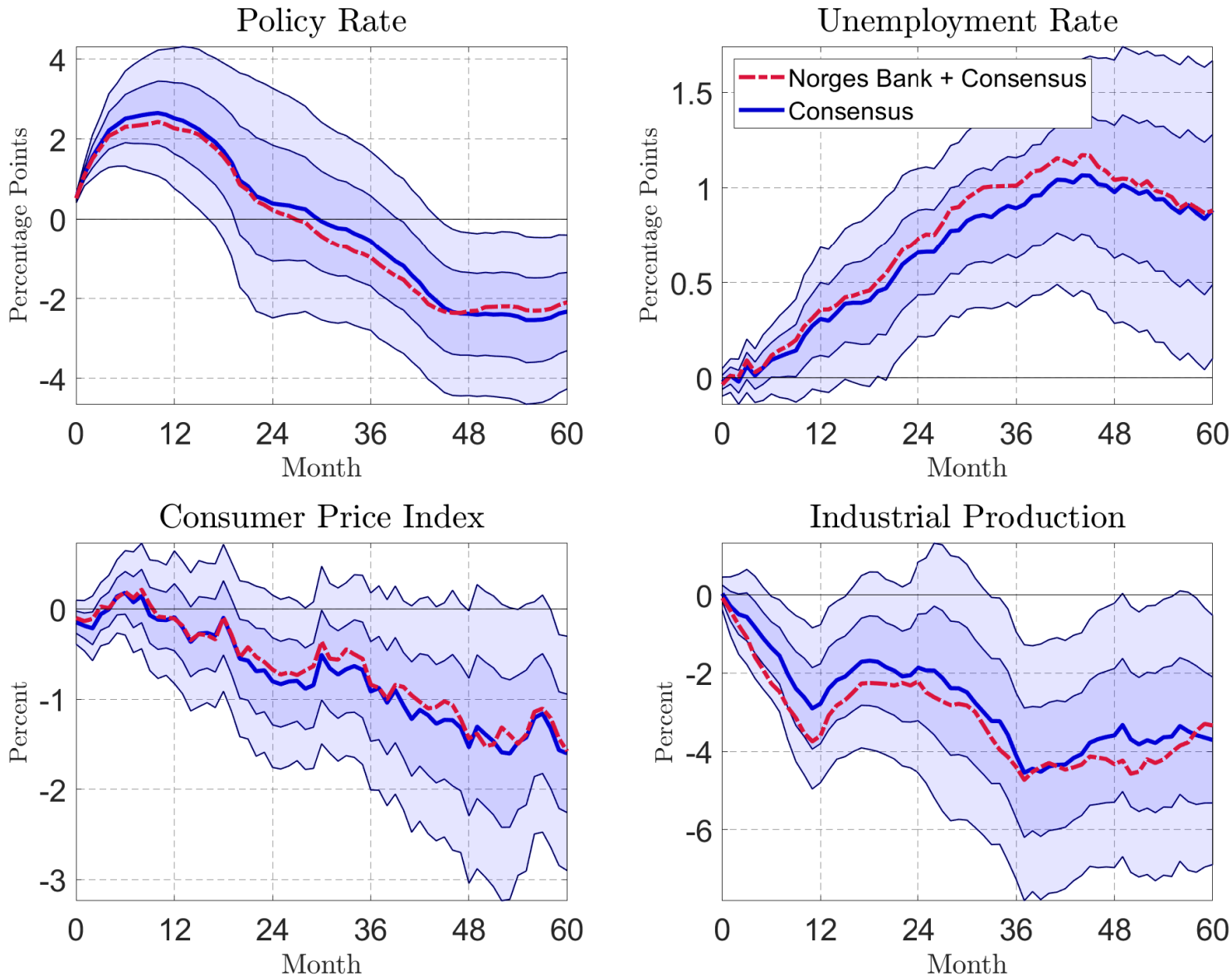
Comparison with U.S. data

Back



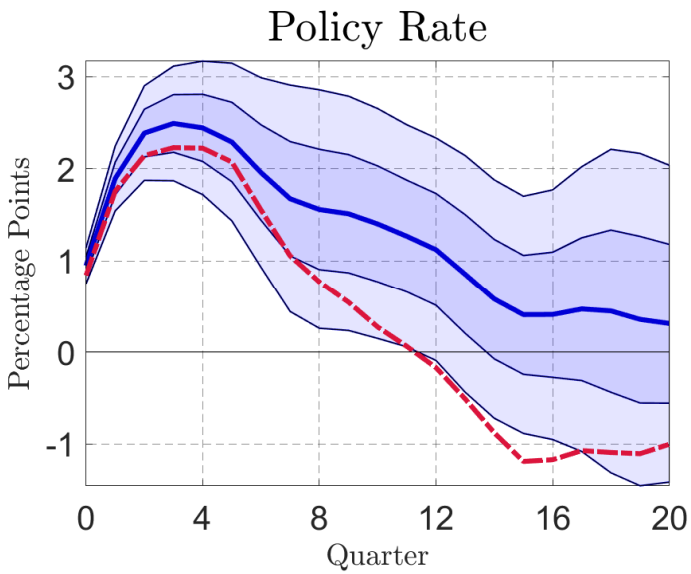
Only Consensus forecasts

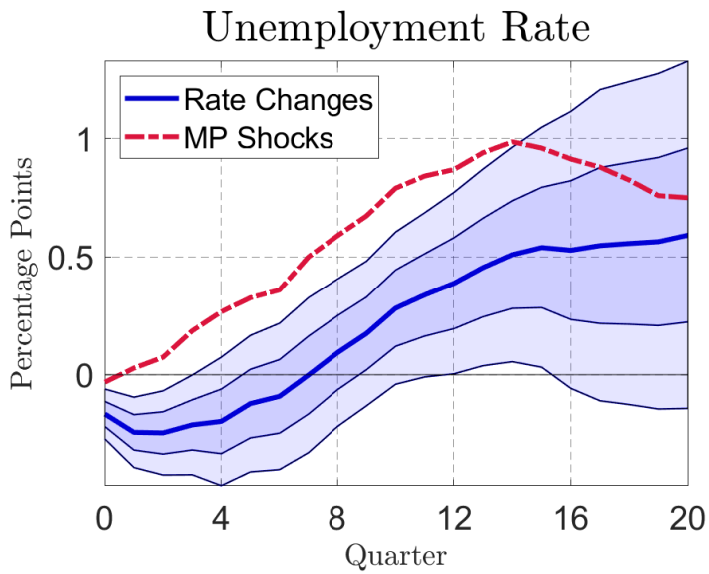
Back

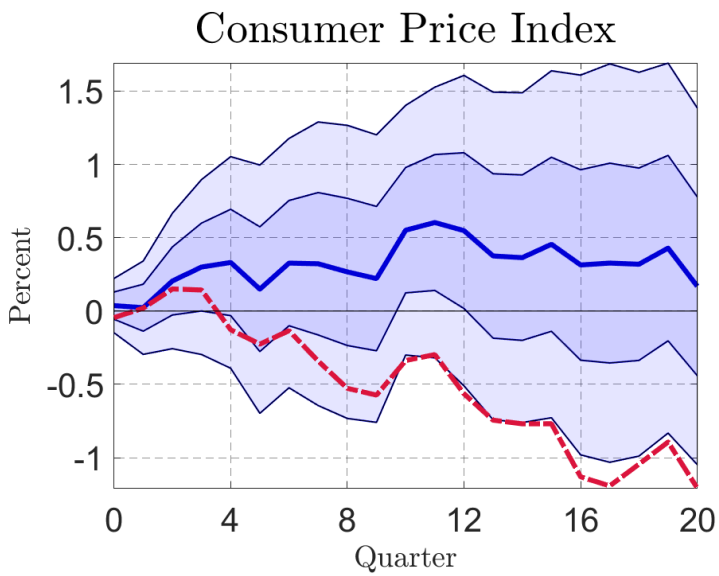


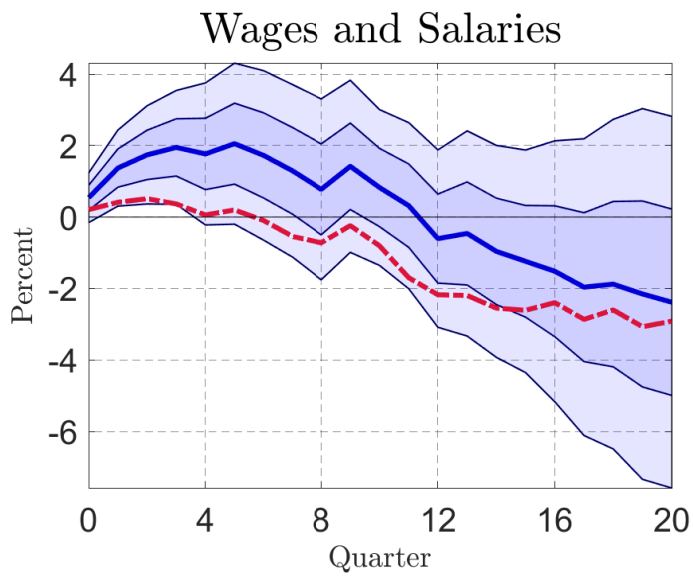
Rate changes

Back



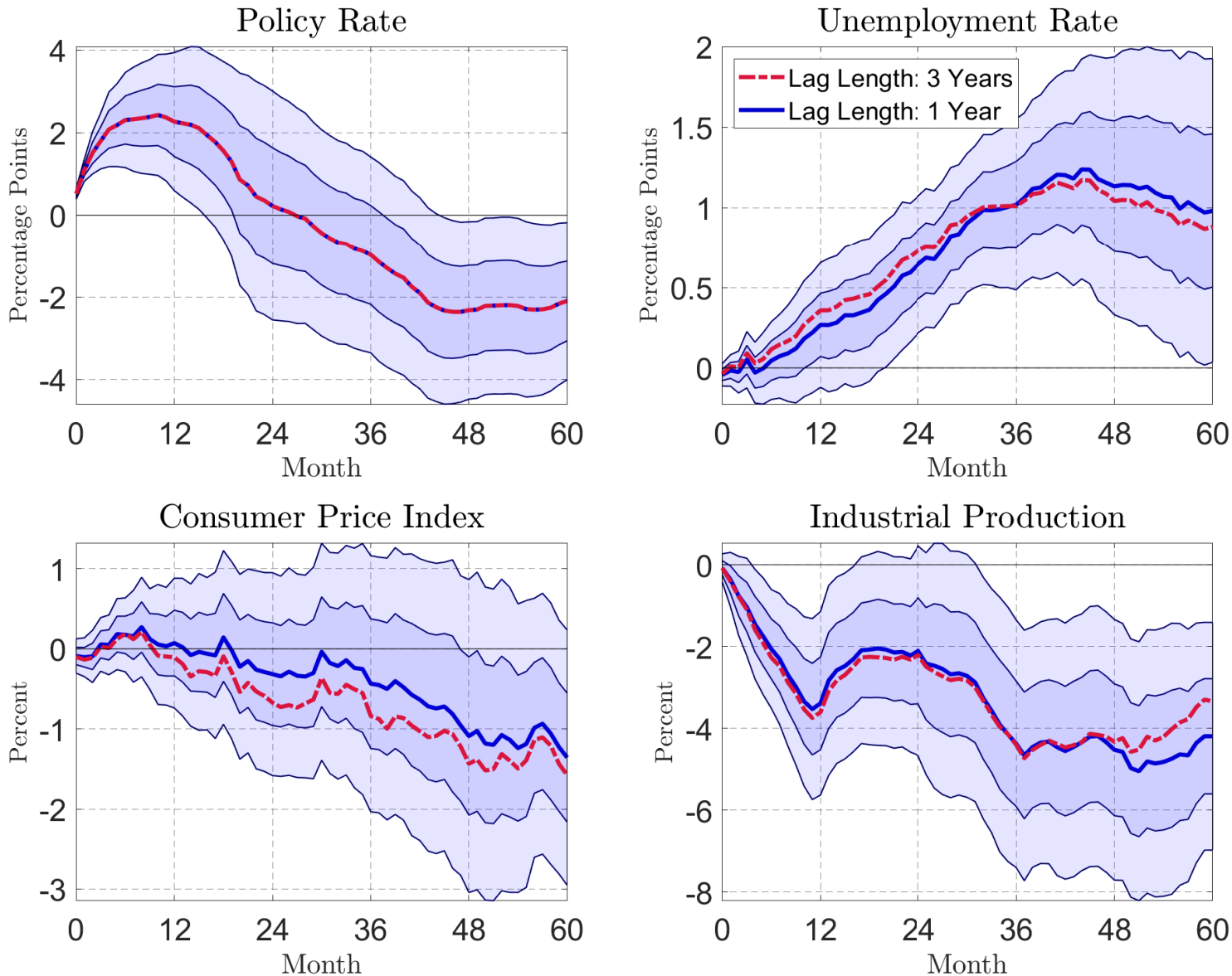






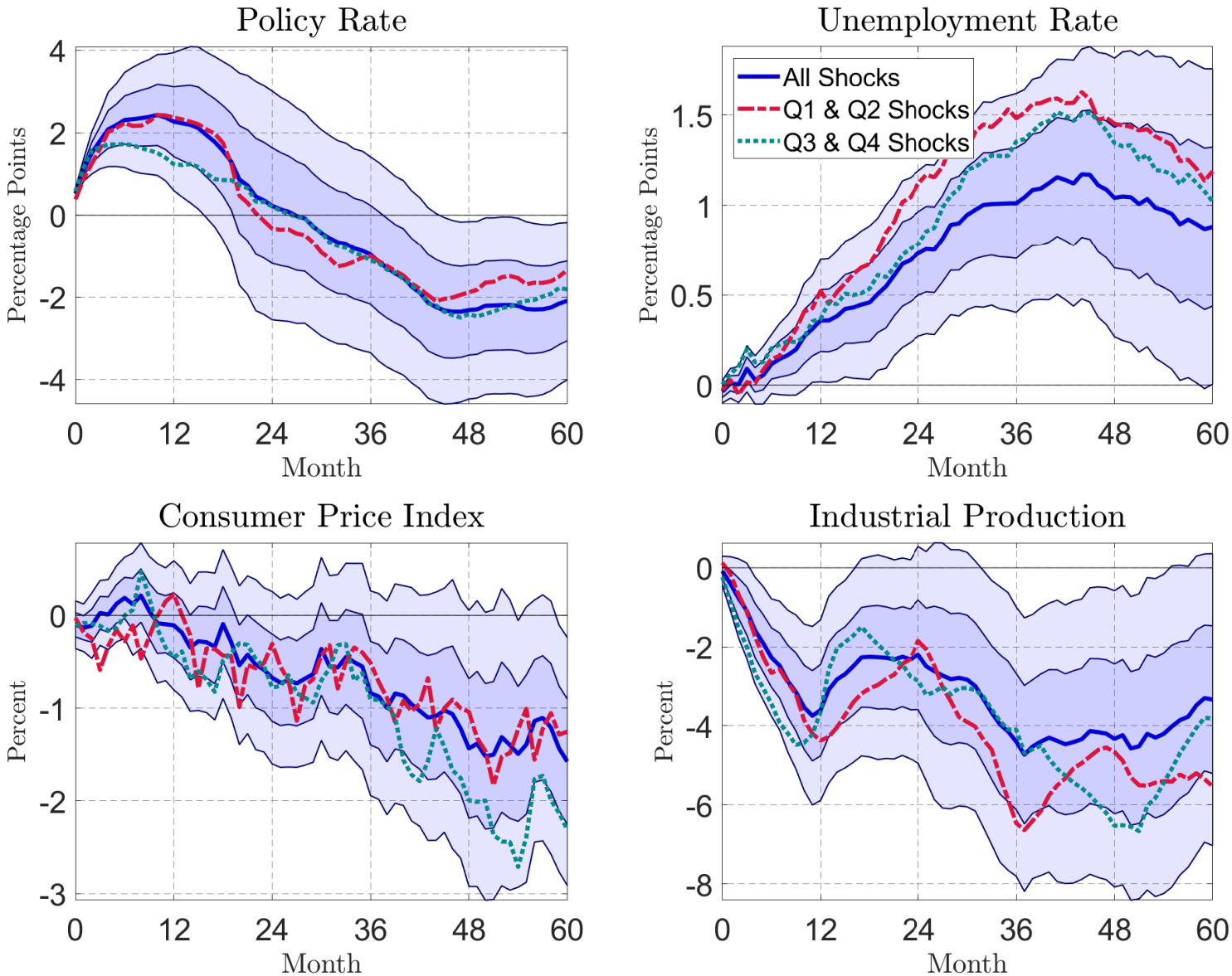
Lag length

Back



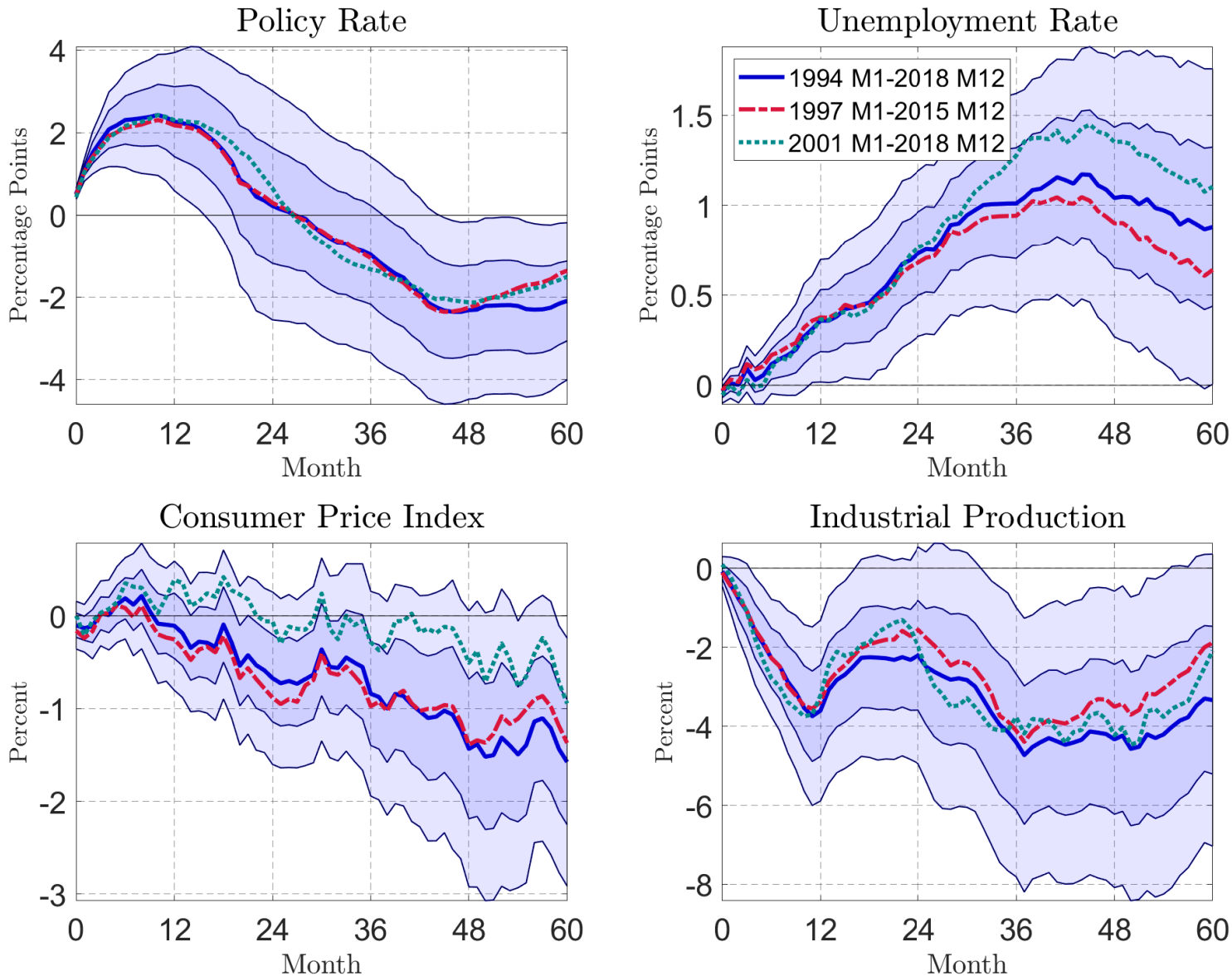
Timing of shocks

Back



Alternative samples

Back



Details on (unrealized) capital gains Back

1. Housing
   - Transactions observed
   - Capital gains = Δ housing wealth not due to transactions
2. Stocks
   - After 2006: individuals stock holdings observed
   - Before 2006: average capital gains for stocks
3. Stock funds
   - Average capital gains for stock funds from national accounts
4. Private business
   - Capital gains zero for the company
   - Attribute capital gains on stock holdings in firm to owner if observer

Sample restrictions Back

1. Adult population (> 20)
2. No change in marital status between couple and single
3. Income and consumption $>$ the minimum level in the Norwegian social security scheme
4. Growth rate in consumption $< 50\%$ in absolute value

Summary statistics

Back

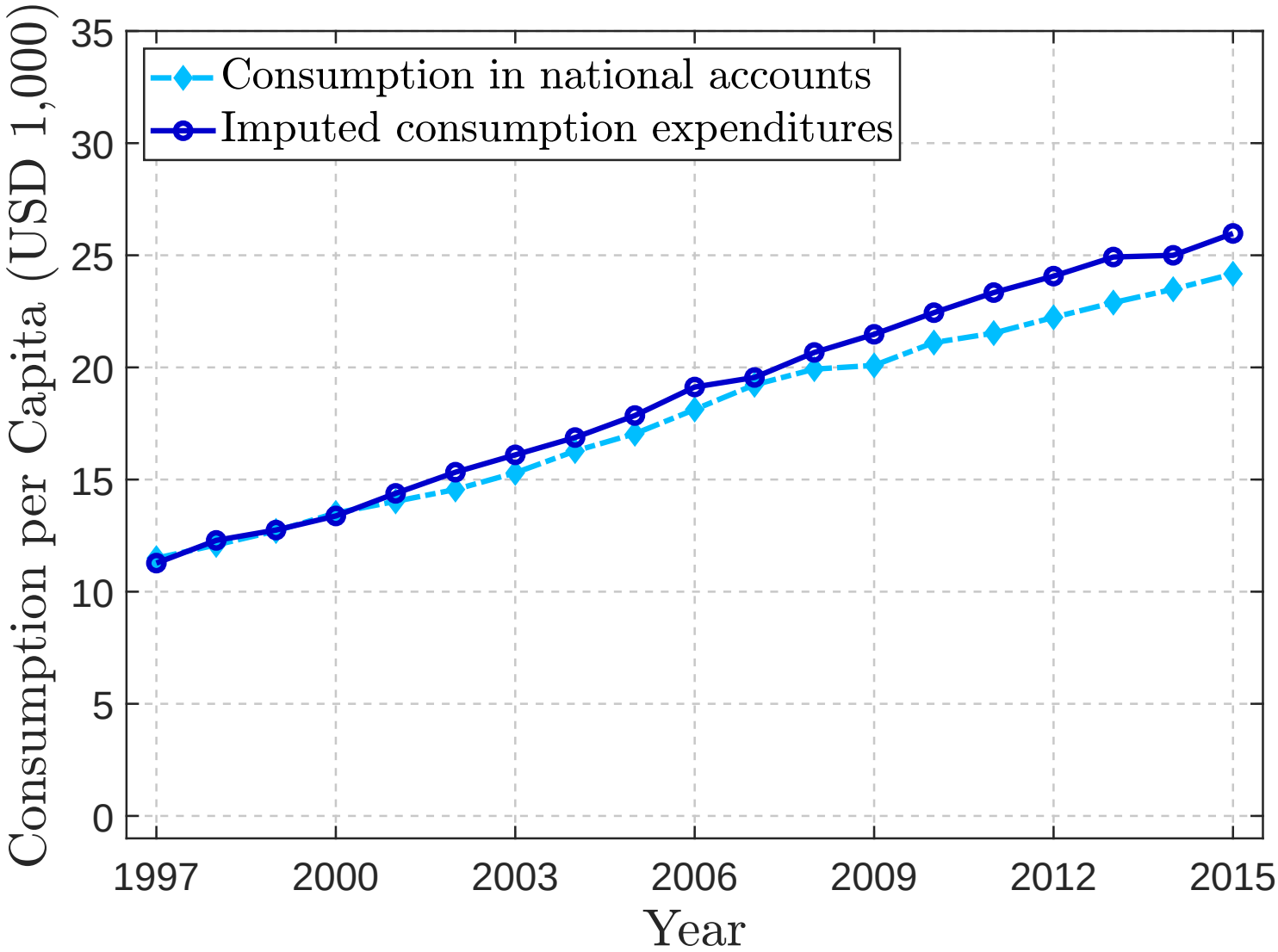
Table 2: Summary statistics

	Mean	SD	P10	Median	P90
Age	51.63	17.85	28.00	50.00	77.00
Consumption	43,091	159,368	22,099	37,714	65,424
Disposable income	43,437	81,284	23,616	39,833	63,817
Income before tax	58,827	89,245	26,940	52,875	93,096
