Monetary policy across the wealth distribution

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Using the Distributional Financial Accounts of the United States, we show that monetary policy has unequal effects across the wealth distribution. The direction and persistence of these effects depend on the policy instrument and the wealth group. Interest rate cuts initially reduce wealth inequality but increase it in the medium run. Asset purchases, instead, increase wealth inequality but only temporarily. Housing is the main channel through which monetary policy affects wealth at the bottom while corporate equities explain wealth growth at the top.

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1. Introduction

Since the Great Recession, unconventional monetary policy tools, such as asset purchases, have played an increasingly important role in the conduct of monetary policy. These tools have helped ease financial conditions and lower long-term interest rates, but they have also drawn harsh criticism from the public for their potential role in increasing wealth inequality. This is because the benefits of expansionary monetary policy would disproportionately accrue to asset owners in the form of capital gains, as lower interest rates and asset purchases boost asset prices.

In this paper, we study the distributional consequences of monetary policy in the United States and identify two channels through which monetary policy has heterogeneous effects across the wealth distribution, net housing wealth and holdings of corporate equities. We use a Vector Autoregressive (VAR) framework and differentiate between interest rate and asset purchase shocks. The primary data source is the Distributional Financial Accounts (DFA) of the United States, which combines household-level data from the Survey of Consumer Finances with the aggregate balance sheet of the household sector.

We contribute by showing that the distributional effects of monetary policy depends to a large extent on the type of policy instrument and the wealth group. An interest rate shock increases net wealth across the distribution within the first year of the shock, with households in the bottom 50% experiencing the largest percentage increase. Six years after the shock, however, the increase in net wealth in response to an interest rate shock is positive only for the top 10%, while households in the bottom 50% experience a large and significant decline. The initial effect of an asset purchase shock on net wealth is more heterogeneous across the distribution, with households in the bottom 50% experiencing the largest percentage increase in wealth, followed by the top 0.1%. However, the effects of an asset purchase shock are short-lived. Overall, our findings suggest a previously undocumented fact about the impact of monetary policy on household wealth: an interest rate shock leads to persistent changes in wealth inequality, while the effects of an asset purchase shock are temporary.

Our paper provides the first comprehensive analysis of the distributional effects of interest rate and asset purchase shocks across the wealth distribution in the US. Two other studies have examined the distributional effects of monetary policy using the DFA, but all have focused only on interest rate shocks. One is Feilich (2023), who finds that a contractionary interest rate shock has larger negative effects at the bottom of the wealth distribution. The other is Bricker et al. (2023), who show that the wealth Gini index increases after an expansionary interest rate shock. Other studies, instead, use a mix of surveys, simulations and estimates of the elasticity of asset prices to monetary policy to show that an expansionary interest rate shock has unequal effects on wealth accumulation (Albert and Gómez-Fernández 2021) and increases the racial wealth gap (Bartscher et al. 2022). However, none of these studies considered the distributional effects of asset purchase shocks in the US.[1] Overall, research on the impact of monetary policy on wealth inequality is less developed compared to income and consumption inequality due to the limited availability of wealth data.[2]

[1]For Italy and the euro area, Casiraghi et al. (2018) and Lenza and Slacalek (2021) find that asset purchases reduce income inequality and have negligible effects on wealth inequality, respectively. De Luigi et al. (2023), instead, find conflicting results using euro area data depending on how wealth inequality is measured: an asset purchase shock increases top wealth shares while it decreases the wealth Gini index.

[2]A contractionary interest rate shock increases labor and consumption inequality in US (Coibion et al. 2017; Dolado, Motyovszki, and Pappa 2021), and wealth inequality in UK (Mumtaz and Theophilopoulou 2017). The income response to expansionary monetary policy is U-shaped across the income distribution in Sweden (Amberg et al. 2022). In Denmark, expansionary monetary policy has larger effects on income, consumption, and wealth across the income distribution (Andersen et al. 2023). Cross-country studies find that a contractionary interest rate shock reduces the top 1% income share (El Herradia and Leroyb 2021) but raises the income Gini index (Furceri, Loungani, and Zdzienicka 2018). For surveys on monetary policy and inequality, see Colciago, Samarina, and de Haan (2019) and Kappes (2021).

Monetary policy may have an impact on wealth inequality through various channels, and in particular through portfolio heterogeneity (McKay and Wolf 2023; Auclert 2019).[3] Previous research emphasizes the role of wealth revaluations from asset prices in driving unequal wealth growth following a monetary policy shock (Bartscher et al. 2022). While we show that both interest rate and asset purchase shocks have heterogeneous effects on capital gains across the wealth distribution, we find that housing and holdings of corporate equities and mutual funds drive the distributional consequences of monetary policy both in the short (0-1 year after the shock) and medium run (3-6 years after the shock).

Households in the bottom 50% of the wealth distribution hold more than half of their assets in the form of real estate and are more leveraged relative to other wealth groups. For this group, we show that the response of net wealth to an interest rate shock is driven by net housing wealth (real estate minus home mortgages). Indeed, this group experiences a temporary increase in real estate holdings but a delayed and persistent rise in home mortgages. Similarly, most of the short-run increase in net wealth following an asset purchase shock is driven by an increase in net housing wealth. The role of housing in the response of households to monetary policy recalls the financial accelerator mechanism, according to which a monetary expansion reduces the external finance premium by increasing home equity (Bernanke, Gertler, and Gilchrist 1999).

Corporate equities and mutual funds are among the most unequally distributed assets according to the DFA - more than 80% of this asset class is owned by households

[3] The channels surveyed by McKay and Wolf (2023) involve the impact of monetary policy on labor income, asset prices (Adam and Tzamourani 2016), nominal wealth redistribution through inflation, and mortgage payments. Using administrative data, the labor market, income, and consumption effect of monetary policy across various dimensions of inequality are analyzed by Holm, Paul, and Tischbirek (2021) for Norway and Hubert and Savignac (2023) for France. For recent contributions examining the transmission of monetary policy to the aggregate economy see Miranda-Agrippino and Ricco (2021) and Brignone, Franconi, and Mazzali (2023).

in the top 10% of the wealth distribution. We show that the effects of monetary policy shocks on wealth accumulation by this group are entirely explained by the response of corporate equities and mutual funds, especially in the short-run and for households in the 99-99.9th percentile of the wealth distribution.

Overall, in this study we address an issue that has received particular attention from monetary policymakers (Yellen 2016; Schnabel 2021). We do so by showing how monetary policy affects wealth inequality, distinguishing between the two main instruments available to monetary policymakers, and highlighting the role of housing and stock markets. Our results do not speak to whether monetary policymakers should take distributional consequences into account. However, if aggregate demand becomes more sensitive to adverse shocks as inequality rises, the benefit of including distributional considerations into account may not be irrelevant (Feiveson et al. 2020).

Road map. The paper is organized as follows. Section 2 introduces and describes the DFA. Section 3 outlines the econometric strategy and the identification of monetary policy shocks. Section 4 presents the main results, and Section 5 explores the channels through which monetary policy affects the distribution of wealth. Section 6 assesses the robustness of our results. Section 7 discusses the results and Section 8 concludes.

2. The Distributional Financial Accounts of the United States

Our primary data source is the DFA, a new dataset that provides quarterly measures of household balance sheets across the wealth distribution (Batty et al. 2021). In this section, we present an overview of the dataset and highlight key findings on the distribution of household wealth, focusing on five wealth groups: the bottom 50%, the next 40% (50th-90th percentile), the next 9% (90th-99th percentile), the top 0.9% (99th-99.9th percentile), and the top 0.1% (99.9th-100th percentile). Throughout this paper, we use the terms "wealth" and "net wealth" interchangeably to refer to total household assets, including consumer durables and unfunded defined benefit pensions, less all debts and other liabilities.

