Distributional Spillover Effects of US Monetary Policy

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EEA: Monetary Policy and its Effects on the Economy

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Research Question

How does US monetary policy affect the income distributions of the four largest European economies?

Motivation

- US monetary policy operations affect economies around the globe.
- **Substantial spillovers to real economic activity and financial conditions** in most advanced economies (Dedola et al., 2017; Miranda-Agrippino & Rey, 2020).
- As individuals differ in their income composition, spillover effects are likely to vary across the income distribution.
- Central bankers have an **interest in better understanding the distributional effects** (both domestically and abroad).

Our paper in a nutshell

How does US monetary policy spill over to European income distributions?

- We use **annual** income inequality data from the World Inequality Database (WID), **quarterly** data for aggregate macro variables and monetary surprises.
- We estimate **Mixed-Frequency Bayesian Proxy SVARs (MF-BPSVARs)** for the US, France, Germany, Italy and the UK.
- We find that:
  - Monetary contractions raise pre-tax income shares for low- to middle-income individuals, yet reduce income shares for high-income individuals in the US.
  - Income inequality increases in Germany. Effects for the remaining countries are less clear-cut and heterogeneous.

Literature

Our paper relates to **three strands of literature**:

1. **International spillovers of US monetary policy**
   (Breitenlechner et al., 2022; Dedola et al., 2017; Degasperi et al., 2020; Iacoviello and Navarro, 2019; Miranda-Agrippino and Rey, 2020)

   Details

2. **Effects of monetary policy on domestic inequality**
   (Coibion et al., 2017, for US; Mumtaz and Theophilopoulou, 2017, for UK; Lenza and Slacalek, 2018, for Euro Area; Amberg et al., 2022, for Sweden; Furceri et al., 2018, for 32 advanced and emerging economies)

   Details

3. **Methodological VAR literature**
   (Arias et al., 2021; Caldara & Herbst, 2019; Chan et al., 2021; Schorfheide & Song, 2015)

   Details

Our contribution

1. We are **the first to empirically estimate the effects** of US monetary policy on the income distributions of the four largest European economies.
2. We look at **selected percentile and decile shares** of the income distribution and **include the top 1%** of the income distribution in our analysis.
3. We estimate the effects using a **MF-BPSVAR model** and put forward a Bayesian estimation algorithm. Both are novel to the literature.

Data

- **Income inequality**: Annual data from the WID from 1990 to 2019
  - ⇒ Shares of pre-tax national income for specific groups of the income distribution (bottom 50%, top 10%, top 1%) of equal-split adults in the US, France, Germany, Italy and the UK.

- **Macro and financial variables:** Quarterly data from various sources
  - ⇒ Real GDP for US and 4 European economies, rest-of-world real GDP, US CPI, US excess bond premium, one-year US Treasury Bill, US dollar NEER and the VXO as a measure of global risk aversion.

- **US monetary policy shocks:** Proxy variable as in Jarociński and Karadi, 2020.
  - ⇒ Intra-daily interest rate surprises in a narrow time window on FOMC meeting days of Gürkaynak et al., 2005.

Details

Methodology: Mixed-Frequency Bayesian Proxy SVAR

Frequency mismatch:

Aggregate macro data	vs.	Inequality data
quarterly		annual

Empirical approach needs to . . .

Handle frequency mismatch	$\Rightarrow$ Mixed-Frequency VAR
Identify monetary policy shock	$\Rightarrow$ Bayesian Proxy SVAR

$\Rightarrow$ **Mixed-Frequency Bayesian Proxy SVAR**

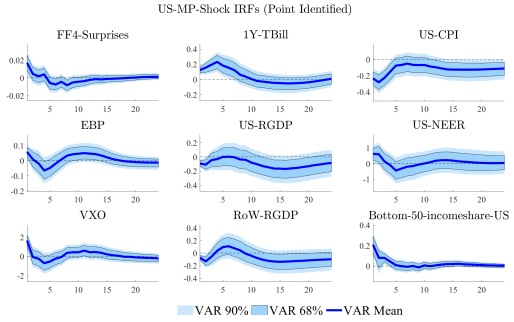
(Stock and Watson, 2012; Caldara and Herbst, 2019; Mertens and Ravn, 2013; Arias et al., 2021; Georgiadis and Schumann, 2022; Schorfheide and Song, 2015)

Details

Results: Domestic macroeconomic effects

- US monetary contractions temporarily **reduce real GDP** and lead to a **financial tightening** in the US.