Labor income	44,210	42,362	0	43,977	92,636
Net capital income	-1,692	21,031	-8,263	-892	2,355
Dividend income	429	19,841	0	0	15
Interest income	873	3,150	5	198	2,207
Interest expenses	3,316	5,072	0	1,631	8,970
Total assets	371,601	1,292,982	5,588	281,798	782,215
Liquid assets	31,337	75,379	565	11,262	78,912
Deposits	26,569	59,632	465	9,065	67,554
Bonds	1,015	13,660	0	0	0
Risky assets	4,261	293,320	0	0	8,038
Stocks	1,945	292,750	0	0	660
Stock funds	2,316	12,507	0	0	5,339
Housing	321,580	371,837	0	248,128	703,170
Total debt	73,658	885,968	0	33,954	186,687
Observations per year	1,909,603	83,648	1,821,377	1,864,722	2,032,543

Notes: The table shows summary statistics for the estimation sample. Disposable income is the sum of labor income, capital income, and transfers, net of taxes. Liquid assets is the sum of deposits, bonds, stocks held directly, and stock funds. Risky assets consist of stocks and stock funds. Stocks also includes stocks held indirectly by holding companies. Total debt includes mortgages, consumer debt, and student debt. All values except age are in U.S. dollars, 2011 prices.

Consumption comparison

Back



Micro-macro responses

Back

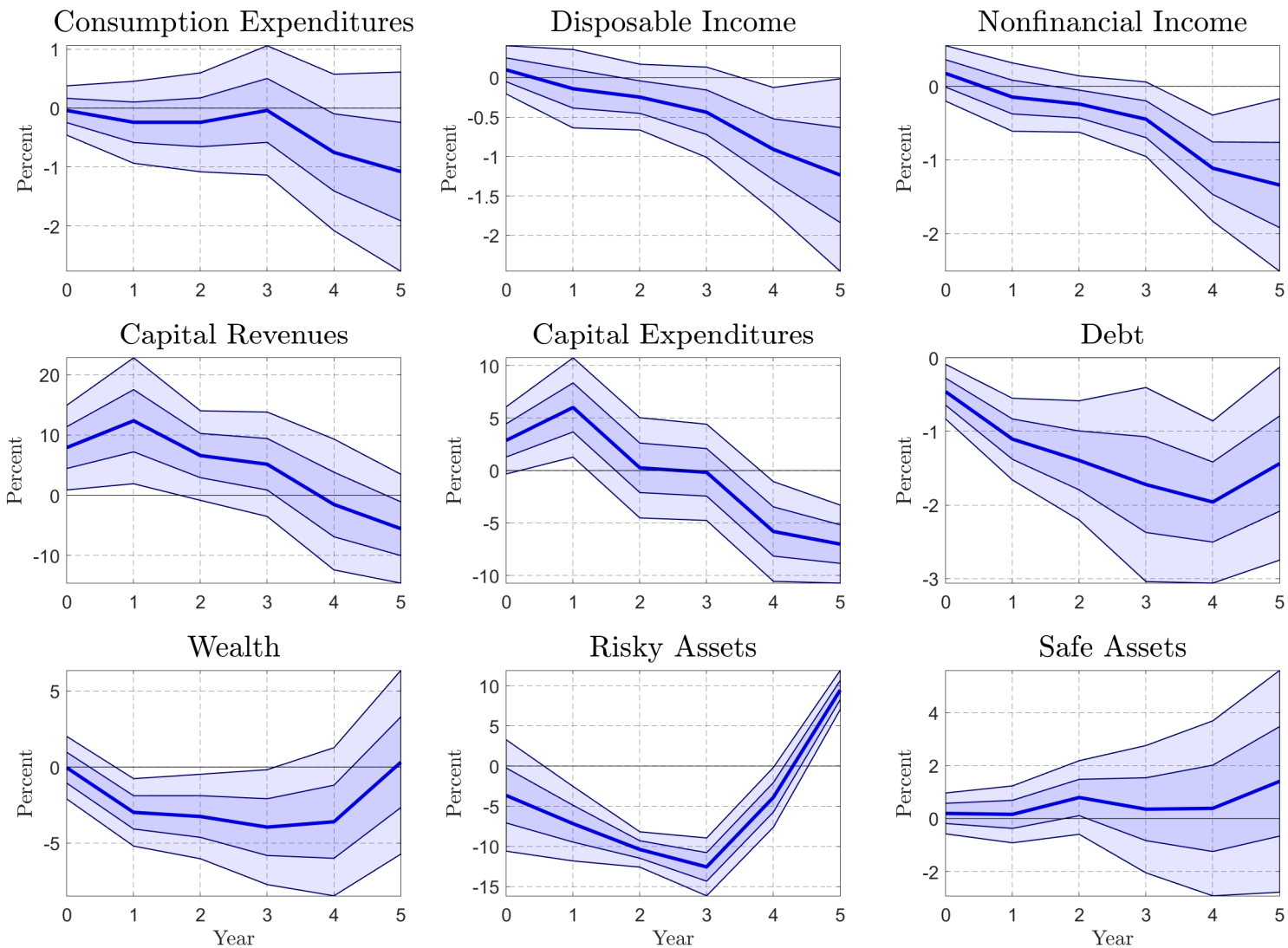
- Estimate local projections

$$\frac{y_{i,t+h} - y_{i,t-1}}{\overline{y}_{t-1}} = \delta_i^h + \beta^h \cdot \epsilon_t^{MP} + \gamma^h X_{i,t-1} + u_{i,t}^h$$

- $\overline{y}_{t-1} = \frac{1}{N}\sum_{i=1}^{N} y_{i,t-1}$
- Controls:
  - 3 years of lags of ϵ_t^{MP}
  - 2 years of lags dependent variable (h=0)
- Driscoll-Kraay standard errors