2.1. Wealth concentration and growth

According to the DFA, US wealth inequality has increased since 1989 (see Figure A.1 in Appendix A). The trend in the top 0.1% wealth share is in line with previous studies using distributional data at various frequencies (Saez and Zucman 2016; Blanchet, Saez, and Zucman 2023; Smith, Zidar, and Zwick 2023). However, differences in the level of inequality persist due to disagreements in the definition of wealth used. For example, according to the DFA, the top 0.1% wealth share stands lower than that estimated by Blanchet, Saez, and Zucman (2023) because wealth in the latter excludes consumer durables and unfunded pensions.[4] In contrast, the bottom 50% wealth share halved between 1989 and 2019 with a marked decrease during the Great Recession.

Figure 1 compares real net wealth growth across wealth groups. Until the early 2000s, wealth growth followed a relatively uniform pattern across all groups, with the exception of the top 1%, which has always experienced higher growth. For the bottom 50%, wealth growth was already stagnant by the early 2000s. During the Great Recession, all groups experienced a slowdown in wealth accumulation, although the severity of the contraction varied considerably. While the bottom experienced an almost complete erosion of net wealth, the impact of the crisis on the top 50% was much less severe. It is

[4]Differently from the DFA, Blanchet, Saez, and Zucman (2023) estimate the wealth distribution using the income capitalization method applied to income tax data. In the DFA, pension entitlements include the balances of defined contribution pension plans, accrued benefits to be paid in the future from defined benefit plans, and annuities sold by life insurers directly to individuals (Batty et al. 2021). In contrast, Blanchet, Saez, and Zucman (2023) excludes unfunded pensions because these are promises of future transfers that are not backed by actual wealth. Similarly, durables are treated as non-financial assets in the DFA but not in Blanchet, Saez, and Zucman (2023).

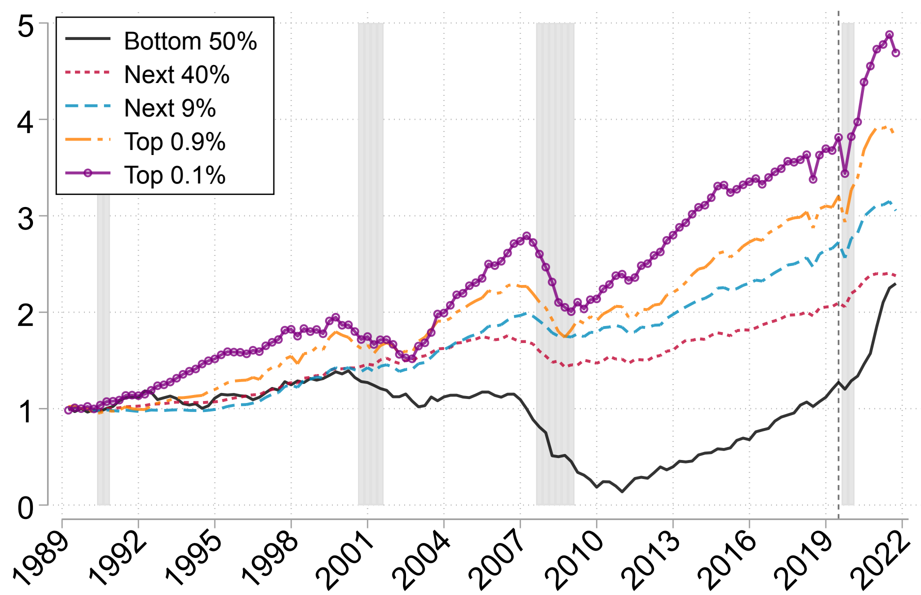


FIGURE 1. Real net wealth growth across the wealth distribution (1989Q3 - 2022Q1)

Notes: The figure shows real net wealth growth across wealth groups according to the Distributional Financial Accounts. All time series are indexed to 1 in 1990Q1 and deflated using the consumer price index. The dashed vertical line indicates the end of the estimation sample of the empirical analysis (2019Q4).

worth noting that the pandemic and its aftermath boosted wealth growth especially for the bottom 50% and the top 1% of the distribution.

2.2. Heterogeneous portfolios across the wealth distribution

Differences in wealth growth arise from changes in saving rates, capital gains, and other returns. Changes in asset prices can significantly affect the dynamics of wealth inequality through two channels (Kuhn, Schularick, and Steins 2020). First, if portfolios differ across the wealth distribution, changes in asset prices will affect wealth differently. Second, when the wealth-to-income ratio is high, changes in asset prices have a larger impact on the wealth distribution than savings alone. For asset prices to affect the distribution of wealth, it is crucial that households' portfolios across the distribution are heterogeneous. Table 1 shows a significant heterogeneity in the composition of

TABLE 1. Average composition of portfolios across the wealth distribution (1989Q3-2019Q4)

	Bottom 50%	Next 40%	Next 9%	Top 0.9%	Top 0.1%
Assets (% of total)					
Nonfinancial assets	71.65	42.41	26.46	20.04	13.57
Real estate	51.14	34.71	22.48	16.69	9.08
Consumer durables	20.51	7.70	3.98	3.35	4.49
Financial assets	28.35	57.59	73.54	79.96	86.43
Deposits	6.39	10.60	11.47	10.77	9.20
Corporate equities and mutual funds	2.57	6.98	16.65	28.90	32.77
Private businesses	2.52	5.02	9.63	18.45	23.70
Pension entitlements	10.78	29.30	28.52	9.91	3.60
Other assets	6.09	5.70	7.27	11.92	17.15
Liabilities (% of total)					
Home mortgages	60.24	77.74	81.03	69.79	49.08
Consumer credit	36.03	19.36	10.25	7.66	10.89
Other liabilities	3.72	2.90	8.72	22.55	40.02
Wealth-to-asset ratio	27.49	81.04	92.02	95.85	98.86

Notes: For each wealth group, the table shows average shares of wealth and type of assets in total assets and type of liabilities in total liabilities. The table reports simple averages between 1989Q3 and 2019Q4. Other assets include US government and municipal securities, corporate and foreign bonds, loans, life insurance reserves, and miscellaneous assets. Similarly, other liabilities are include depository institutions loans n.e.c., other loans and advances, deferred and unpaid life insurance premiums.

portfolios across the wealth distribution. Moving toward the top, households hold a larger share of financial assets and a smaller share of non-financial assets. Real estate and consumer durables together account for more than 70% of total assets for households in the bottom 50%, while the importance of corporate equities, mutual funds and private businesses increases for wealthier groups. Pensions account for nearly one-third of total assets for households in the next 40% and the next 9% of the distribution. Home mortgages make up the bulk of liabilities, and their relative importance grows with wealth levels except for the top 1%. Conversely, the share of consumer credit declines as we move up in the distribution.

3. Econometric methodology

We now describe the identification of monetary policy shocks and the econometric approach used to estimate the distributional effects of monetary policy.

3.1. Conventional monetary policy: interest rate shock

A common approach to the identification of monetary policy shocks is to measure high-frequency changes in interest rates around policy announcements. This strategy is based on the assumption that asset prices respond *solely* to monetary policy shocks during a short time window around policy announcements. However, surprise series identified in this way may be subject to endogeneity problems if the central bank possesses private information about the state of the economy (Miranda-Agrippino and Ricco 2021; Jarociński and Karadi 2020) or if both the central bank and economic agents react to publicly available economic news (Bauer and Swanson 2023). To address these problems, we use the high-frequency surprise series identified by Jarociński and Karadi (2020), which isolates *pure monetary policy* surprises based on the negative comovement between changes in the 3-month federal funds futures rate and the S&P500 stock price index around policy announcements. Changes in these futures reflect the overall stance of monetary policy by capturing both the actual rate setting and the near-term path of future rates.