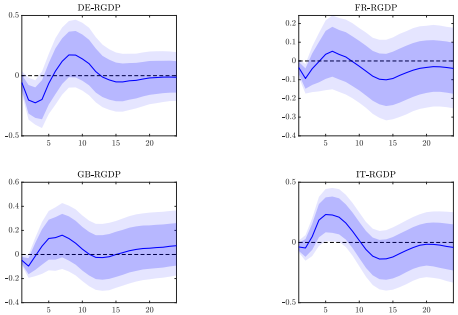
  $\Rightarrow$ Results are in line with findings from the empirical literature (Breitenlechner et al., 2022; Caldara & Herbst, 2019).



Results: Macroeconomic spillover effects

- **Real GDP abroad declines** temporarily and contracts in tandem with US real GDP.
- The size of the reductions mirrors the one in the US.

  $\Rightarrow$ Results are in line with findings from the empirical literature (Dedola et al., 2017; Degasperi et al., 2020; Iacoviello & Navarro, 2019).

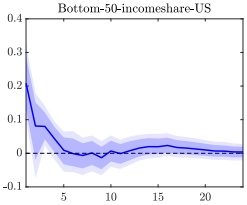


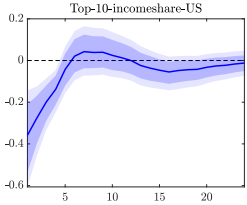
Results: Domestic distributional effects

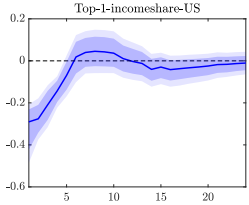
- **US monetary contractions have substantial distributional effects in the US:**
  - Decline in income inequality following US monetary tightening, mainly driven by reduction in income shares for the top 10% and top 1%.

⇒ Results are somewhat different from Coibion et al., 2017 (may be due to different sample periods, different proxies for monetary surprises).

Details







Results: Distributional spillover effects

- **US monetary contractions have substantial distributional spillover effects:**
  - Slight declines in income inequality in France and Italy. FR IT
  - Increase in income inequality following US monetary tightening in Germany. DE
  - No clear-cut results for the UK. UK

$\Rightarrow$ Sources of income and income compositions differ across countries. This may drive the results.

Conclusion

- We estimate the distributional spillover effects of US monetary policy on the four largest European economies.
- Our results suggest:
  - Monetary contractions reduce pre-tax income inequality in the US.
  - Pre-tax income inequality increases in Germany. Effects for the remaining countries are less clear-cut and heterogeneous.

Next steps

- Disentangle income response for labor and capital income (receive additional information about income composition and income sources).
- Modify inequality indicator (use averages instead of shares, post-tax national income).
- Disentangle income response for additional income deciles and percentiles.
- Extend sample countries.
- Redo analysis for wealth inequality.

Thank you!

Appendix

Transmission channels: Spillovers of US monetary policy

- **Exchange Rate Channel:** US monetary tightening leads to appreciation of US dollar. Stronger dollar shifts demand away from US goods towards goods produced in other countries.

  $\Rightarrow$ GDP in foreign countries will increase (due to cheaper exports).

- **Trade Channel:** US monetary tightening reduces incomes and expenditures in the US and lowers US demand for domestically produced and imported goods.

  $\Rightarrow$ GDP in foreign countries will decrease.