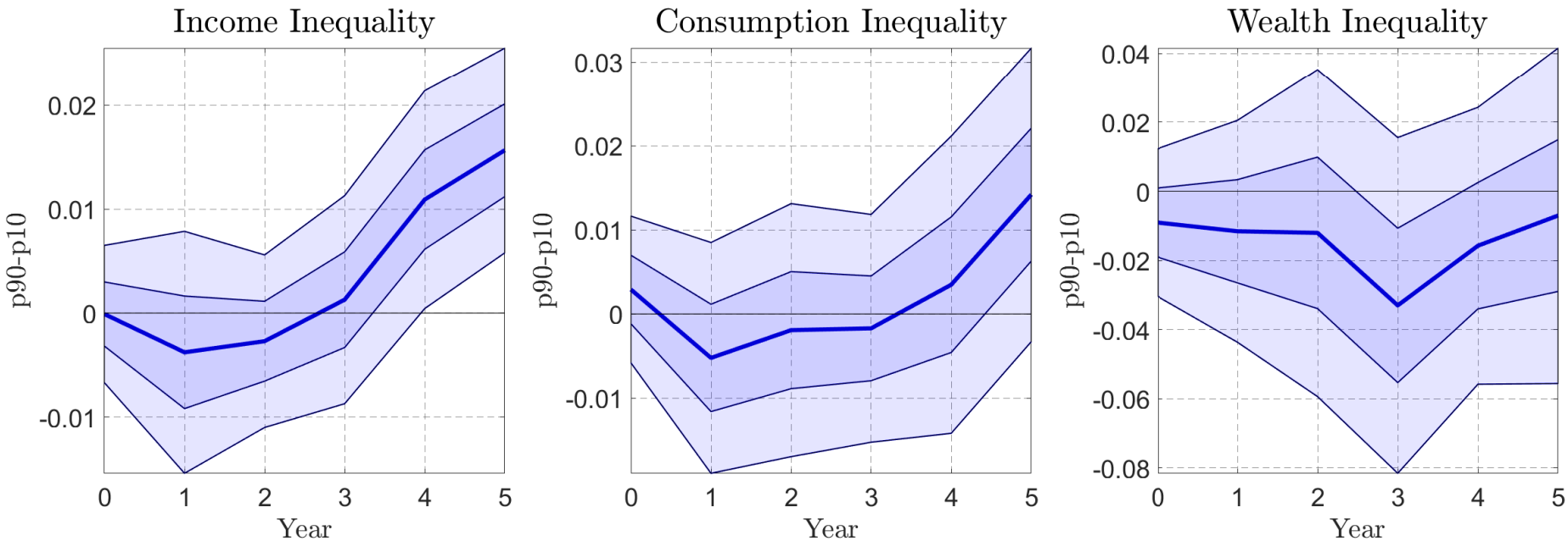
Micro-macro responses

Back



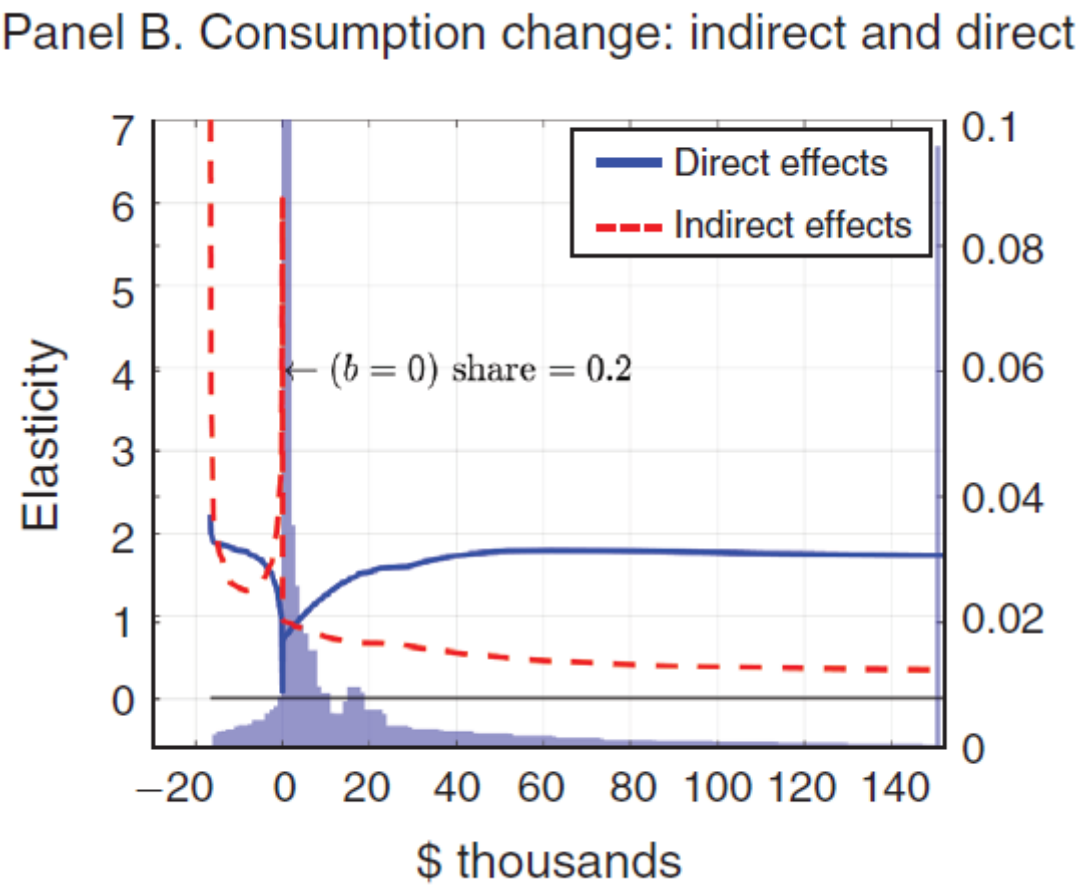
Inequality responses

Back



Monetary transmission by liquid assets in models

Back



Kaplan-Moll-Violante (2018)

Monetary transmission by liquid assets in models

Back

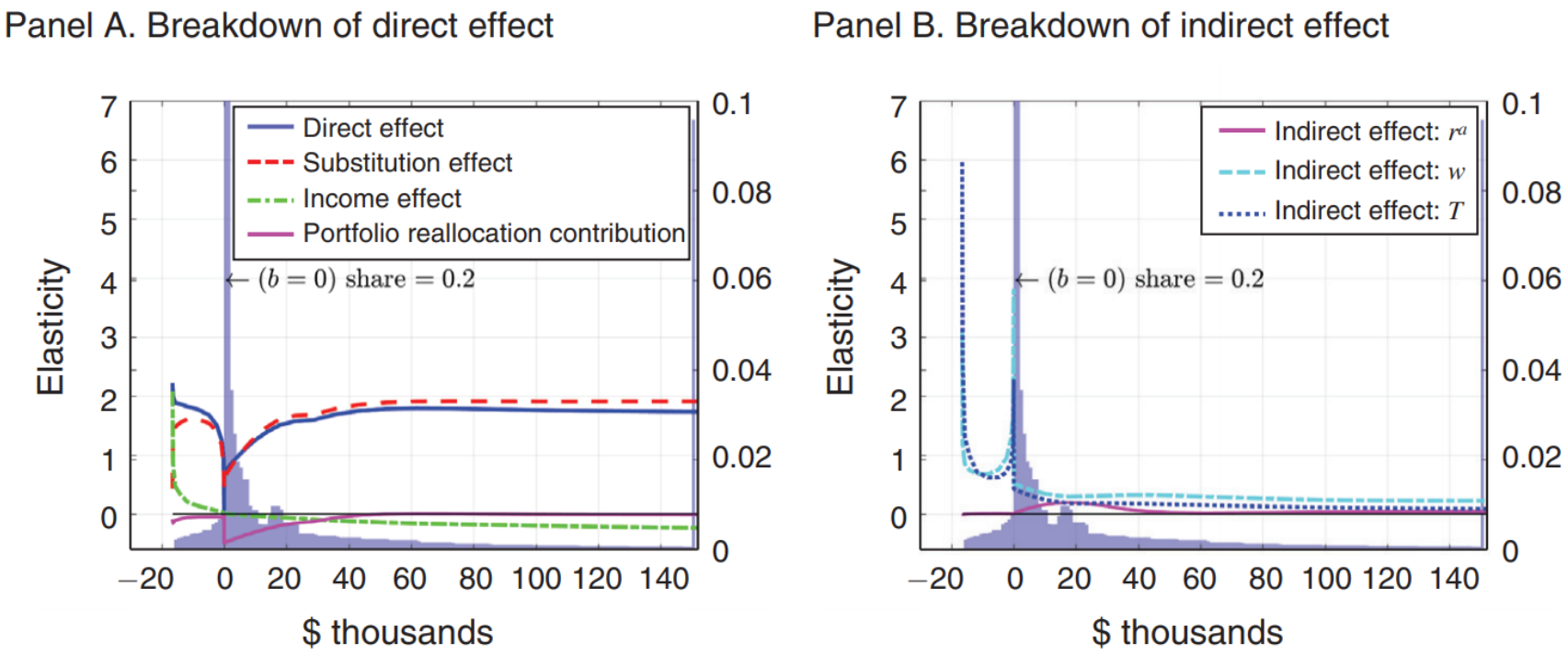


FIGURE 6. CONSUMPTION RESPONSES BY LIQUID WEALTH POSITION

Kaplan-Moll-Violante (2018)

Monetary transmission channels ($r \uparrow$) Back

- Substitution effect ($c \downarrow$)
- Standard income effect
  ($c \uparrow$ if rate exposure > 0, $c \downarrow$ if rate exposure < 0)
- Cash-flow effect
  (same as standard income + front-load c response)
- Indirect income effects
  (same sign as movement of non-financial income)

Monetary transmission channels ($r \uparrow$) ▸ Back

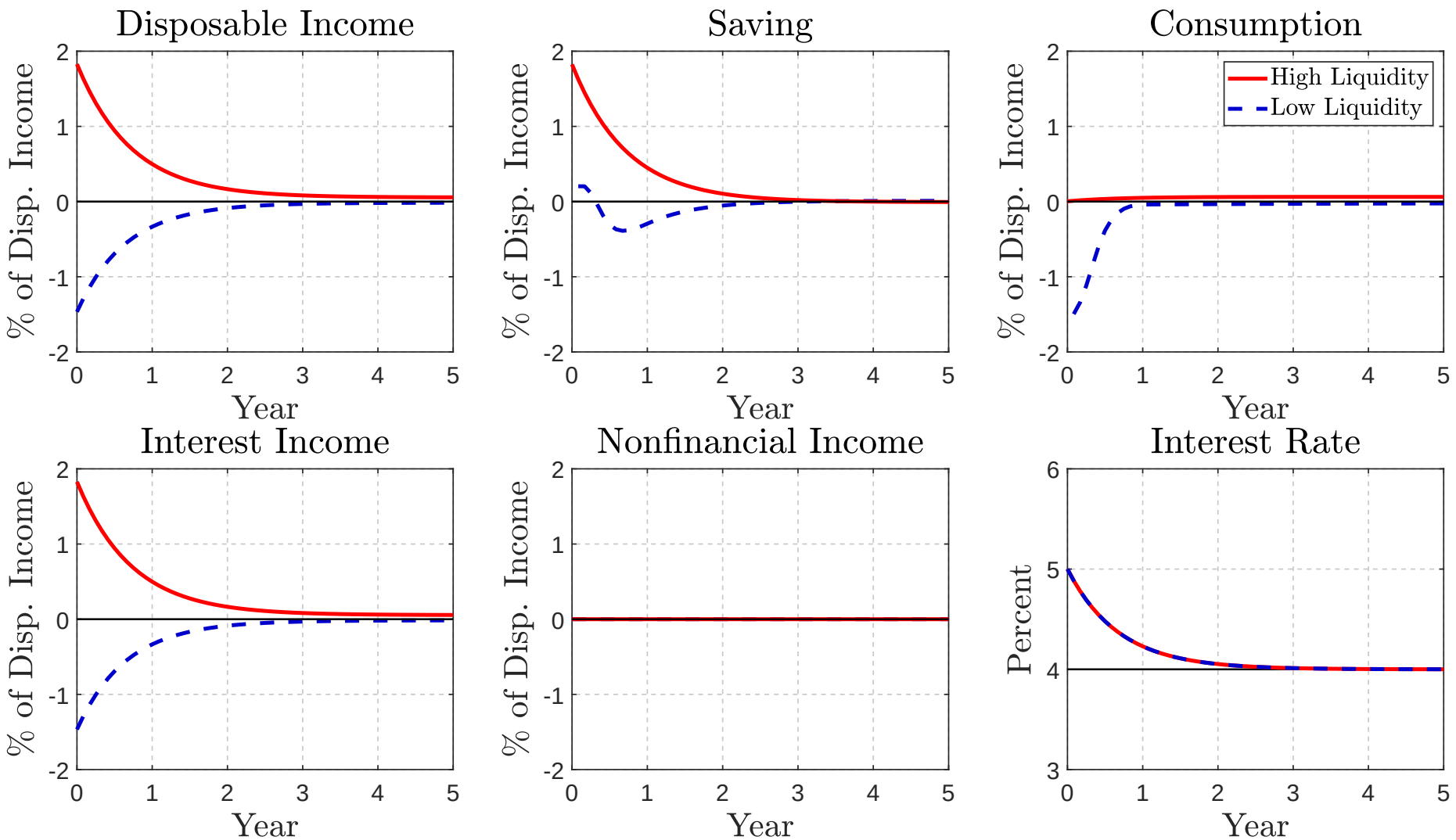
- Substitution effect ($c \downarrow$)
- Standard income effect
  ($c \uparrow$ if rate exposure > 0, $c \downarrow$ if rate exposure < 0)
- Cash-flow effect
  (same as standard income + front-load c response)
- Indirect income effects
  (same sign as movement of non-financial income)

Predictions from models: channels depend on liquidity

1. High-liquid: 'all' substitution & standard income effects
2. Illiquid: mostly cash-flow, substitution & indirect income effects

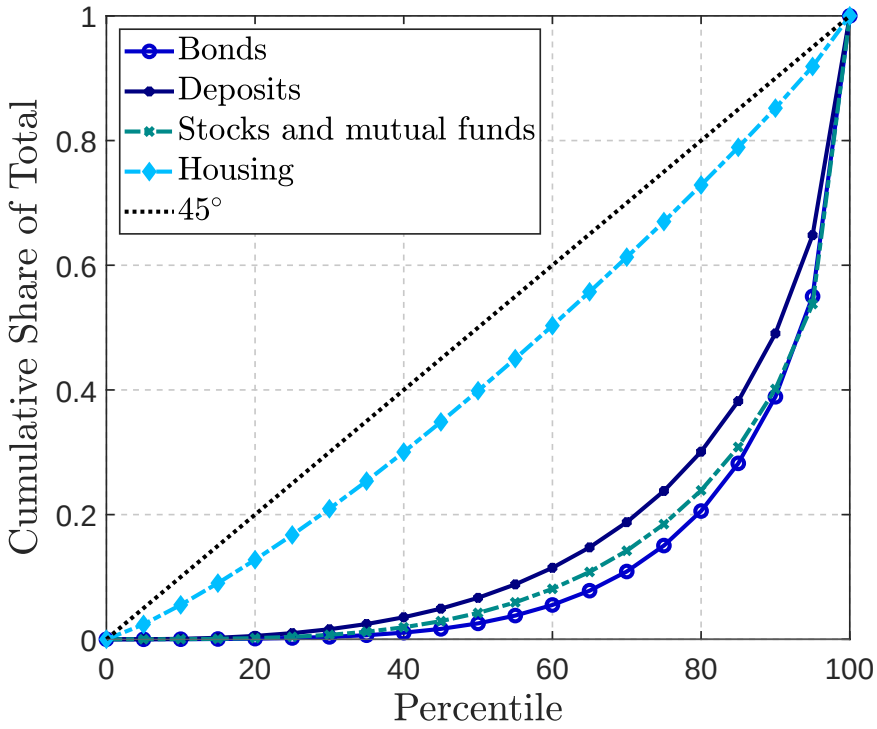
Model

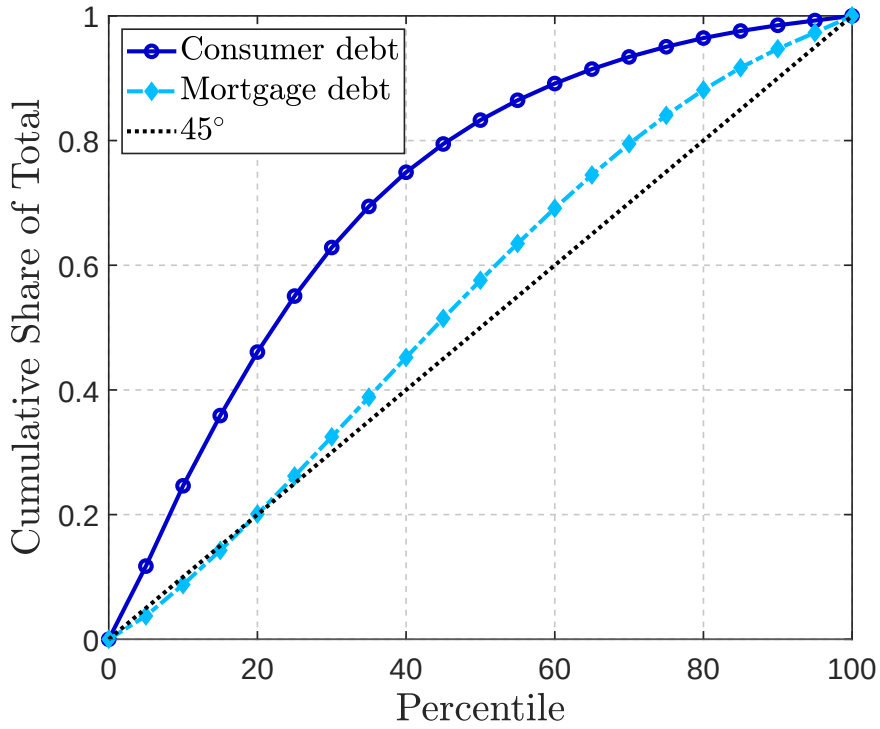
Back


Disposable Income
Saving
Consumption
Interest Income
Nonfinancial Income
Interest Rate
% of Disp. Income
Percent
Year
High Liquidity
Low Liquidity