One could use this series directly as an internal instrument in a quarterly VAR with distributional data and estimate the dynamic effects of the first orthogonalized shock (Plagborg-Møller and Wolf 2021). However, this strategy may prevent us from correctly identifying monetary policy shocks in a relatively short sample, since the DFA is not available before 1989. The problem is outlined in Ramey (2016), who argue that monetary policy has been conducted more systematically since around 1984. In addition, the quarterly frequency of the DFA may exacerbate the difficulty of estimating a monetary policy shock in a post-1984 sample. To address these issues, we propose a two-step procedure. First, following Forni, Gambetti, and Ricco (2022), we estimate the unit-variance shock from a monthly Proxy VAR estimated over a longer sample, from July 1979 to December 2019 (see Appendix C.2 for details).[5] In line with Gertler and Karadi (2015), we choose the starting point to coincide with the beginning of Volcker's Chairmanship as there is evidence of a regime change relative to the pre-Volcker period. In the second step, we compute a quarterly average of the unit-variance shock across months and use it as an internal instrument in the VAR with distributional data. This approach guarantees that we have enough variability in the sample to correctly identify a surprise series of conventional monetary policy shocks ($\hat{s}_t^R$). We refer to its orthogonalized residual in the internal-instrument VAR as the interest rate shock.[6]

3.2. Unconventional monetary policy: asset purchase shock

To identify surprise changes in unconventional monetary policy, we use the large-scale asset purchase factor of Swanson (2021). This factor represents one of the principal components that explain asset price changes around monetary policy announcements between July 1991 and June 2019. By construction, the large-scale asset purchase factor

[5] The monthly model has six lags and includes the log of industrial production, the log of the consumer price index, the unemployment rate, the excess bond premium of Gilchrist and Zakrajšek (2012), the log of a commodity price index, and the 1-year Treasury rate as the policy variable. The F-statistic in the first stage is 10.89, which is above the threshold recommended by Stock, Wright, and Yogo (2002). A crucial assumption underlying the Proxy VAR is the invertibility condition. A shock is invertible if it is a linear combination of contemporaneous VAR residuals. To test the validity of this assumption, we use the text Forni, Gambetti, and Ricco (2022) and show that the shock is invertible (see Table C.1 in Appendix C.2).

[6] An alternative approach would have been to use the surprise series as an external instrument in a quarterly Proxy VAR with macroeconomic and distributional data. However, as noted above, variability in the instrument would be insufficient to correctly identify the shock in a quarterly sample since 1989. Moreover, both the the short sample and the quarterly frequency, exacerbate the problem of weak instruments.

is uncorrelated with other factors capturing changes in the federal funds rate and forward guidance, making it an appropriate measure of "the component of FOMC announcements that conveys information about asset purchases above and beyond changes in the federal funds rate itself" (ibid., p. 37).[7]

In contrast to the conventional monetary policy shock, the proxy for asset purchases covers all events associated with the so-called QE1, QE2 and QE3. This makes the identification a more straightforward task. To enhance comparability between the two procedures, we purge the large-scale asset purchase factor from the information contained in Greenbook forecasts, as in Miranda-Agrippino and Ricco (2021), and obtain an informationally-robust asset purchase surprise series ($\hat{s}_t^{LSAP}$). In the text, we refer to its orthogonalized residual from the internal-instrument VAR as the asset purchase shock. Further details of this procedure can be found in Appendix C, along with a plot of both shocks (Figure C.1).

3.3. Model, identification and specification

Model. The core framework for our analysis is the following Bayesian VAR model:

$$\underset{n\times 1}{\mathbf{y}_t} = \underset{n\times 1}{\mathbf{c}} + \sum_{j=1}^{p} \underset{n\times n}{\mathbf{B}_j} \mathbf{y}_{t-j} + \underset{n\times 1}{\mathbf{u}_t} \quad \text{with} \quad \mathbf{u}_t \sim \mathcal{N}\left(\underset{n\times 1}{\mathbf{0}}, \underset{n\times n}{\mathbf{\Sigma}}\right) \tag{1}$$

where $\mathbf{y}_t$ is a $(n \times 1)$ vector of endogenous variables, $\mathbf{c}$ is a $(n \times 1)$ constant vector, $\mathbf{B}_j$ are $(n \times n)$ matrices of parameters with $j = 1, \ldots, p$, $\mathbf{u}_t$ is a $(n \times 1)$ vector of innovations with zero mean and variance-covariance matrix $\mathbf{\Sigma}$. Time is indexed by $t = 1, \ldots, T$, each time period is a quarter, and the lag length is $p = 4$. To address the challenge of dimensionality resulting from a relatively large number of parameters compared to the sample size, we estimate the model using Bayesian techniques and follow Giannone,

[7] Swanson (2021) shows that changes in the large-scale asset purchase factor have small effects on yields at short maturities but a larger impact on long-term rates, particularly on Treasury bonds.

Lenza, and Primiceri (2015) in setting the priors (see Appendix C.1).

Identification. To obtain impulse responses, we estimate the VAR in (1) using the two monetary policy surprise series as internal instruments (Plagborg-Møller and Wolf 2021). Let z_t be a generic instrument (in our case, $\hat{s}_t^R$ or $\hat{s}_t^{LSAP}$), ε_t^p be the monetary policy shock and $\boldsymbol{\varepsilon}_t^q$ be a $(n-1) \times 1$ vector of other structural shocks. The internal instrument approach requires the instrument z_t to be correlated with the shock of interest ε_t^p, to be orthogonal to all other shocks $\boldsymbol{\varepsilon}_t^q$ as well as to all leads and lags of the structural shocks. Formally, we assume:

$$\mathbb{E}[z_t \varepsilon_t^{p'}] \neq 0 \tag{2}$$

$$\mathbb{E}[z_t \boldsymbol{\varepsilon}_t^{q'}] = \mathbf{0} \tag{3}$$

$$\mathbb{E}[z_t \boldsymbol{\varepsilon}_{t+k}] = \mathbf{0}, \quad \text{for } k \neq 0 \tag{4}$$

where (2) is the relevance condition with the structural shock of interest, (3) is the exogeneity condition with the remaining structural shocks, and (4) is the orthogonality condition to leads and lags of the structural shock. Under these assumptions, we can estimate the causal effect of monetary policy by augmenting the VAR with the monetary policy surprise series. The internal instrument strategy has the favorable property that it leads to consistent estimates of the impulse responses even if the instrument is contaminated with measurement error and the shock is not invertible (Plagborg-Møller and Wolf 2021; Li, Plagborg-Møller, and Wolf 2022; Forni, Gambetti, and Ricco 2022; Känzig 2021). We implement the internal instrument approach by ordering the monetary policy surprise series $\hat{s}_t^i$ (with $i = R, LSAP$) first in the VAR and compute impulse responses to the first orthogonalized shock.

TABLE 2. Models and variables description

	Series	Unit	Source
Panel A: *Models with macroeconomic data*			
1	Policy shock:		
	Interest rate surprise ($\hat{s}_t^R$)		Sections 3.1
	Asset purchase surprise ($\hat{s}_t^{LSAP}$)		Sections 3.2
2	Real GDP	BoC 2012$	Bureau of Economic Analysis
3	Consumer price index	2015 = 100	Bureau of Economic Analysis
4	Excess bond premium	Percent	Gilchrist and Zakrajšek (2012)
5	Interest rate or spread:		
	1-year Treasury Rate	Percent	McCracken, Ng et al. (2021)
	Term spread	Percent	McCracken, Ng et al. (2021)
Panel B: *Models augmented with Distributional Financial Accounts data for each wealth group i*			
	Model with macroeconomic data +		
6	Consumer durables$_i$	Bil. of 2015$	DFA
7	Real estate$_i$	Bil. of 2015$	DFA
8	Deposits$_i$	Bil. of 2015$	DFA
9	Pension entitlements$_i$	Bil. of 2015$	DFA
10	Corporate equities and mutual funds$_i$	Bil. of 2015$	DFA
11	Private businesses$_i$	Bil. of 2015$	DFA
12	Home mortgages$_i$	Bil. of 2015$	DFA
13	Consumer credit$_i$	Bil. of 2015$	DFA
14	Net wealth$_i$	Bil. of 2015$	DFA

Notes: DFA is Distributional Financial Accounts. Bil. is billions. Real estate assets are owner-occupied real estate including vacant land and mobile homes at market value. Deposits include checkable deposits and currency, time deposits and short-term investments, and money market fund shares. Pension entitlements includes defined contribution (DC) pension plans, accrued benefits to be paid in the future from defined benefit (DB) plans, and annuities sold by life insurers directly to individuals. Corporate equities and mutual funds exclude equities and mutual fund shares owned through DC pensions. Private businesses (or equity in noncorporate business) is proprietors' equity in noncorporate business (including non-publicly traded businesses and real estate owned by households for renting out to others). Home mortgages are residential home mortgage loans as reported by lenders. Consumer credit includes credit card, student loan, and vehicle loan balances, and other loans extended to consumers.