- **Financial Channels:** US monetary tightening affects prices of various financial assets and liabilities held abroad because of the **global financial cycle** (see Miranda-Agrippino and Rey, 2020; Rey, 2015).

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Literature: Spillovers of US monetary policy

- Dedola et al., 2017: Monetary contractions **reduce industrial production and real GDP**, **raise unemployment** across AEs and EMEs and **lower inflation** in AEs.
- Iacoviello and Navarro, 2019: Policy-induced rise in US rates of 100 b.p. reduces GDP in AEs by 0.5% after three years.
- Degasperi et al., 2020: Decrease in industrial production and global economic activity following a monetary tightening.

  $\Rightarrow$ **Trade Channel matters.**
- Breitenlechner et al., 2022: Reduction in global equity prices following a monetary tightening.
- Miranda-Agrippino and Rey, 2020: Deterioration in financial conditions and a rise in aggregate risk aversion following a monetary contraction.

  $\Rightarrow$ **Financial Channels matter.**

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Transmission channels: Domestic distributional effects

- **Earnings Heterogeneity Channel:** Transition from employment to unemployment (or vice versa) affects labor income.
- **Income Composition Channel:** Individuals differ in their primary sources of income. Monetary policy affects these sources in a heterogeneous manner.
- **Portfolio Composition Channel:** Changes in asset prices (housing, bonds and stocks) affect wealth.
- **Financial Segmentation Channel:** More financially literate individuals can adjust their portfolios more quickly in response to changes in monetary policy than others.
- **Savings Redistribution Channel**: An increase in interest rates or a decrease in inflation will benefit savers and hurt borrowers.

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Literature: Domestic distributional effects

- Coibion et al., 2017: Monetary contractions **increase inequality in labor earnings, total income, consumption and expenditures** in the US.

  $\Rightarrow$ **Income Composition matters.**

- Mumtaz and Theophilopoulou, 2017: Monetary contractions increase earnings, income and consumption inequality in the UK.

- Amberg et al., 2022: Expansionary monetary policy leads to a **U-shaped response** of (post-tax) income in Sweden.

  $\Rightarrow$ **Labor income gains matter at the bottom, capital income gains matter at the top.**

- See also Lenza and Slacalek, 2018, for the Euro Area, Furceri et al., 2018, for 32 advanced and emerging economies, Casiraghi et al., 2018, for Italy and Andersen et al., 2022, for Denmark.

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Literature: VAR Methodology

- Schorfheide and Song, 2015, develop a VAR for time series observed at mixed frequencies (monthly and quarterly).
- Chan et al., 2021, put forward a more efficient approach to estimating MF-VARs.
- Caldara and Herbst, 2019, and Arias et al., 2021, develop algorithms for estimating Bayesian Proxy SVARS.

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Data description

Variable	Description	Source	Frequency	Coverage
DE, FR, GB, IT, US bottom10, bottom50, top10, top1 income share	Pre-tax national income share	WID	Annual	1990 - 2019
US 1Y-TBill	1-year Treasury Bill yield at constant maturity	US Treasury/Haver	Quarterly	1990q1 - 2019q2
US CPI	Consumer price index	BLS/Haver	Quarterly	1990q1 - 2019q2
US EBP	Excess bond premium	See Favara et al. (2016)	Quarterly	1990q1 - 2019q2
DE, FR, GB, IT, US RGDP	Real gross domestic product	OECD	Quarterly	1990q1 - 2019q2
RoW RGDP	Real gross domestic product	OECD	Quarterly	1990q1 - 2019q2
VXO	CBOE market volatility index	Wall Street Journal/Haver	Quarterly	1990q1 - 2019q2
US dollar NEER	Nominal broad trade-weighted dollar index	FRB/Haver	Quarterly	1990q1-2019q2

Notes: WID stands for World Inequality Database, BLS for Bureau of Labor Statistics, OECD for Organisation for Economic Co-operation and Development, and FRB for Federal Reserve Board.