Liquid assets distribution

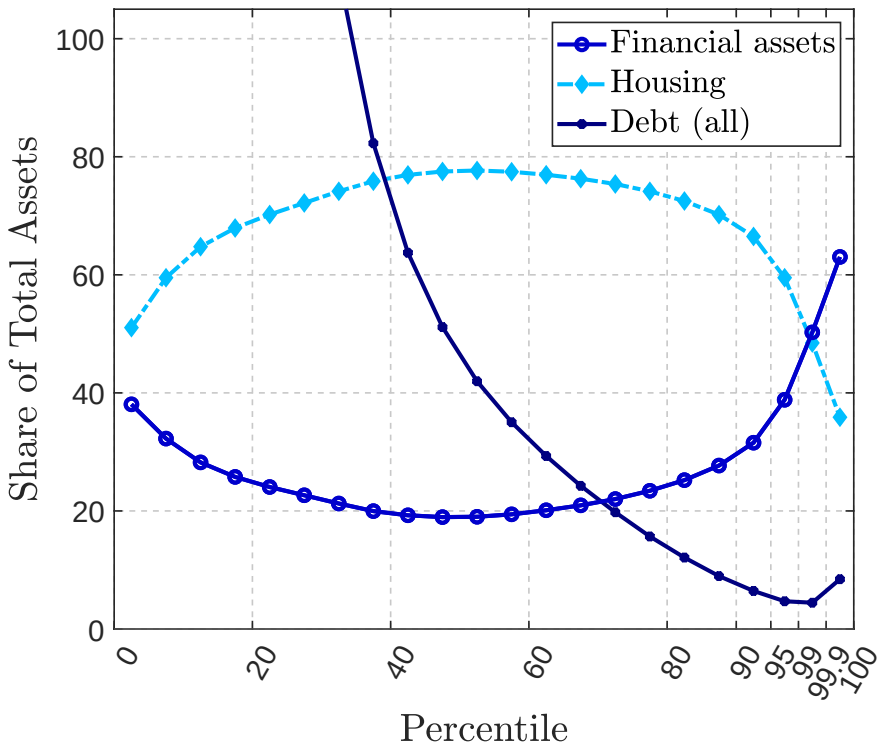
Back

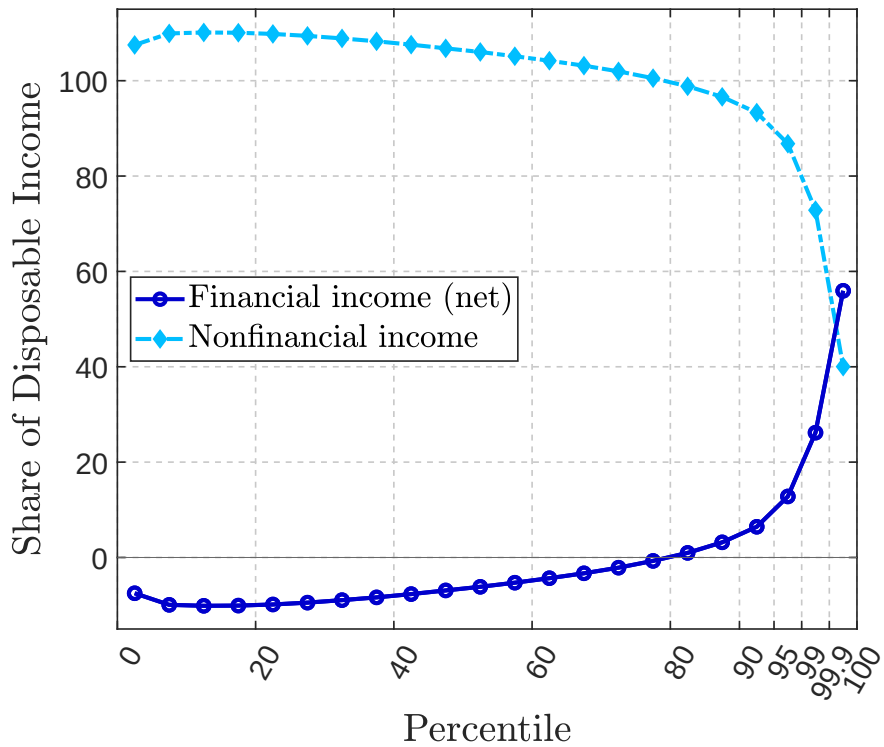




Liquid assets distribution

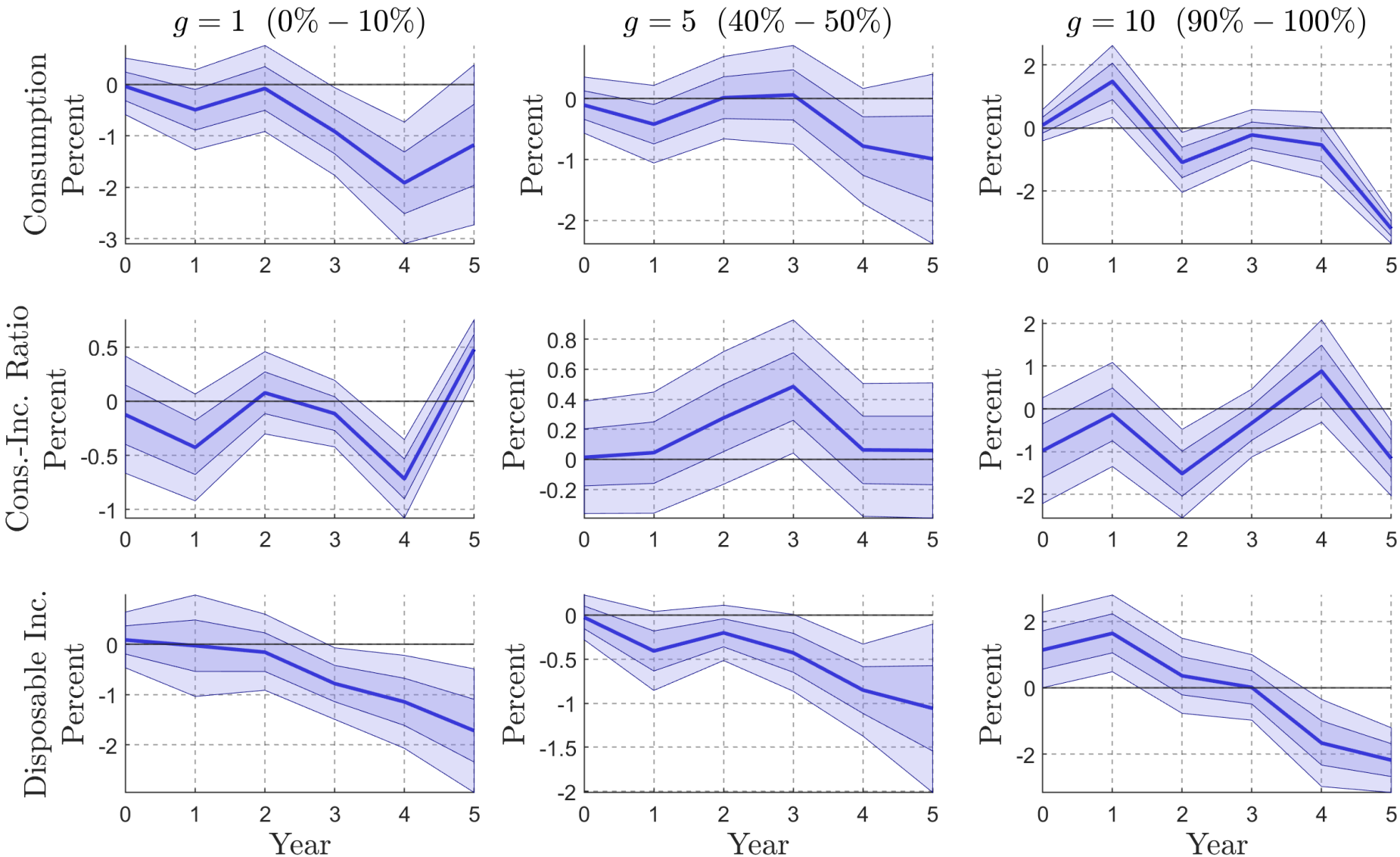
Back





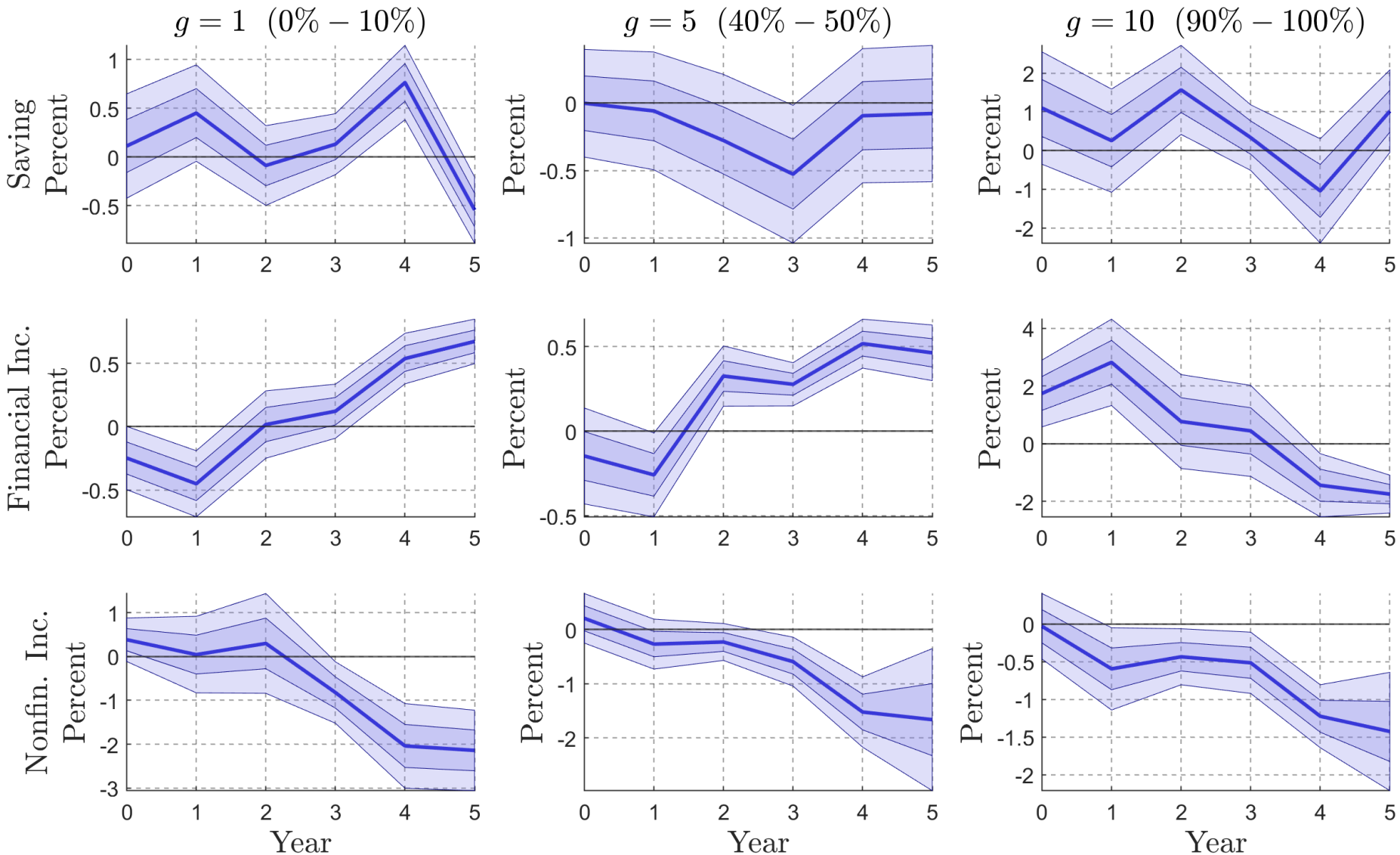
Responses by liquid asset; selected groups

Back



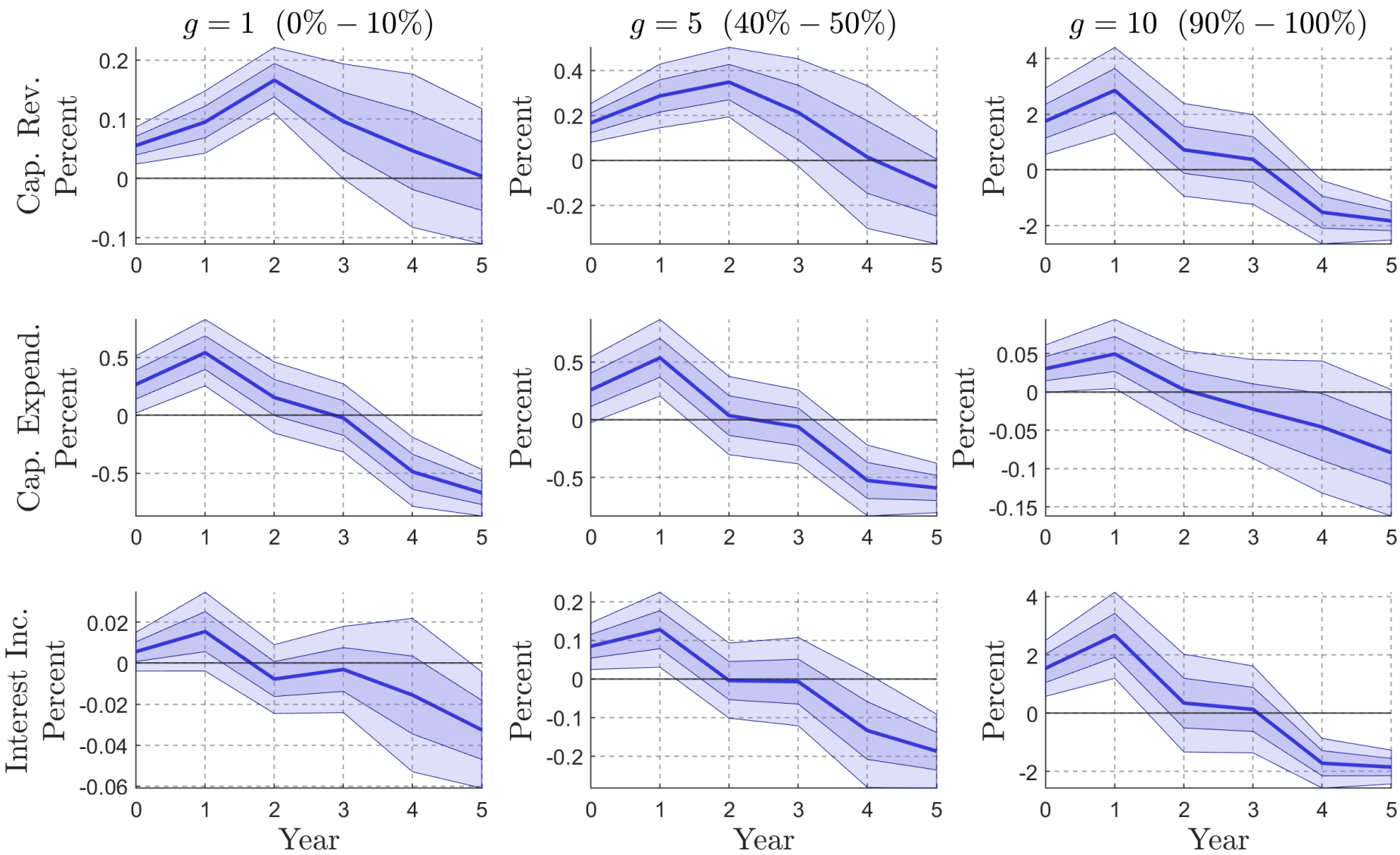
Responses by liquid asset; selected groups