Specification. We use different specifications of the VAR model in (1). We start with a standard model in which the vector of endogenous variables $\mathbf{y}_t$ includes, in the following order, the monetary policy surprise, real GDP, the consumer price index, the excess bond premium (Gilchrist and Zakrajšek 2012), and the policy variable. In the model for conventional (unconventional) monetary policy, the surprise is $\hat{s}_t^R$ ($\hat{s}_t^{LSAP}$), and the policy variable is the 1-year Treasury yield (term spread). The term spread is the difference between the 10-year and the 3-month Treasury yields. We refer to these specifications as the models with macroeconomic data, and all the details are summarized in Table 2, Panel A. We then augment these models with the balance sheet components from the DFA to study the distributional effects of monetary policy (Table 2, Panel B). More specifically, we estimate a wealth group-specific model for each type of monetary policy shock (the next Section expands on the variables included).

All variables, except monetary policy surprises, interest rates, spreads, and ratios, are expressed in levels of their natural logarithms. Interest rates, spreads and ratios are expressed in percent. Nominal variables, including macroeconomic and distributional variables, are deflated using the consumer price index. Models for conventional monetary policy are estimated using quarterly time series from 1989Q3 to 2019Q4, and from 1992Q3 to 2016Q4 for unconventional monetary policy.

4. Results

This section presents the main findings on the distributional impact of monetary policy. We examine how both interest rate and asset purchase shocks affect the level and distribution of net wealth, using net wealth shares as a measure of wealth inequality.

4.1. Macroeconomic effects of monetary policy

We begin our analysis by examining the impact of monetary policy on macroeconomic aggregates using the models in Table 2, Panel A. Figure 2 plots the impulse responses normalized to produce a 1% response in real GDP three quarters after the shock. We adopt this normalization convention to facilitate comparison across models, and we maintain it throughout the paper unless explicitly stated otherwise. In addition, following our sign convention, the impulse responses trace the effects of expansionary monetary policy shocks.

An interest rate shock leads to an immediate decline of about 60 basis points in the 1-year Treasury rate. Similarly, an asset purchase shock narrows the term spread by about 30 basis points. Both the decline in interest rates and the narrowing of the spread are statistically significant, with a faster reversion observed after an interest rate shock. Consistent with previous research on the macroeconomic effects of monetary policy, both shocks increase real GDP, raise the price level, and ease financial conditions as measured by the excess bond premium (Gertler and Karadi 2015; Ramey 2016). The long-lasting response of output to interest rate shocks is consistent with other studies using US (Bauer and Swanson 2022) and cross-country data (Jordà, Singh, and Taylor 2023).[8]

4.2. Monetary policy and wealth inequality

To evaluate the distributional effects of monetary policy shocks, we estimate the augmented models in Table 2, Panel B. We estimate a separate model for each type of shock and wealth group. Our analysis focuses on consumer durables, real estate, deposits, pension entitlements, corporate equities and mutual funds, private businesses, home mortgages, consumer credit, and net wealth. Together, these categories account for more than 90% of total assets for most of wealth groups. Home mortgages and consumer credit are the largest components of total liabilities across these groups (see Figure A.3 for a breakdown of liabilities).

To illustrate the impact of monetary policy shocks on net wealth across the wealth distribution, we focus on the percentage change in real net wealth resulting from monetary policy shocks, for specific points in time (impact and one, three, and six years after the shock). We interpret the impact and one-year responses as short-run

[8] The persistent real effects of monetary policy are consistent with theoretical models that take into account consumption habits, variable capital utilization, and staggered wage contracts (see, for example, Christiano, Eichenbaum, and Evans 2005).

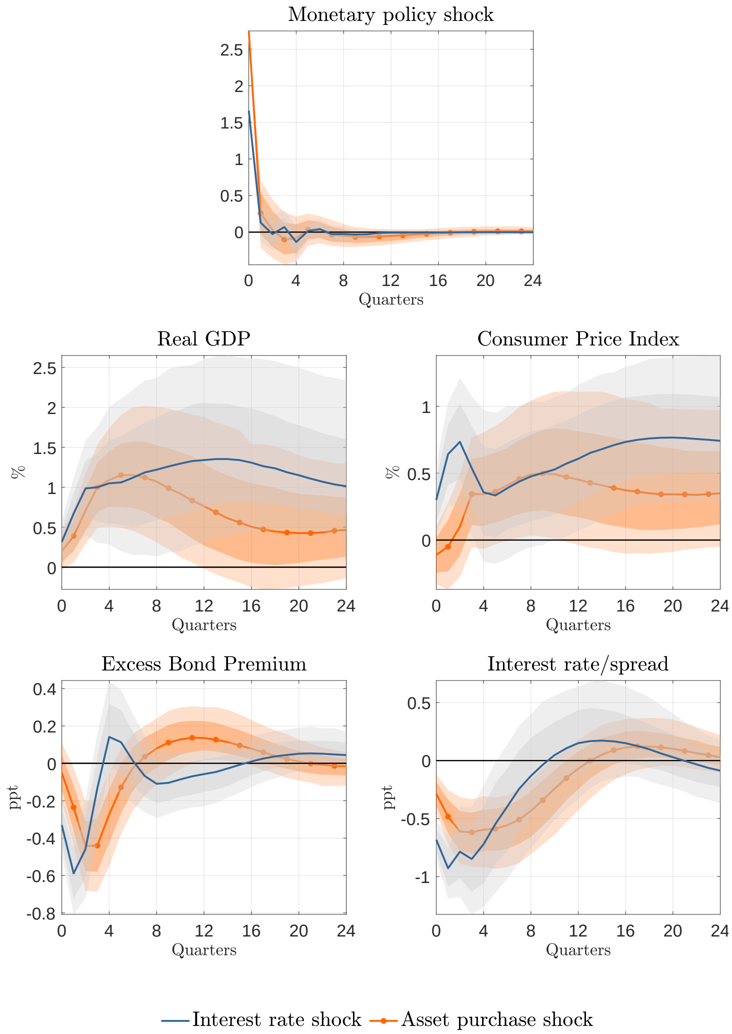


FIGURE 2. Macroeconomic effects of monetary policy

Notes: The figure shows the impulse response functions to an interest rate (solid line) and an asset purchase (solid line with markers) shock estimated using the Bayesian VAR described in Table 2, Panel A. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands.

distributional effects of monetary policy. Similarly, the three- and six-year responses represent the medium-run effects. We report the short- and medium-run impact of monetary policy shocks on net wealth across the wealth distribution in Figure 3 and Figure 5.

To shed light on the effects of monetary policy shocks on wealth inequality, we use the estimated impulse responses to derive the implied changes in wealth shares induced by each shock. Specifically, for each group i, we denote w_{it} as real net wealth, $w_i = {}^1\!/_T \sum_{\forall t} w_{it}$ as the average real net wealth in our sample, and $\omega_i = {}^{w_i}\!/_{\sum_{\forall i} w_i}$ as the average wealth share. We then simulate the evolution of real net wealth for each group i using the following equation:

$$w_{ih} = w_i(1 + IRF_{ih}) \quad \text{with} \quad h = 0, \ldots, 24. \tag{5}$$

The term IRF_{ih} represents the median response of net wealth for group i in period h to a monetary policy shock. Finally, we compute the implied deviation in net wealth share from its average ($\Delta\omega_{ih}$) for each group i using the following formula:

$$\Delta\omega_{ih} = \omega_{ih} - \omega_i \quad \text{with} \quad \omega_{ih} = \frac{w_{ih}}{w_h} \quad \text{and} \quad w_h = \sum_{\forall i} w_{ih}. \tag{6}$$

We report the effect of monetary policy on wealth shares in Figure 4 and Figure 6 and consider the top 1% wealth share as measure of wealth inequality.