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Methodology: MF-VAR

Macro variables $\Rightarrow$ observed quarterly
Inequality variables $\Rightarrow$ observed annually

Companion form of a VAR(p) in quarterly frequency $t = 1, \ldots, T$:

$$z_t = C + \Phi z_{t-1} + G\Sigma^{\frac{1}{2}} u_t \qquad u_t \sim N(0, I_n), \tag{1}$$

- z_t : Variables observed quarterly ($y_{q,t}$) and annually ($y_{a,t}$)
- C : Constant terms
- Φ : Is $np \times np$; first n rows collect the autoregressive coefficients ($\Pi_1, ..., \Pi_p$), remaining $n(p-1)$ rows yield identities of lagged values of $y_{q,t}$ and $y_{a,t}$
- G : Selection matrix, with $G = [I_n, 0_{(n(p-1))}]$
- $\Sigma^{\frac{1}{2}}$: Cholesky factor of the $n \times n$ Variance-Covariance matrix (Σ)

Methodology: MF-VAR ctd.

Assume that inequality variables evolve on a quarterly basis,
but only the four-quarter moving average is observed once a year:

$$x_{a,t} = 1/4(y_{a,t} + y_{a,t-1} + y_{a,t-2} + y_{a,t-3}). \tag{2}$$

Augmenting the state vector $\tilde{z}_t = [z_t, x_{a,t}]$, such that the final state equation is

$$\tilde{z}_t = \bar{C} + \bar{\Phi}\tilde{z}_{t-1} + \bar{G}\Sigma^{\frac{1}{2}} u_t \qquad u_t \sim N(0, I_n) \tag{3}$$

$\bar{C} = \tilde{A}^{-1}[C; 0_{n_{a,x}}], \bar{\Phi} = \tilde{A}^{-1}[\Phi, 0_{[(n+n_{a,x})\times 1]}; D], \bar{G} = \tilde{A}^{-1}[G, 0_{[n\times 1]}], \tilde{A} = I_{np+n_{a,x}} + F$

D : Last $n_{a,x}$ rows of $\tilde{\Phi}$ and is designed to replicate the dependence of $x_{a,t}$ on the lags of $y_{a,t}$.
F : Is a matrix of zeros with entries of $-\frac{1}{4}$ at the position that links $x_{a,t}$ to the contemporaneous values of $y_{a,t}$.

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Methodology: MF-VAR ctd.

As in Schorfheide and Song, 2015, the measurement equation is

$$y_t^{obs} = S_t \tilde{z}_t. \tag{4}$$

S_t selects the observable quarterly series $y_{q,t}$ and, if at time t, the four-quarter average of the $y_{a,t}$ is part of y_t^{obs}, it selects the row for the corresponding aggregator $x_{a,t}$.

(3) and (4) form a linear Gaussian state space model.

$\Rightarrow$ Simulation smoother of Durbin and Koopman, 2002, to draw from the conditional posterior of the missing observations $y_{a,t}$, conditional on the data and the parameters.

Methodology: MF-BPSVAR

We apply a Bayesian Proxy SVAR to the mixed-frequency VAR just outlined.
Write the reduced form in (1) as a system of structural equations

$$y_t = \Pi y_{t-1} + B\epsilon_t, \qquad \epsilon \sim N(0, I_n) \tag{5}$$

B: the structural elasticity matrix
$\Pi = BB_1$ (B_1: structural lagged coefficients)
$u_t = B\epsilon_t$
Here we assume that $p = 1$.

Methodology: MF-BPSVAR ctd.