Back



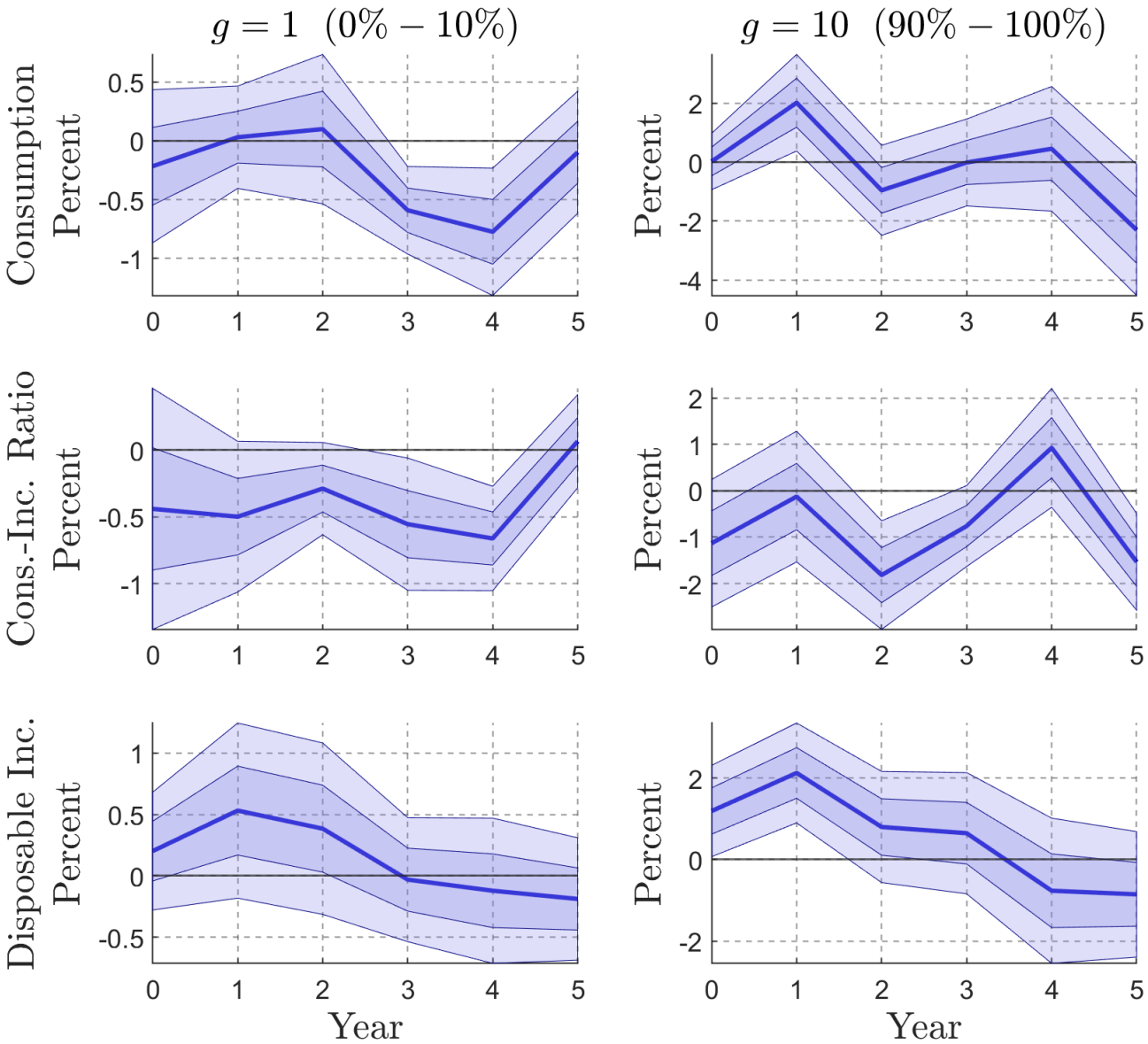
Responses by liquid asset; selected groups

Back



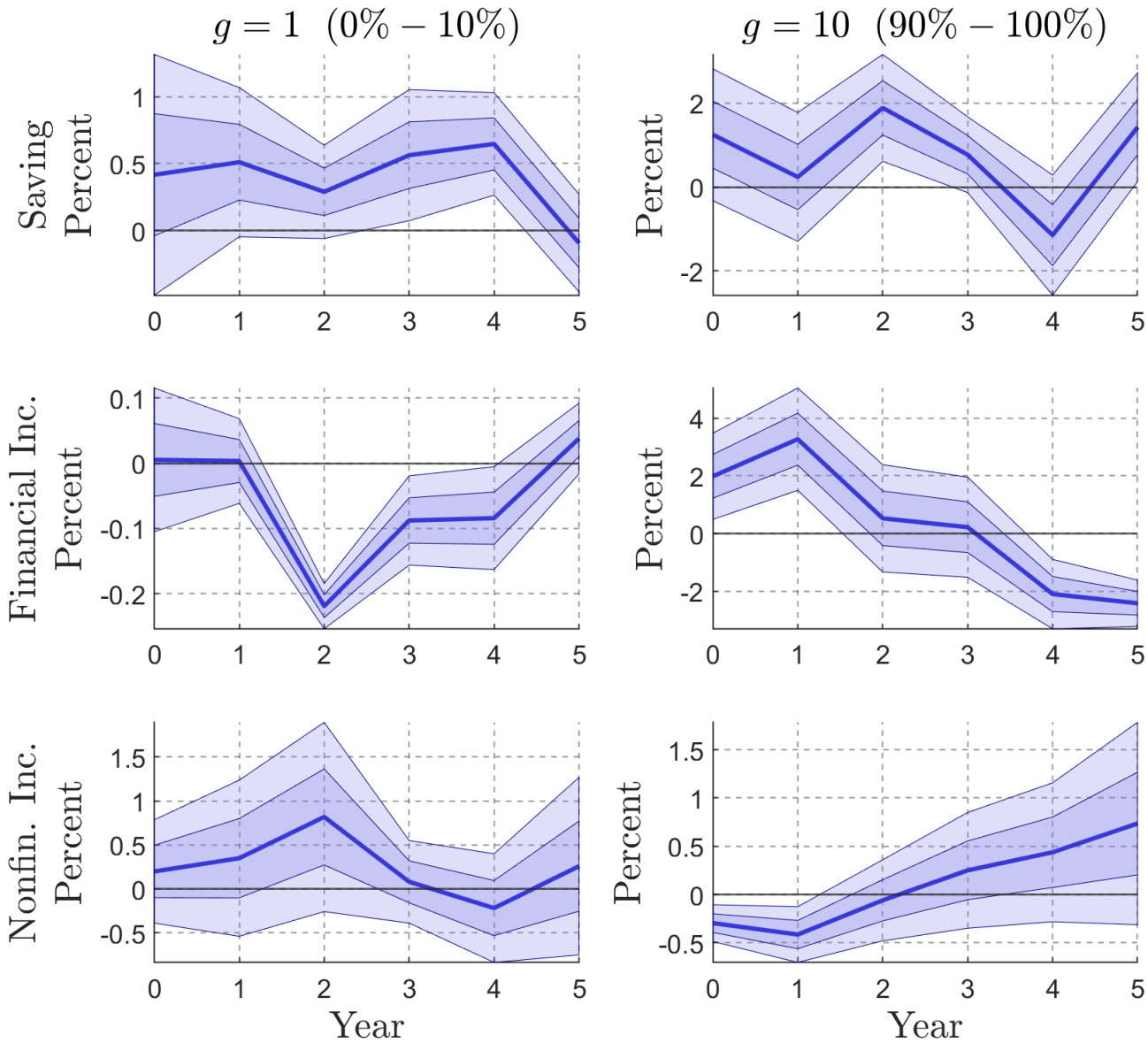
Responses by liquid asset; group comparisons

Back



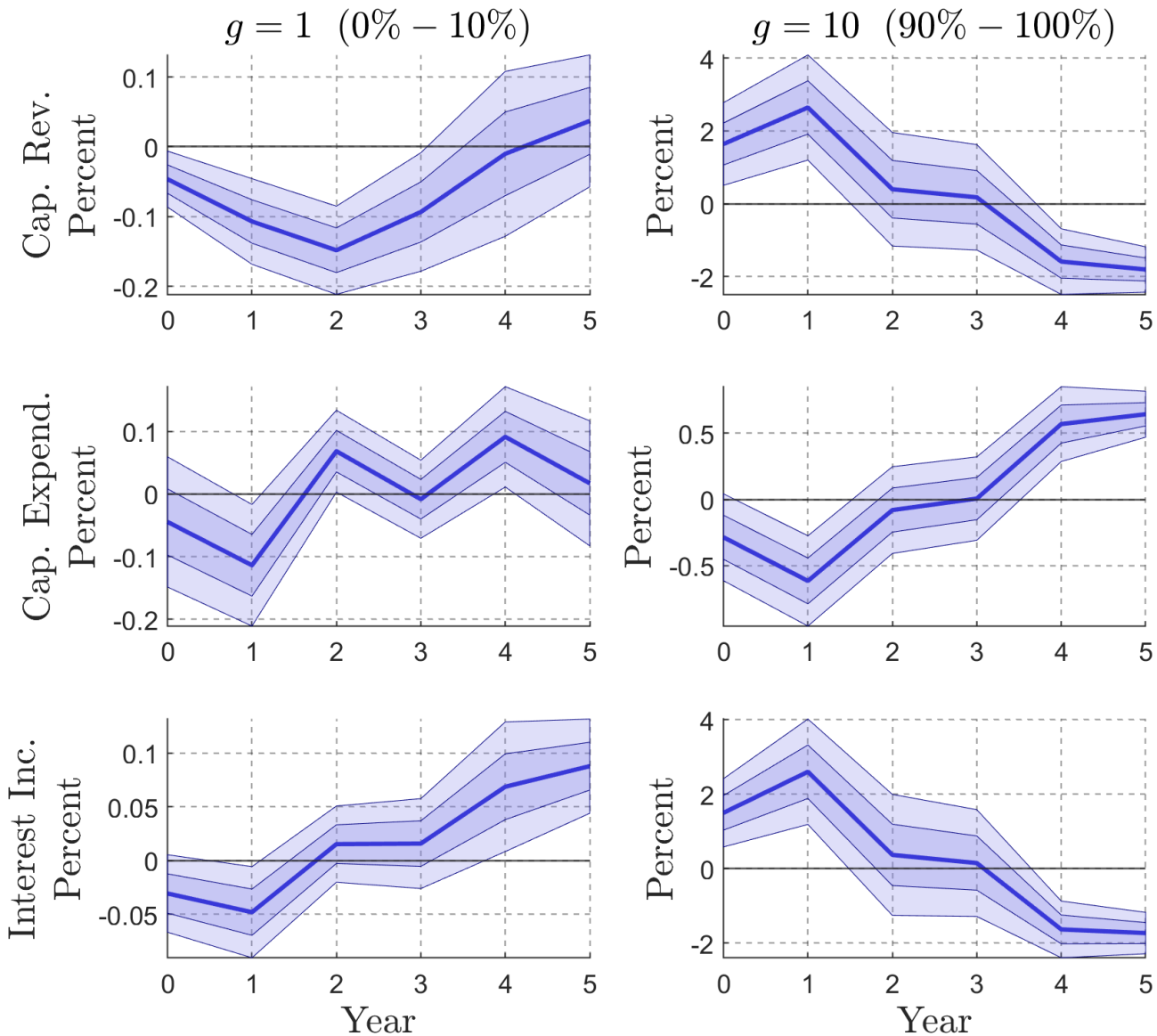
Responses by liquid asset; group comparisons

Back



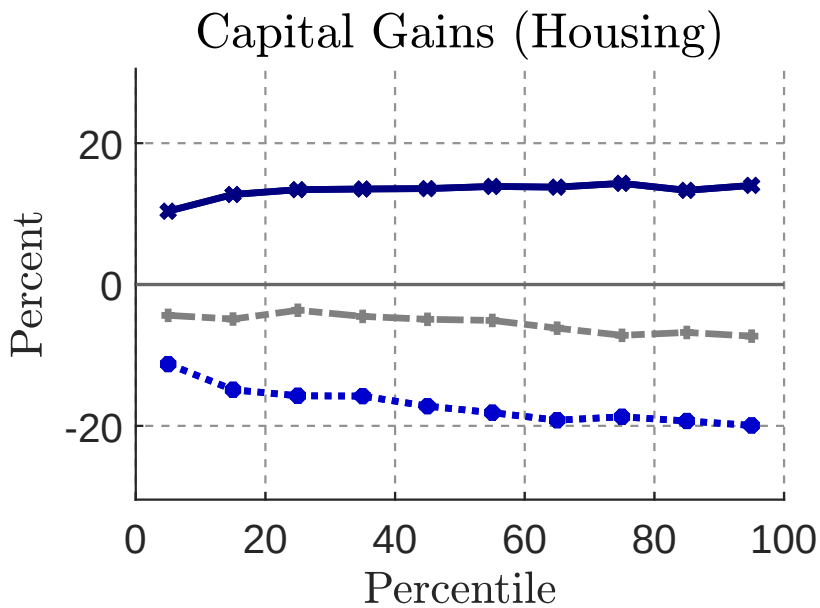
Responses by liquid asset; group comparisons

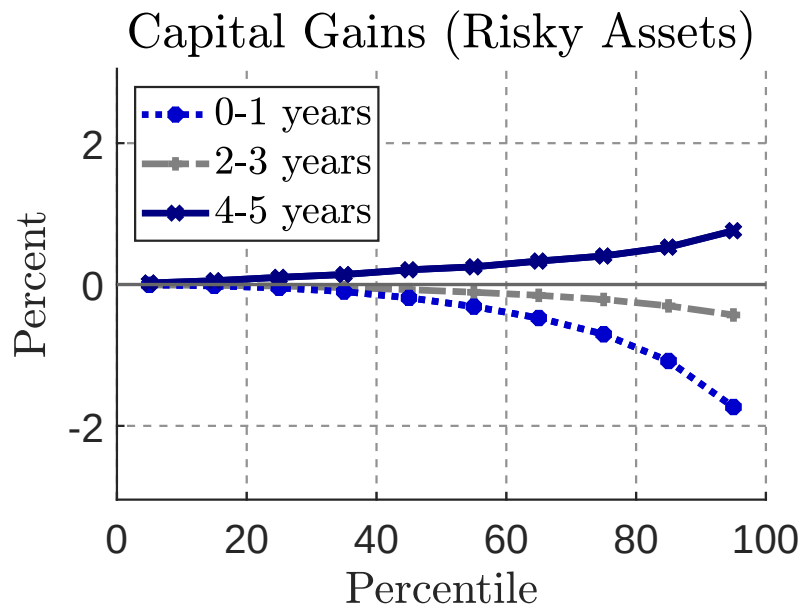
Back



IRFs by Liquid Assets – Wealth Effects

Back



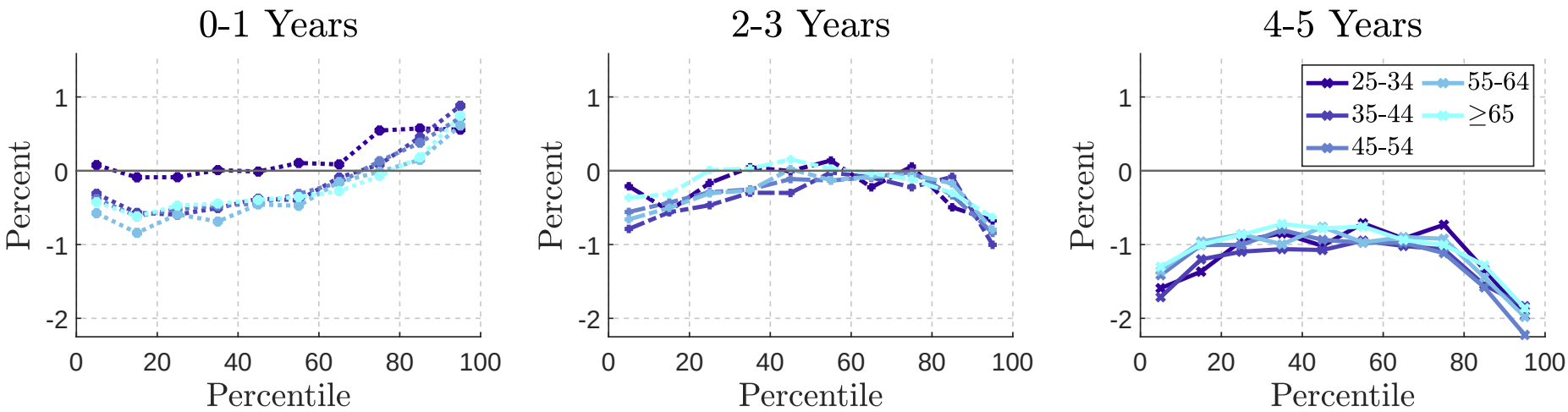


Characterizing the Top 10% Back

- Threshold high ($>$\$120,000 in several years)
- Persistence
  - 90% in top 10% prior year
  - 67% in top 10% for past five years
- Consumption response robust at top when only considering households that are persistently in top 10% (3 past years)