4.2.1. Interest rate shock

Figure 3 shows that an interest rate shock increases aggregate net wealth in the short run. Across the distribution, it has broadly positive effects, although heterogeneous in size.[9] Most of the percentage increase in net wealth is concentrated among households in the bottom 50%, the next 40%, and the top 0.9% of the distribution, amounting to 4.6%, 2.9%, and 2.3%, respectively. The positive effects of the shock on net wealth persist for at least one year, except for the top 0.9%, but are not statistically significant.

[9] The increase is statistically significant at the 90% credible interval for all groups except for the bottom 50%, for which it is at the 68% credible interval. Figure B.1 in Appendix B shows the full impulse response functions.

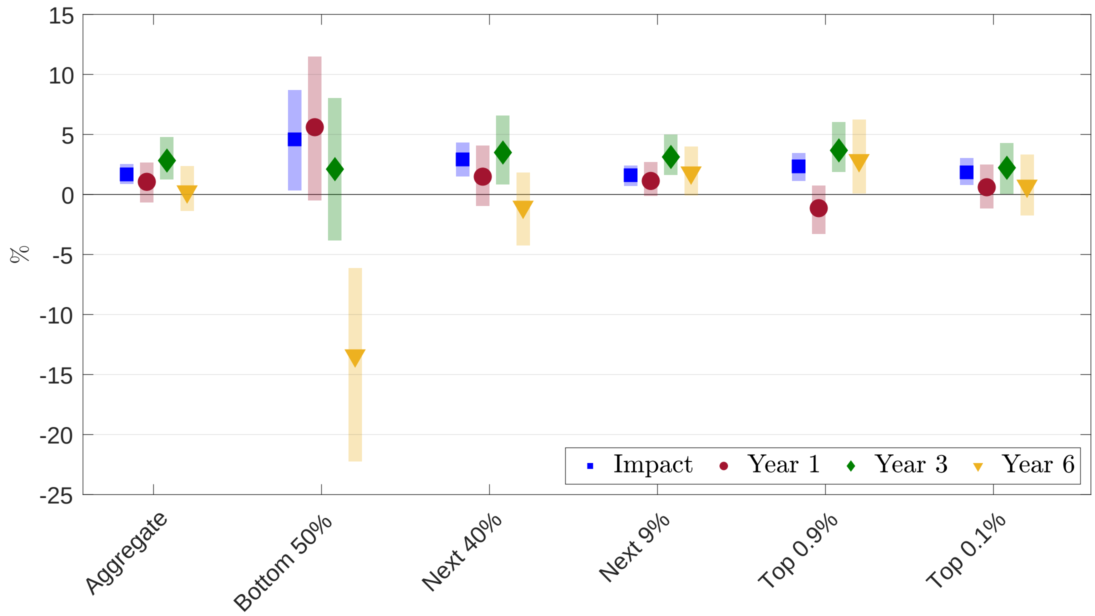


FIGURE 3. Change in net wealth after an interest rate shock

Notes: The figure shows the response of real net wealth to an interest rate shock estimated from the group-specific Bayesian VAR described in Table 2, Panel B. Net wealth is deflated using the consumer price index. Markers are median impulse responses from the posterior distribution. Intervals are 68% posterior coverage bands. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. See Figure B.1 in Appendix B for the full impulse response functions.

In the medium run, the impact of an interest rate shock varies substantially across the distribution. Three years after the shock, the percentage increase in net wealth is statistically significant for all groups, except for the bottom 50%. Six years after the shock only households in the top 10% record positive net wealth growth, although it is statistically significant only for the top 0.9%. The remarkable result from this graph is that households in the bottom 50% experience a decline in net wealth of more than 13% six years after the shock. Households in the next 40%, who own about a third of total wealth, also register negative wealth growth (-1%) in the same period. This is an important result because it suggests that an expansionary interest rate shock can have long-lasting effects that are different across the distribution.

Figure 4 plots the full dynamics of wealth inequality after an interest rate shock in deviation from average wealth shares (solid lines with markers).[10] An expansionary interest rate shock reduces inequality in the short run but increases it in the medium run. The initial reduction of inequality is mainly determined by an increase in the wealth share of the next 40% and a decrease in that of the top 0.9%. The bottom 50%, instead, experiences relatively small increases in their wealth share, despite recording the highest growth in net wealth. This is not surprising given that this group holds little wealth. In the medium run, the wealth share of the top 1% increases, largely driven by the top 0.9%. Within the bottom 99%, we observe a large reduction in the wealth share of the bottom 90% which outweighs the increase in the wealth share of the next 9%. The decline in the wealth share of the bottom 50% (-0.29 pp) is roughly half than that of the next 40% (-0.54 pp). As before, the largest percentage reduction of wealth at the bottom 50% (-13%) accounts for less than half than the reduction of the next 40% (-1%) in explaining movements in wealth shares.

4.2.2. Asset purchase shock

While the aggregate effect of an asset purchase shock is positive in the short run, there are large differences between the bottom 50% and other groups (Figure 5). After an asset purchase shock, households in the bottom 50% experience the largest short-run percentage increases. Both at impact and one year after the shock, households in the bottom 50% of the distribution experience significantly higher growth in net wealth than other groups (7.4% at impact and 7.9% after one year). For the next 40%, the shock

[10]Table B.1 in Appendix B reports back-of-the-envelope calculation from changes in net wealth levels to changes in shares. For each horizon and wealth group, it shows the percentage change in net wealth, the corresponding (real) dollar change, and the implied wealth share, both in level and in deviation from its sample average, induced by an interest rate shock. By including the dollar changes in real net wealth, we aim to emphasize that seemingly uniform percentage changes in net wealth lead to highly heterogeneous outcomes in terms of wealth accumulation and concentration depending on the initial level of wealth.

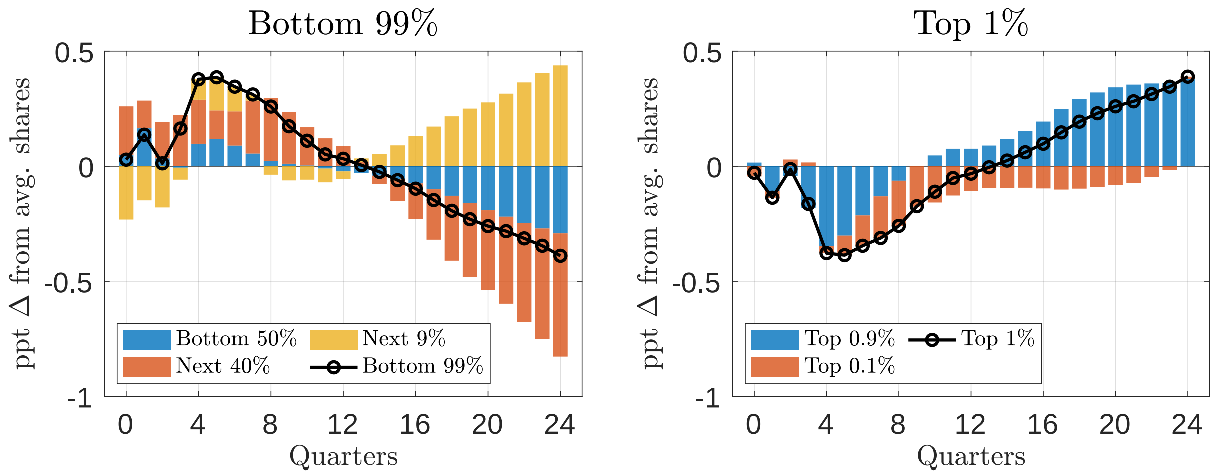


FIGURE 4. Change in wealth shares after an interest rate shock

Notes: The figure shows the implied response of wealth shares to an interest rate shock. Implied changes in wealth shares are expressed in deviation from their sample averages and using the median impulse response. See Section 4.2 for more details in the derivation of changes in wealth shares.

has no impact on net wealth accumulation. In contrast, at the top 10%, the effects of an asset purchase shock are positive but smaller in magnitude relative to the bottom 50%. In the medium run, an asset purchase shock reduces net wealth for the top 50%, except for the top 0.9%, but its effects dissipate at longer horizons.