We identify a US monetary policy shock ($\epsilon_{mp,t}$) by using high-frequency financial data as a proxy variable (m_t).
Assuming $E[\epsilon_{mp,t} m_t] = \sigma_{mp}$ and $E[\epsilon_{\setminus mp,t} m_t] = \underset{(n-1\times 1)}{0}$

The full MF-BPSVAR is

$$\tilde{y}_t = \tilde{\Pi}\tilde{y}_{t-1} + \tilde{B}\tilde{\epsilon}_t \tag{6}$$

$\tilde{y}_t \equiv (y_t, m_t)$ and $\tilde{\epsilon} \equiv (\epsilon_t, v_t')' \sim N(0, I_{n+k})$, where v_t are the measurement errors that affect the proxy variables.

$$\tilde{\Pi} = \begin{bmatrix} \Pi & \Pi_{m,y} \\ 0_{1\times n} & \Pi_{m,m} \end{bmatrix} \text{ and } \tilde{B}\tilde{\epsilon}_t = \begin{bmatrix} B_{\setminus mp,t} & B_{mp} & 0 \\ 0 & \sigma_{mp} & \sigma_v \end{bmatrix} \begin{bmatrix} \epsilon_{\setminus mp,t} \\ \epsilon_{mp,t} \\ v_t \end{bmatrix} \tag{7}$$

Methodology: Metropolis-Within-Gibbs algorithm

Follow Georgiadis and Schumann, 2022,

- First find the **joint posterior mode of the parameters**.
- Then **cycle through the conditional posteriors**.

1. $P(\widetilde{b}|Y_q, Y_a, \widetilde{\Pi}) \rightarrow$ Adaptive Metropolis-Hastings algorithm
2. $P(\Pi_{y,m}, \Pi_{m,m}|\widetilde{b}, Y_q, Y_a) \rightarrow$ Gibbs Step
3. $P(Y_a|\widetilde{b}, Y_q, \widetilde{\Pi}) \rightarrow$ Durbin and Koopman, 2002, simulation smoother

Until N effective draws have been generated.

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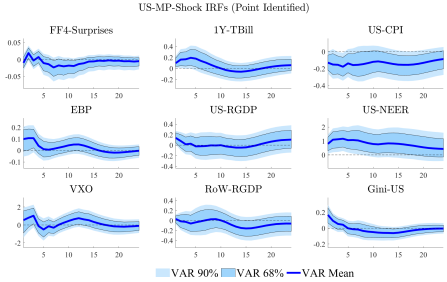
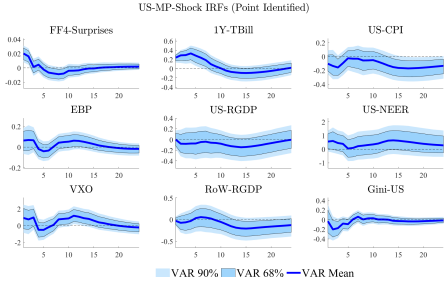
Potential reasons for differences in results to Coibion et al., 2017

1. Different sample period (1980-2008 vs. 1990-2019)
2. Different monetary surprises (RR vs. JK shocks)
3. Different inequality measures:
   - Different data sources (CEX vs. WID)
   - Coibion et al., 2017, exclude the top 1% of the income distribution.
   - Coibion et al., 2017, include transfers in their measure of pre-tax income.
   - Coibion et al., 2017, look at the first difference, not at the level of the inequality variable.
4. Different frequency for inequality variable (quarterly vs. annual)
5. Different methodology (LP vs. MF-BPSVAR)

Potential reasons: Different sample period (1990-2008 vs. 1990-2019)

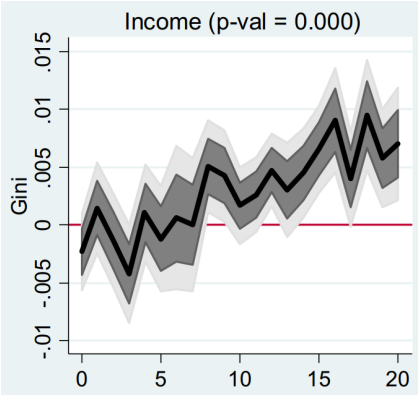
- If we use our JK shock series (left panel) and (almost) the same time period as Coibion et al., 2017, our results are in line with their findings:

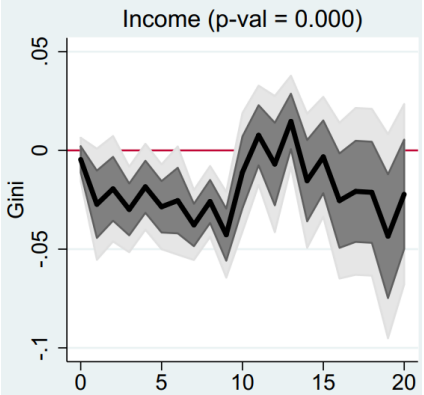




Potential reasons: Different monetary surprises (RR vs. JK shocks)

- Replacing RR shock series (left panel, from Coibion et al., 2017) with JK shock series (right panel) changes the results:





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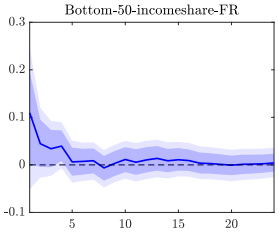
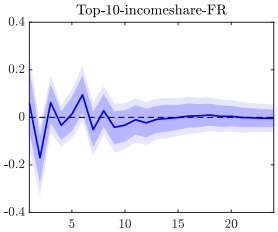
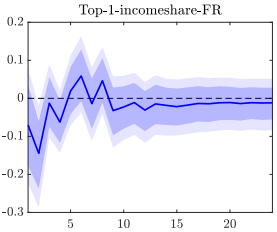
Results: Distributional spillover effects in France







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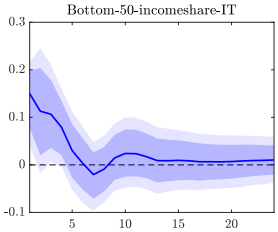
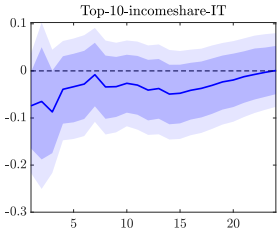
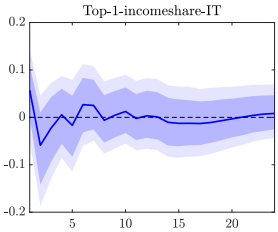
Results: Distributional spillover effects in Italy







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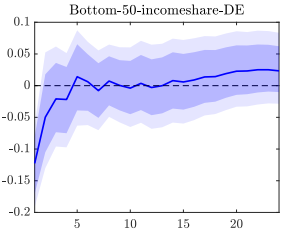
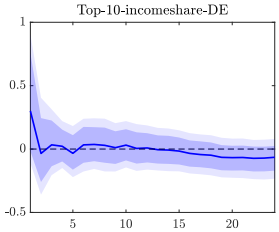
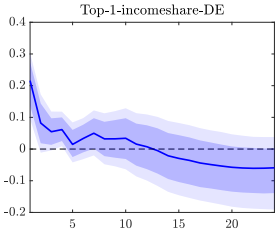
Results: Distributional spillover effects in Germany







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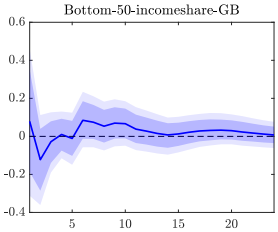
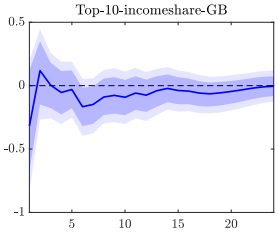
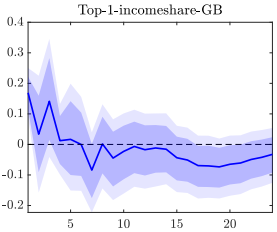
Results: Distributional spillover effects in the UK







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