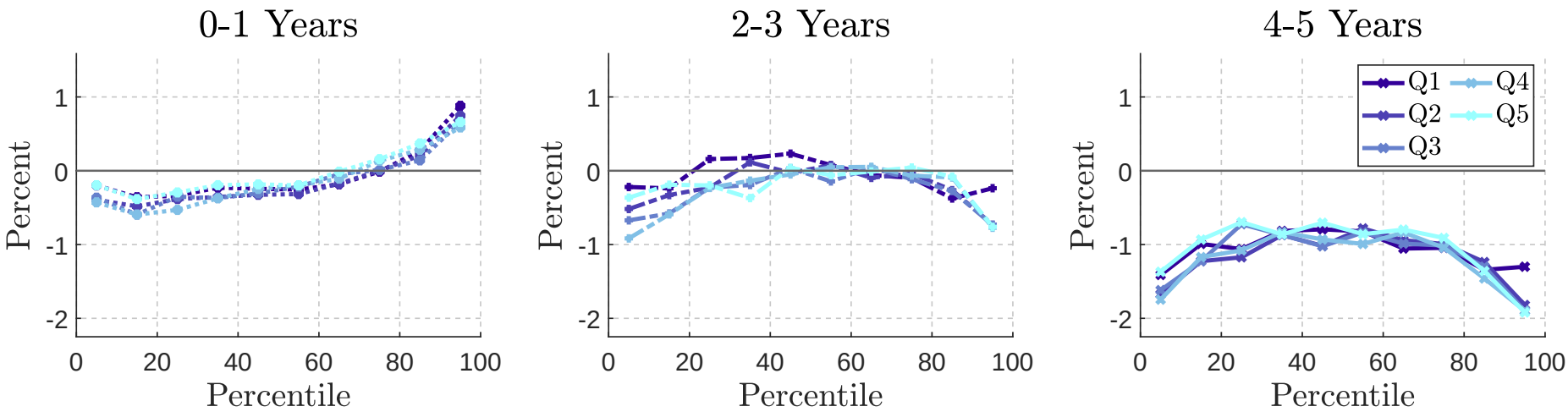
Consumption Responses by Age

Back



Consumption Responses by Lagged Income

Back



Responses relative to average income

Back

- Estimate local projections

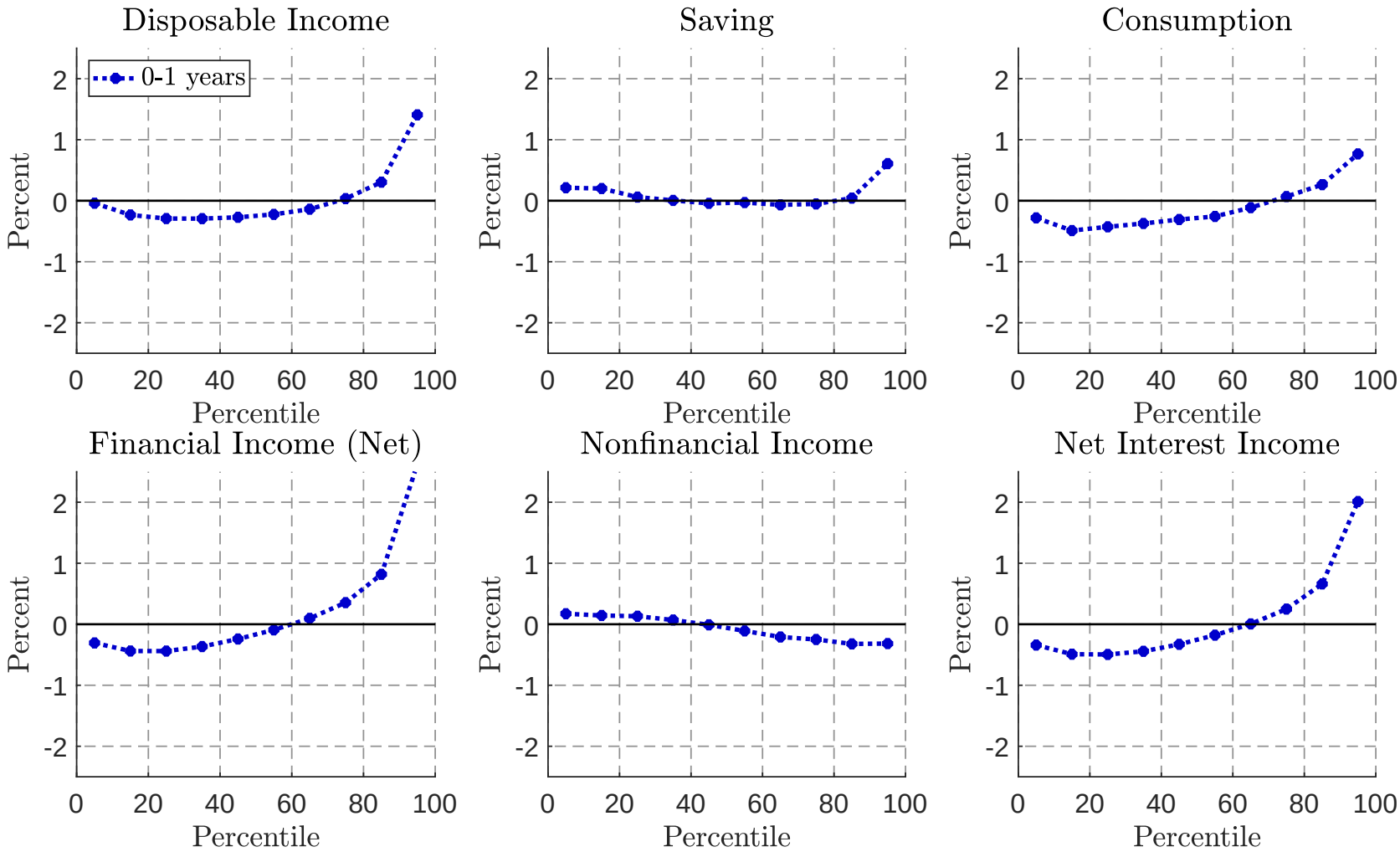
$$\frac{y_{i,t+h} - y_{i,t-1}}{\overline{inc}_{i,t-1}} = \delta_i^h + \beta_g^h \cdot \epsilon_t^{MP} + \gamma_g^h X_{i,t-1} + u_{i,t}^h$$

  for deciles across liquid asset distribution

- $\overline{inc}_{t-1} = \frac{1}{N}\sum_{i=1}^{N} inc_{i,t-1}$
- Controls:
  - 3 years of lags of ϵ_t^{MP}
  - 2 years of lags dependent variable (h=0)
- Driscoll-Kraay standard errors