Figure 6 plots the full dynamics of wealth inequality after an asset purchase shock (solid lines with markers).[11] An expansionary asset purchase shock increases inequality in the short run with no effect in the medium run. The initial increase of inequality is mainly determined by a decrease in the wealth share of the next 40% and an increase in that of the top 0.9%. The bottom 50% experiences a comparatively smaller (positive) change in its wealth share, despite recording the largest growth in net wealth. Again, this is due to the low level of wealth for this group (see Table B.2 in Appendix B). In the medium run, the wealth share of the top 1% slowly goes back to the pre-shock level with

[11]As with an interest rate shock, Table B.2 in Appendix B shows the dynamics of wealth inequality induced by an asset purchase shock, at specific points in time, together with the dollar changes in real net wealth.

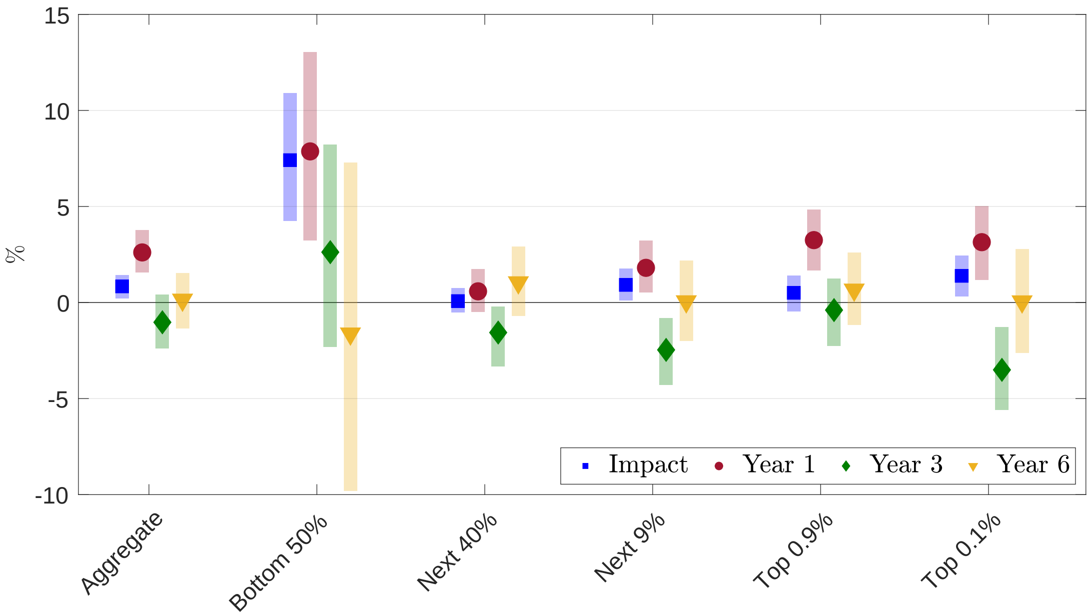


FIGURE 5. Change in net wealth after an asset purchase shock

Notes: The figure shows the response of real net wealth to an asset purchase shock estimated from the group-specific Bayesian VAR described in Table 2, Panel B. Net wealth is deflated using the consumer price index. Markers are median impulse responses from the posterior distribution. Intervals are 68% posterior coverage bands. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. See Figure B.1 in Appendix B for the full impulse response functions.

the top 0.9% contributing positively while the top 0.1% negatively. Among the bottom 99%, the wealth share falls primarily for the next 9% while it increases for the next 40%. The bottom 50% contributes negatively but marginally. Ultimately, Figure 6 shows that the distributional effects of an asset purchase shock are transitory.

Overall, these findings provide valuable insights into the effects of different types of monetary policy on wealth inequality. An interesting stylized fact emerges: while an interest rate shock leads to long-lasting changes in wealth shares, an asset purchase shock induces cyclical fluctuations that eventually dissipate at longer horizons.

Monetary policy and balance sheets. We also explore the impact of monetary policy shocks on assets and liabilities across the wealth distribution. Following an interest rate shock, all wealth groups experience an increase in real estate, while mortgage

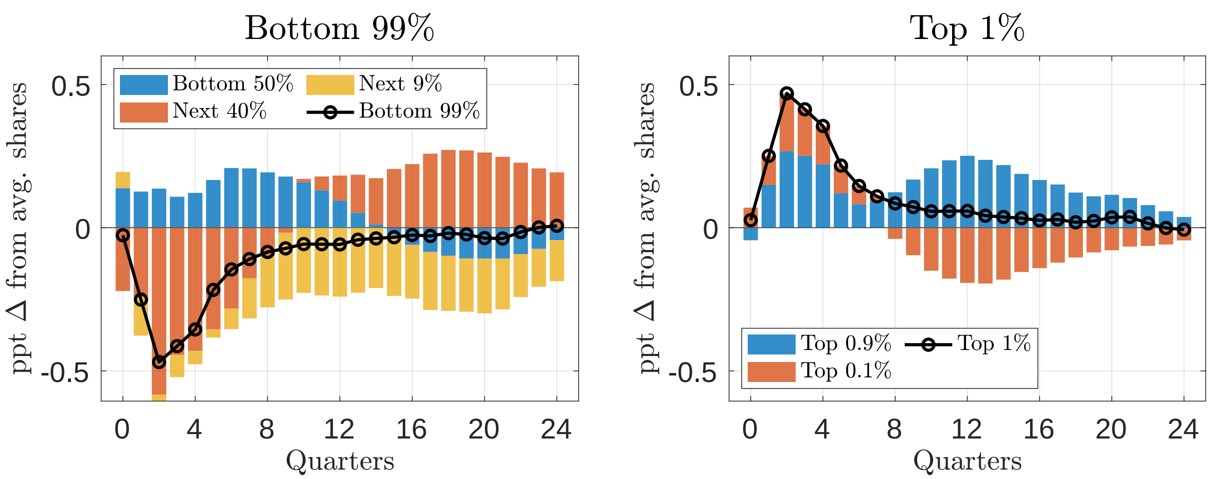


FIGURE 6. Change in wealth shares after an asset purchase shock

Notes: The figure shows the implied response of wealth shares to an interest rate shock. Implied changes in wealth shares are expressed in deviation from their sample averages and using the median impulse response. See Section 4.2 for more details in the derivation of changes in wealth shares.

debt growth is more heterogeneous. For the bottom 90%, in particular, mortgage debt growth offsets the expansion of gross housing wealth. In contrast, an asset purchase shock has mixed effects on real estate, showing a short-term increase followed by a decline. This shock reduces mortgage debt for the bottom 90%, with the reduction extending to all groups except the next 40% six years after the shock. There is limited variation across wealth groups in the responses of corporate equities and mutual funds. Following an interest rate shock, these assets play a significant role in wealth growth over time, especially for the top 0.9%. Similarly, following an asset purchase shock, corporate equities and mutual funds are crucial in driving wealth growth. The corporate equities response to an asset purchase, however, is cyclical: it peaks about a year after the shock and then declines temporarily over the medium term for the next 49%. An interest rate shock has a positive effect on private businesses for the top 90%, especially in the medium term. The response to an asset purchase shock shows a cyclical pattern, with a short-term increase followed by a decline for the bottom 50% and the top 10%. All impulse response functions are shown in Figure E.1 and Figure E.2 in Appendix E.

5. Channels

In this section, we examine two key channels that underlie the distributional effects of monetary policy.[12] The first channel we explore is the housing wealth channel, which primarily affects the bottom of the wealth distribution. Given that housing is a significant component of wealth for this group, it plays a crucial role in explaining why households in the bottom 50% experience a substantial increase in net wealth followed by a slowdown after both shocks. The second channel we examine involves the response of corporate equities and mutual funds to monetary policy shocks. This channel operates with much greater intensity at the top of the wealth distribution, where holdings of corporate equities and mutual funds are larger relative to total assets.

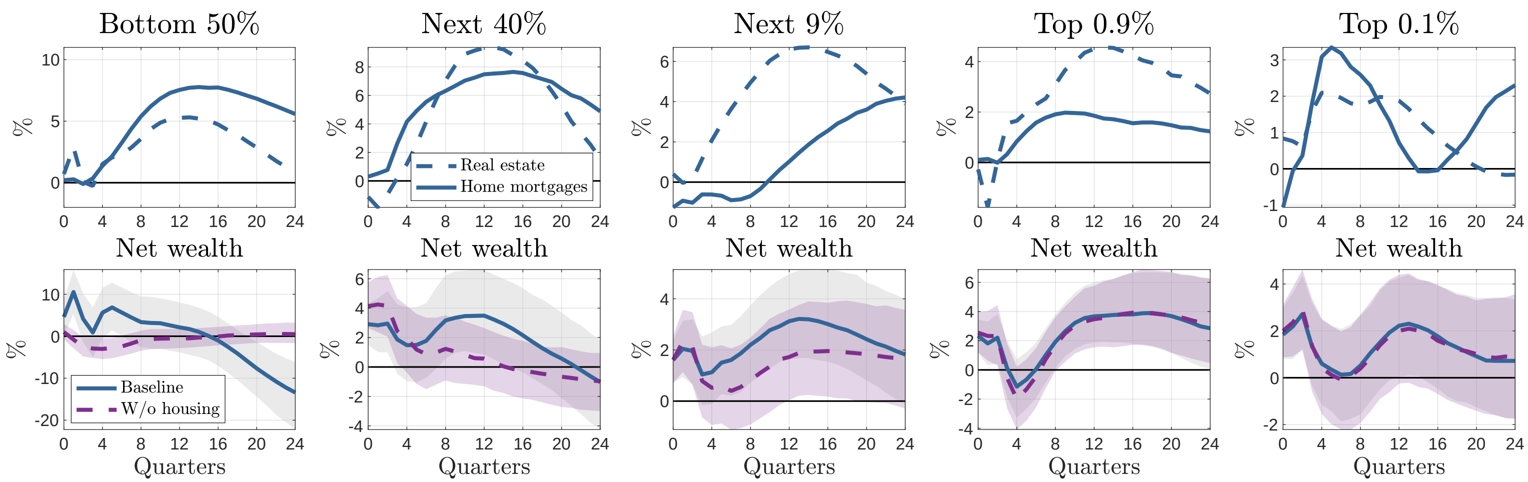
5.1. Monetary policy and the housing channel

A remarkable finding of the previous section is that, following an interest rate shock, households in the bottom 90% experience a decline in net wealth in the medium run, when the increase in home mortgages exceeds that of real estate assets (first row in Figure 7, Panel A). For the bottom 50%, in particular, the decline in net wealth is large and significant.

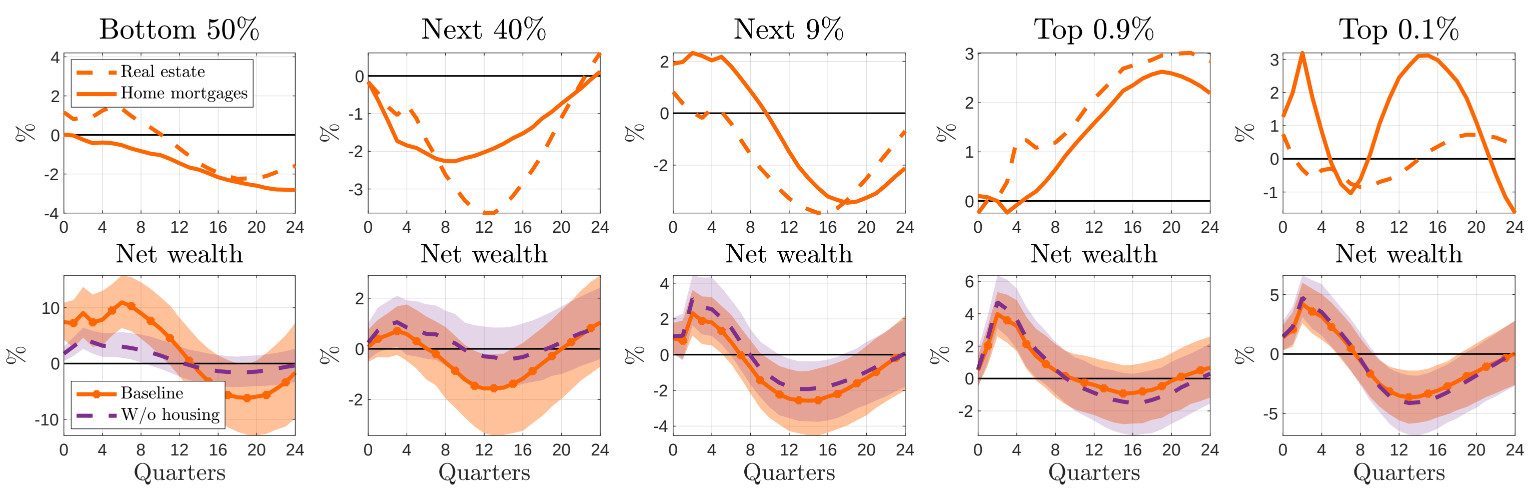
For the bottom 50%, the temporary increase in real estate holdings relative to home

[12] Another channel that has received considerable attention in the literature is that of asset prices or capital gains, in isolation or relative to other determinants of wealth accumulation such as savings (Blanchet and Martínez-Toledano 2022; Feilich 2023; Bartscher et al. 2022; De Luigi et al. 2023). In Appendix F we explore the role of capital gains (that is, revaluation of net wealth) in driving the short-run effects of monetary policy on net wealth. Relatively to the literature which assumes specific price indexes to *price* wealth and its components, we obtain capital gains by distributing the aggregate revaluations to each wealth group in the DFA. We show that the response of capital gains to monetary policy exhibits scale dependence, that is wealthier households experience larger increases in capital gains following both interest rate and asset purchase shocks.

mortgages following an interest rate shock leads to a short-run expansion in net housing wealth (real estate minus home mortgages). In the medium run, however, net housing wealth decreases as home mortgages increase persistently relative to real estate. By comparison, households in the next 40% experience a similar increase in both real estate and home mortgage, with the latter dominating in the medium-run. The second row in Figure 7. Panel A, presents estimates from a series of models where we replace net wealth in the specification of Table 2, Panel B, with a measure of net wealth that excludes net housing wealth. If net housing wealth is not an important driver of the response of net wealth, then we would expect the response of net wealth excluding real estate and mortgages to be virtually unchanged. In fact, we observe no evidence of a boom and bust in net wealth at the bottom 50% after excluding net housing wealth (dashed line). For the other groups, net housing wealth represents a smaller share of wealth and is less important in explaining the effects of an interest rate shock. Indeed, the differences in the responses between the two wealth measures are diminish as we move towards the top of the distribution.