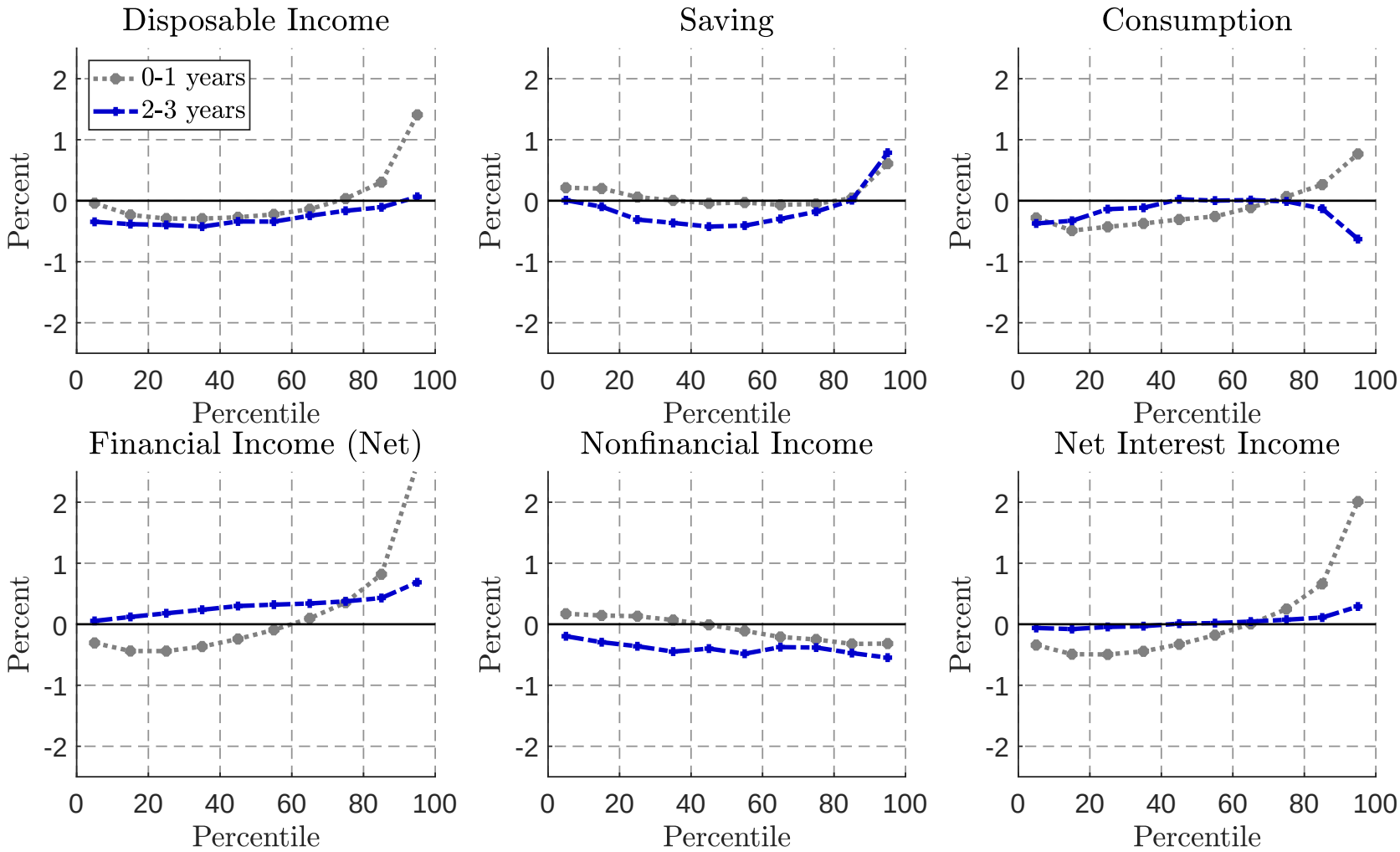
Responses relative to average income

Back



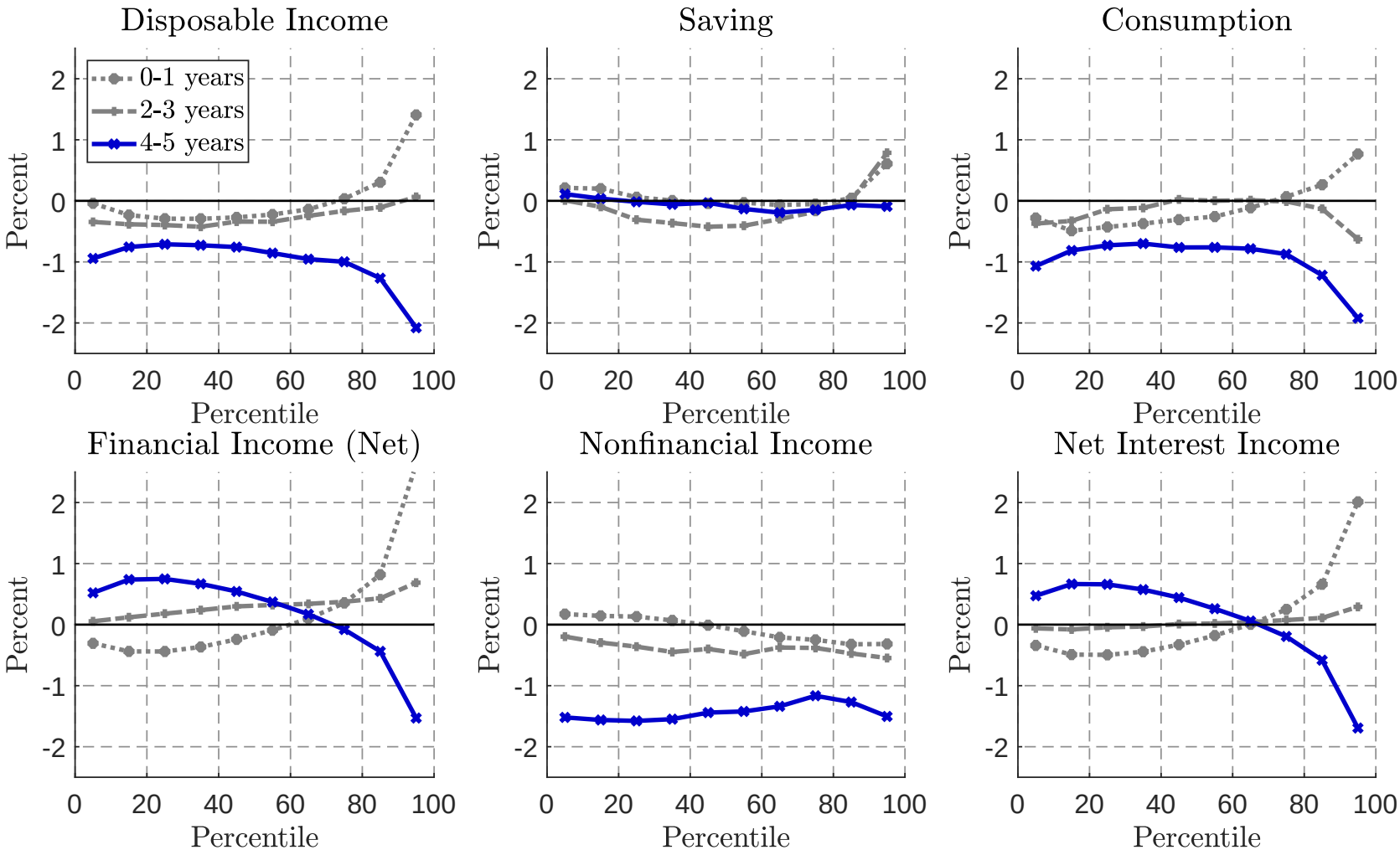
Responses relative to average income

Back



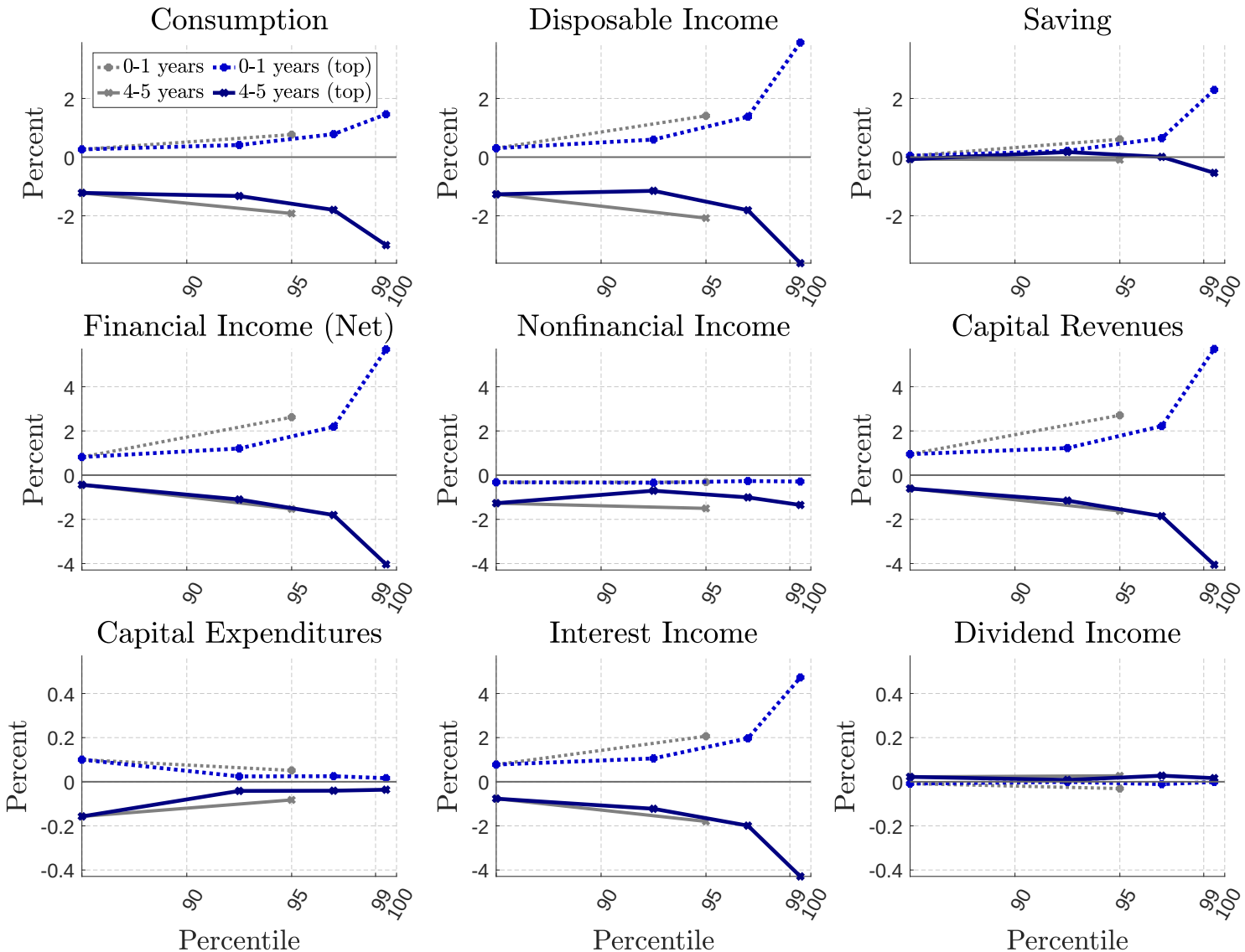
Responses relative to average income

Back



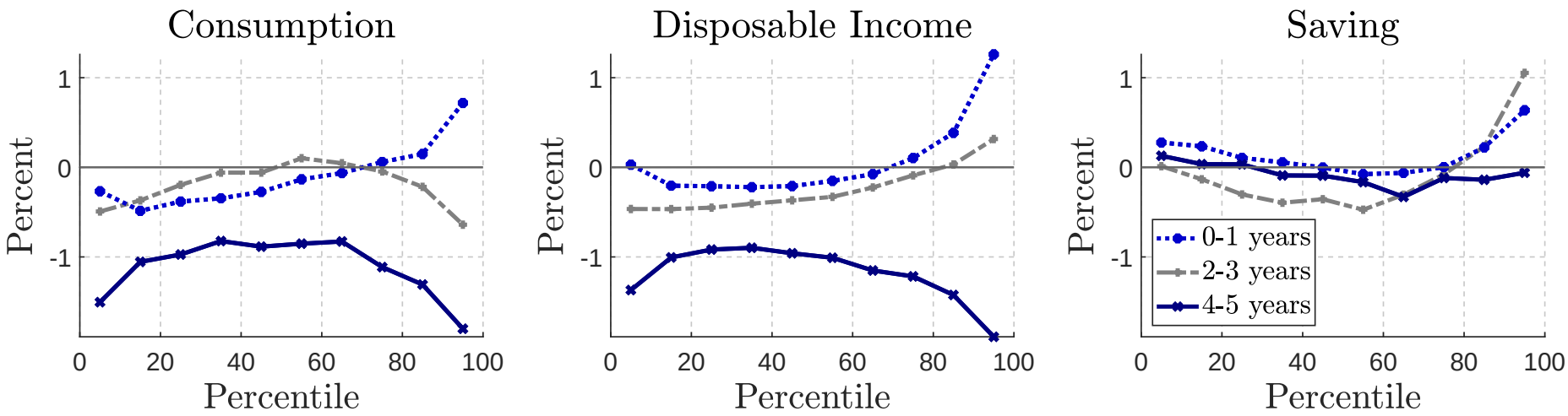
IRFs by Liquid Assets – Top 10%

Back



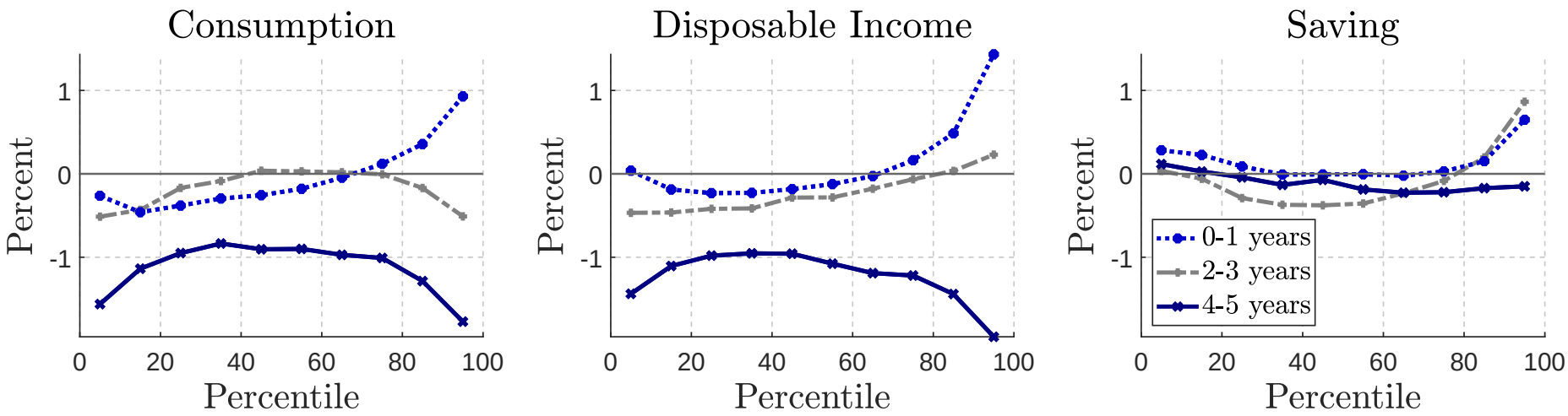
IRFs by Liquid Assets per Income Unit

Back



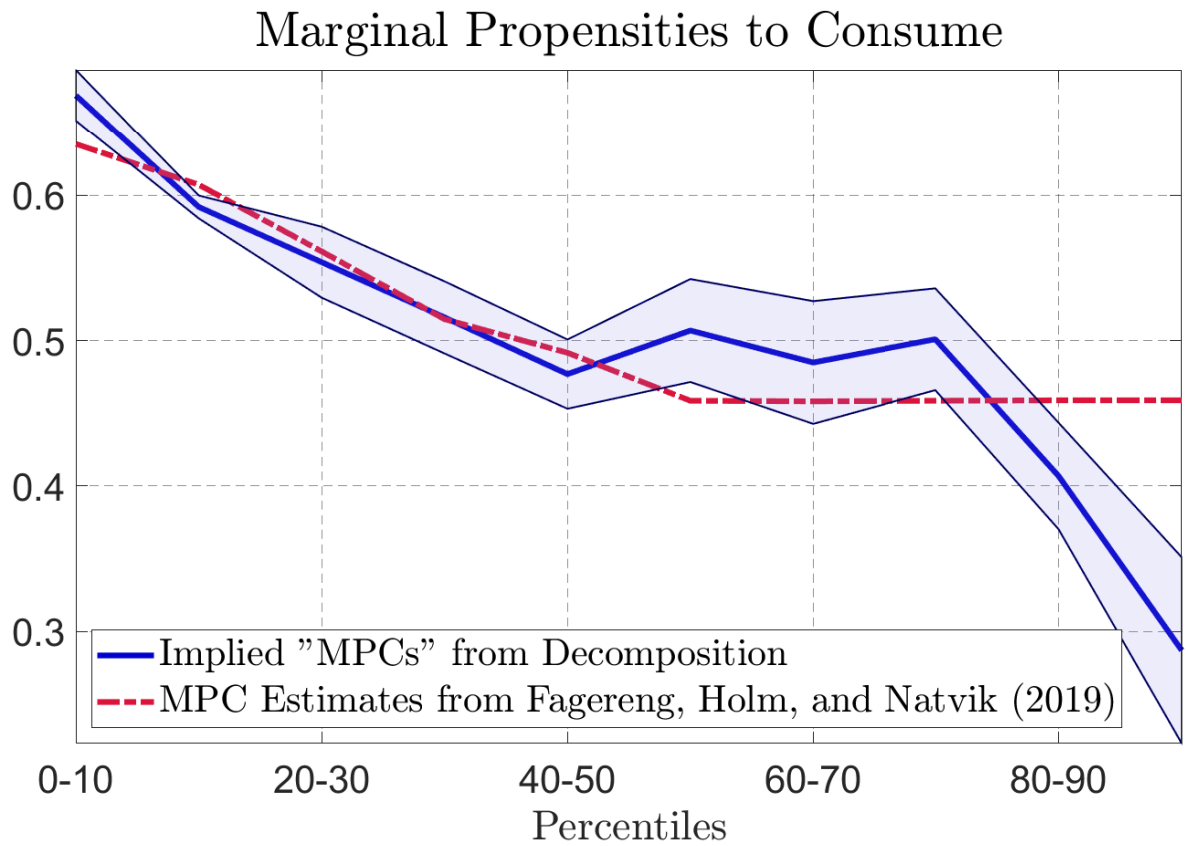
IRFs by Liquid Assets – Non-stockholders

Back



MPCs by Liquid Assets

Back



Responses by rate exposure; selected groups

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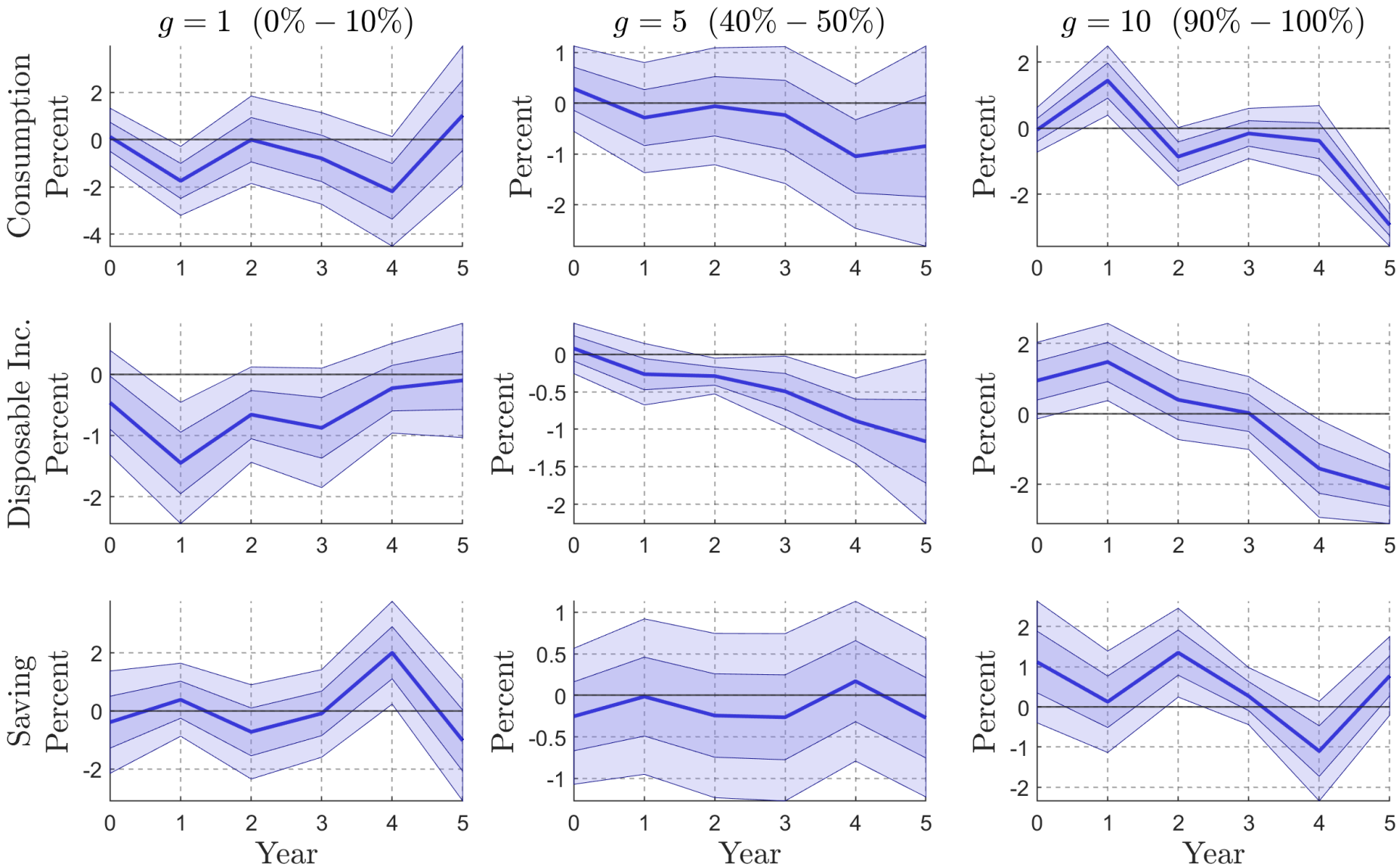

Responses by rate exposure; selected groups

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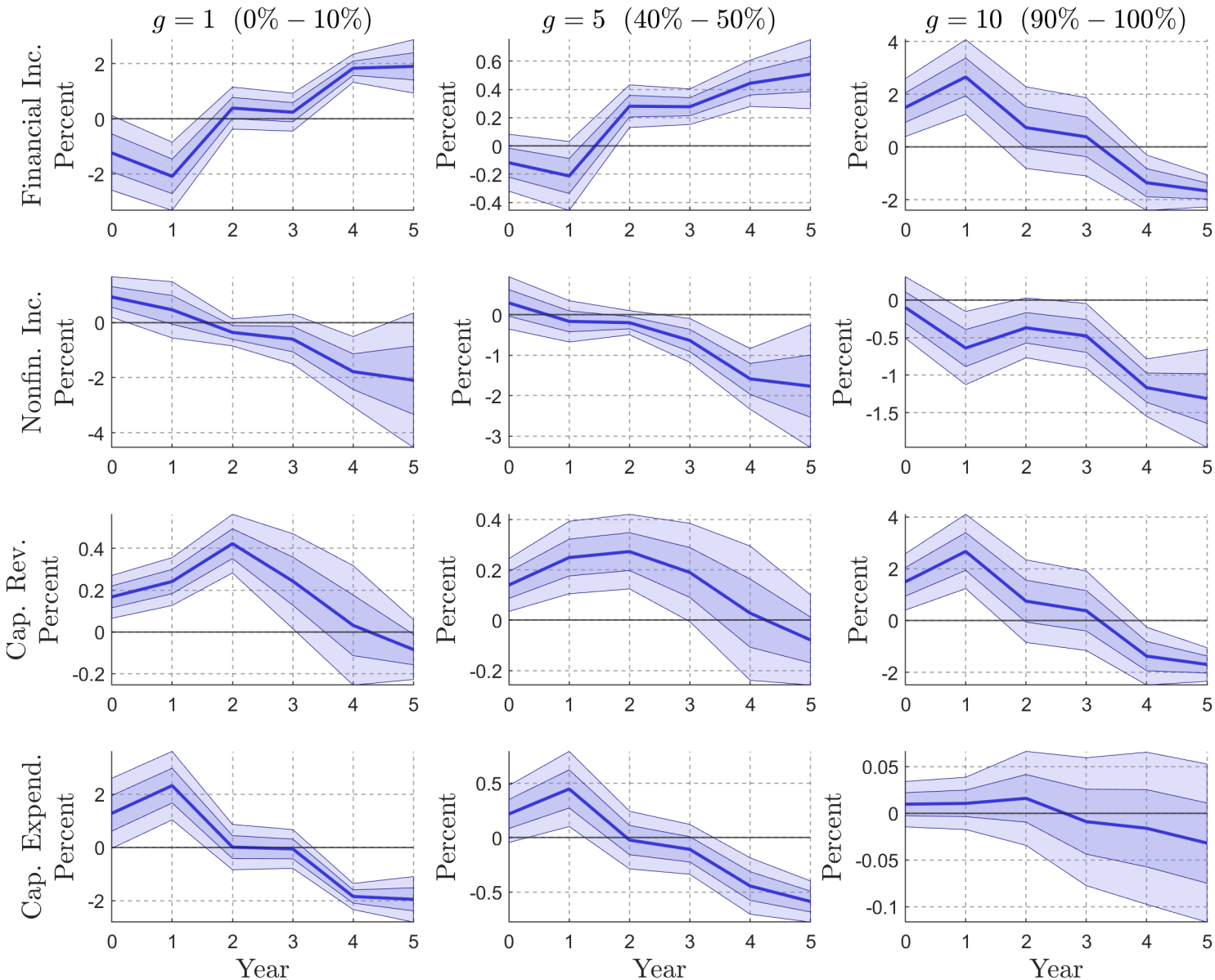

Responses by rate exposure; group comparison

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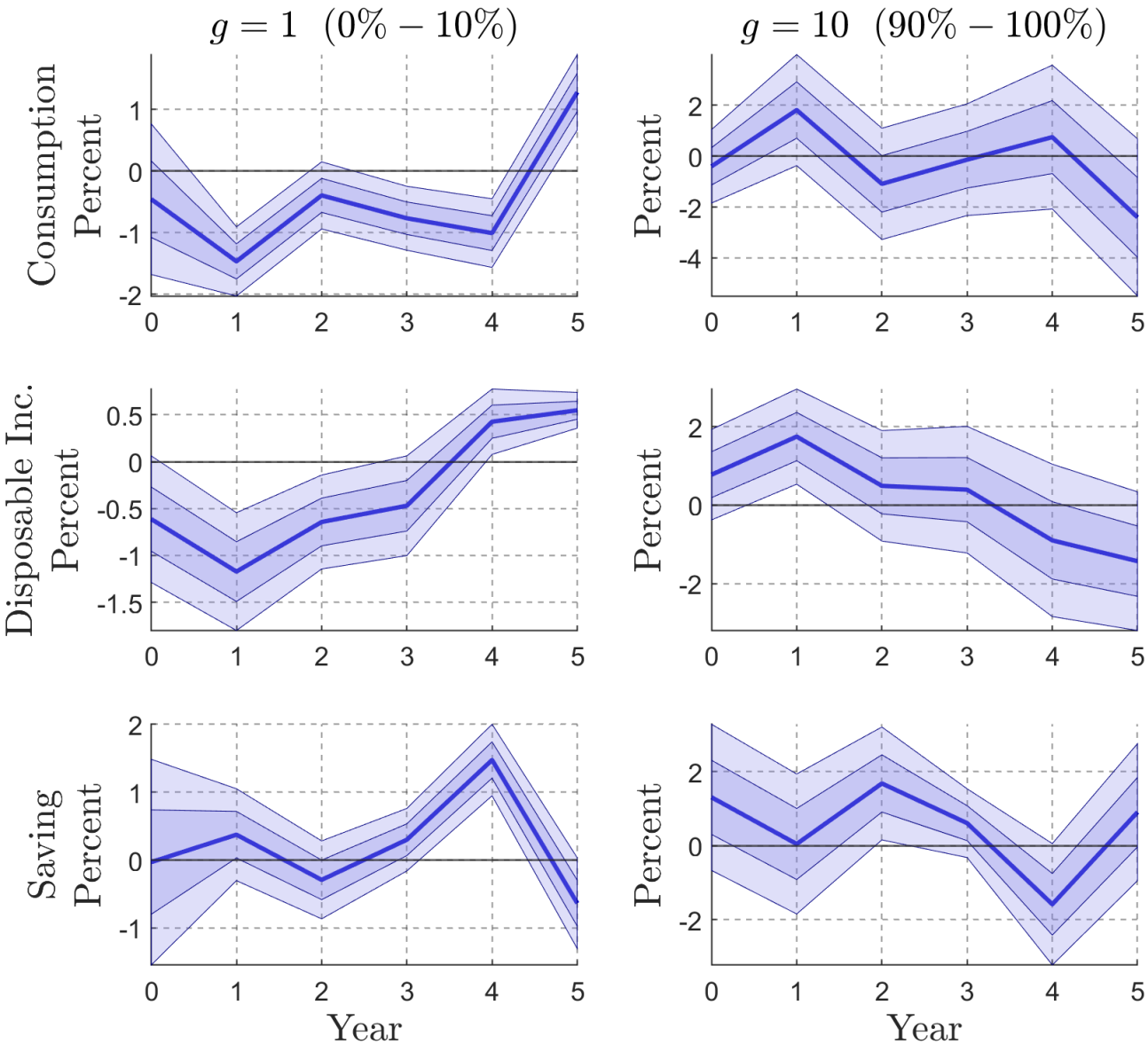

Responses by rate exposure; group comparison

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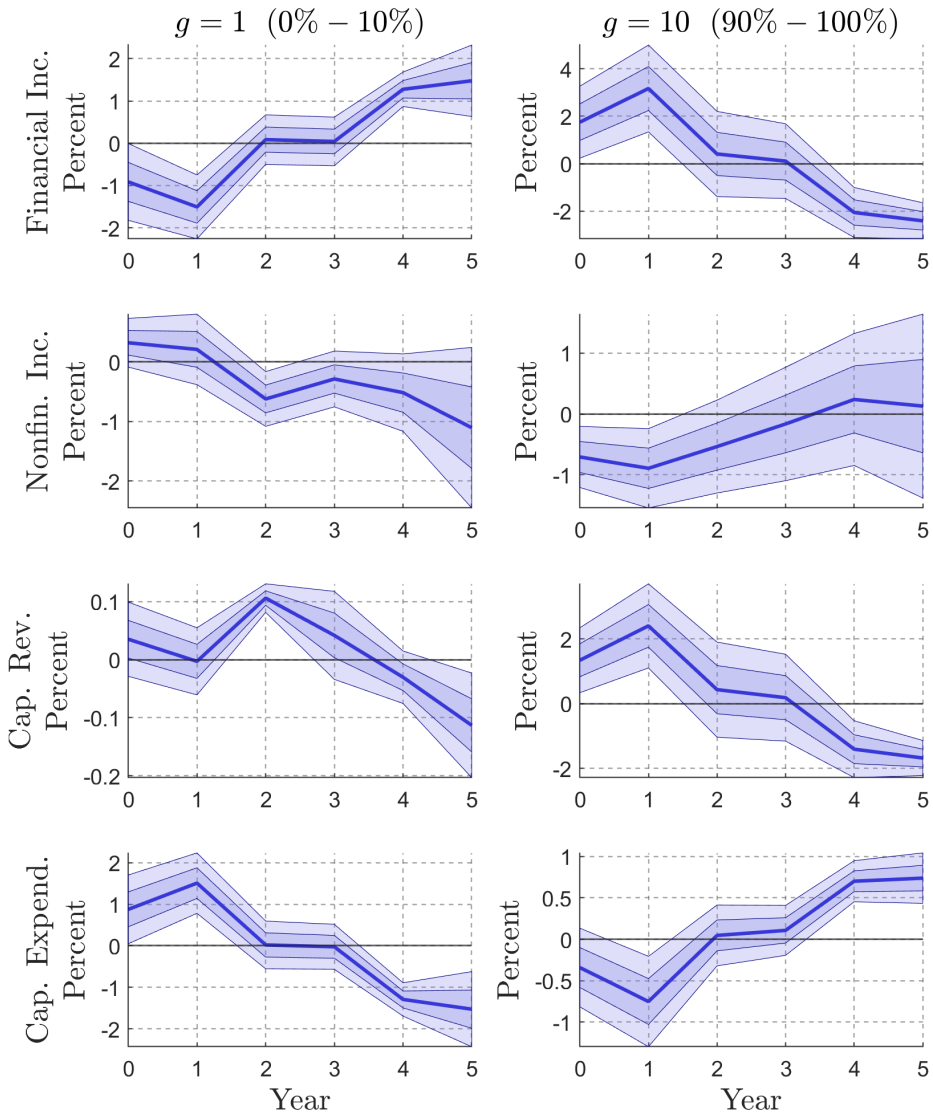

Direct vs. indirect by liquid assets

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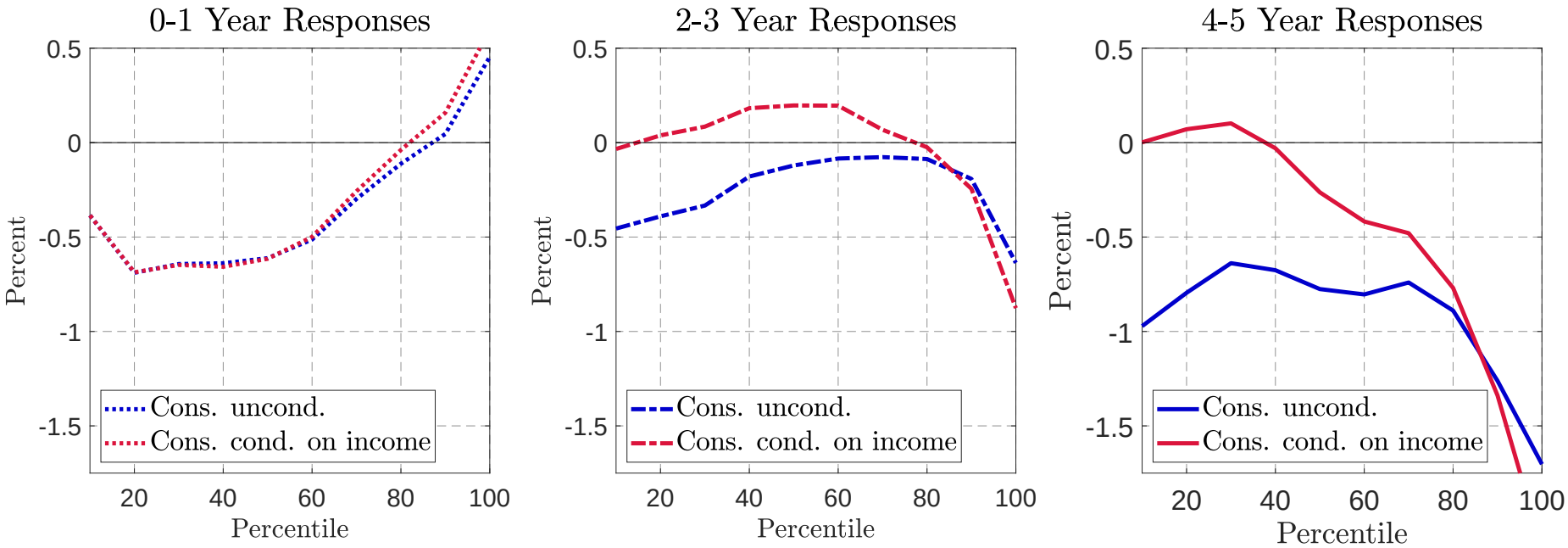

MPC Estimates

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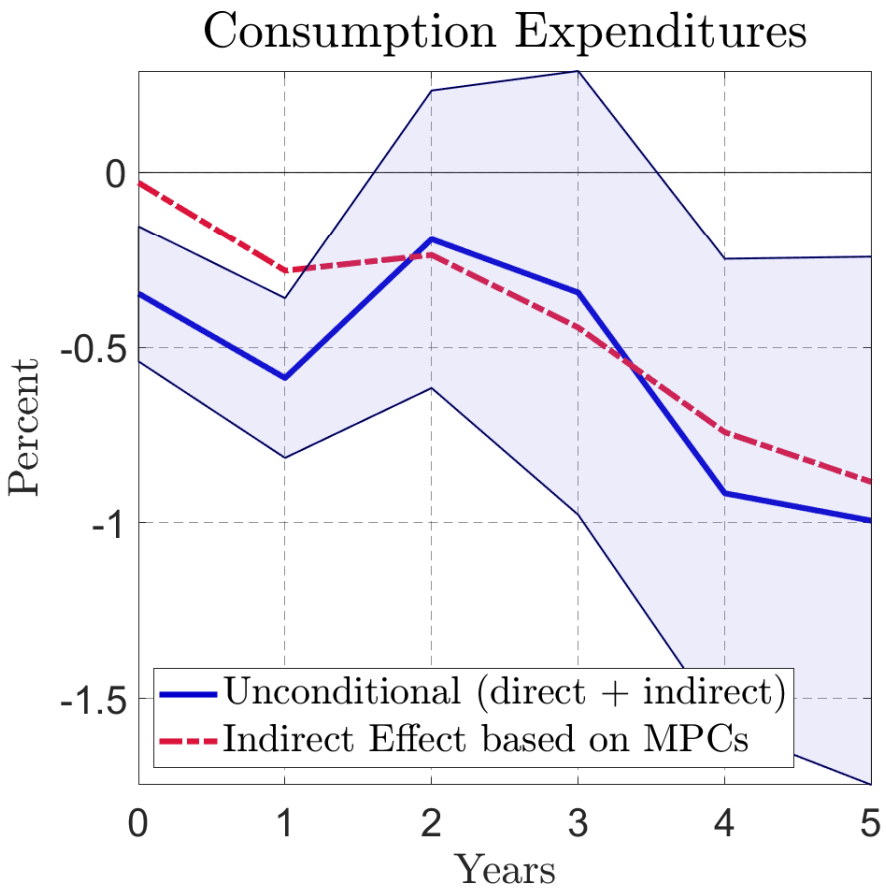

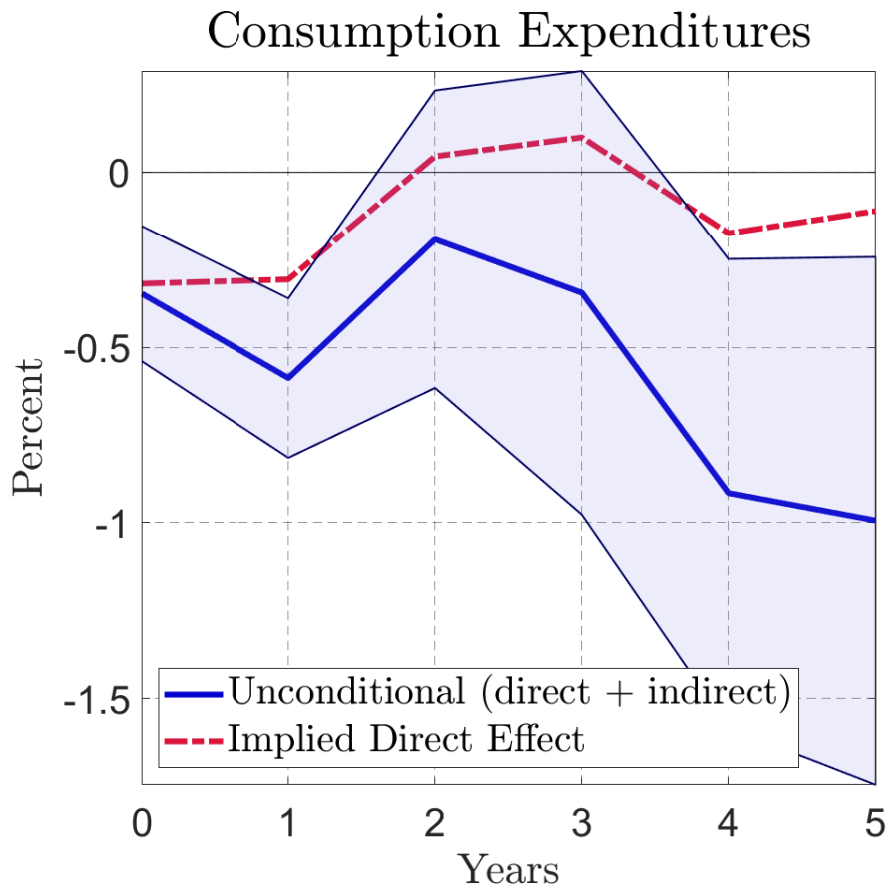

Accounting for Capital Gains

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