A. Interest rate shock



B. Asset purchase shock

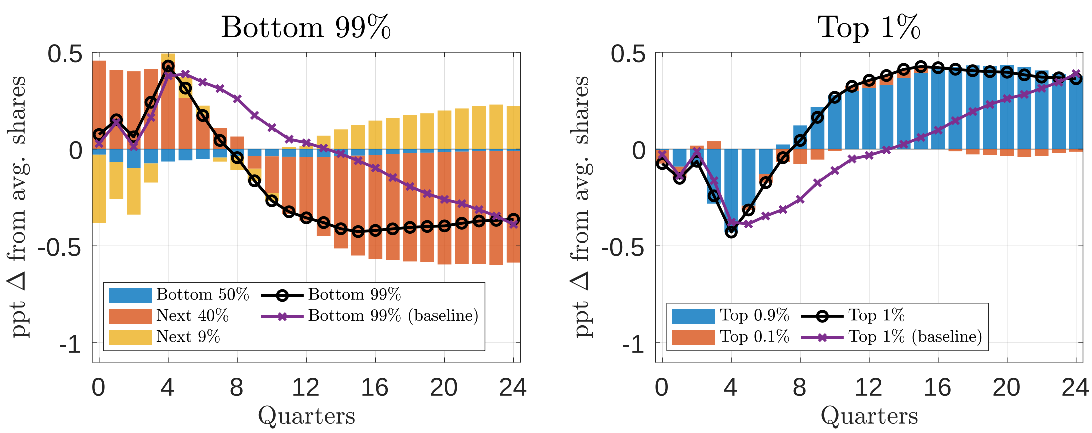
FIGURE 7. Monetary policy and net housing wealth

Notes: The figure shows the impulse response functions to an interest rate (Panel A) and an asset purchase (Panel B) shock. Baseline refers to the response of net wealth. W/o housing refers to the response of net wealth net real estate and home mortgages. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid and dashed lines are median impulse responses from the posterior distribution. Shaded areas are 68% posterior coverage bands.

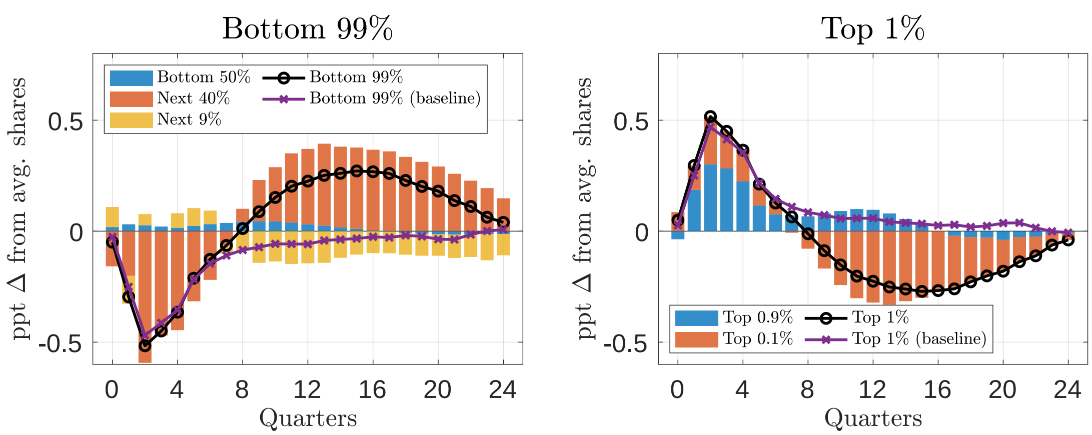
Figure 8, Panel A, shows that the initial reduction in wealth inequality following an interest rate shock is shorter-lived when excluding real estate and home mortgages from net wealth. In the figure, we plot the implied changes in wealth shares obtained from the response of net wealth (net of real estate and mortgages) to an interest rate shock. We then compare these changes (solid line with circles) to the baseline changes in wealth shares obtained using the traditional definition of net wealth (solid line with crosses). Without net housing wealth, most of the dynamics of the bottom 99% is determined by the next 40%. Moreover, the bottom 50% wealth share declines instead of increasing in the short run and it remains unaffected by monetary policy in the medium run.

An asset purchase shock has mixed effects on real estate and home mortgages across the distribution (Figure 7, Panel B, first row). Real estate responds positively only for the bottom 50% and for the top 0.9%. Home mortgages, instead, decrease immediately for the bottom 90% and with a delay next 9%. For the bottom 50%, the combination between the temporary increase in real estate and the immediate and persistent decrease in mortgages has the effect of boosting net housing wealth. In the second row of Figure 7, Panel B, we observe that switching off the influence of real estate and mortgages eliminates the short-run growth in wealth. Indeed, the response of net wealth to an asset purchase shock is flatter (dashed line). For the next 40%, switching off the influence of real estate and mortgages removes the medium-run contraction in net wealth observed three years after the shock. For all other groups, we do not observe a significant contribution of net housing wealth. Switching off the response of net housing wealth changes the effects of an asset purchase shock on wealth inequality, especially in the medium term (Figure 8, Panel B). An asset purchase shock initially increases the top 1% wealth share, as in the baseline, but then it reduces it. The exclusion of net housing wealth, however, confirms the short-lived effects of an asset purchase shock.

Overall, the role of net housing wealth in driving the distributional effects of monetary policy varies by type of policy. On the one hand, the reaction of net housing wealth



A. Interest rate shock



B. Asset purchase shock

FIGURE 8. Changes in wealth shares: the housing channel

Notes: The figure shows the implied response of wealth shares to an interest rate (Panel A) and an asset purchase (Panel B) shock. Vertical bars and solid lines with circles are changes in wealth shares with net wealth defined as total assets minus all debts and liabilities, net of net housing wealth (real estate minus home mortgages). Solid lines with crosses are changes in wealth shares with net wealth defined as total assets minus all debts and liabilities (baseline). Implied changes in wealth shares are expressed in deviation from their sample averages and using the median impulse response. See Section 4.2 for more details in the derivation of changes in wealth shares.

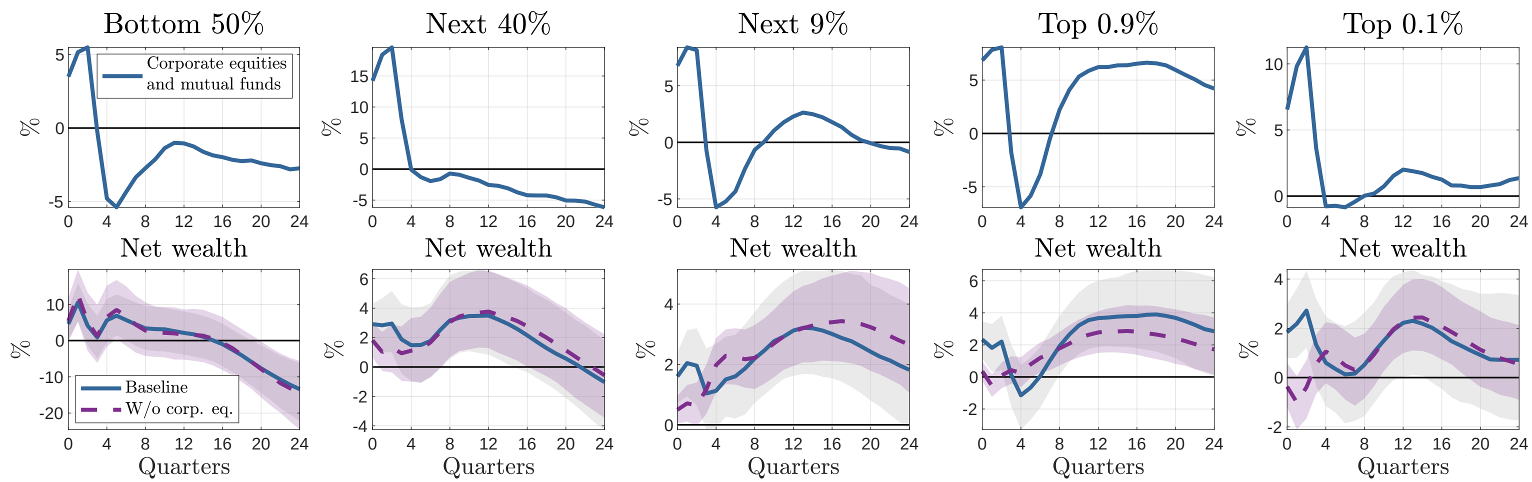
makes the short-run inequality-increasing effects of an interest rate shock last longer. On the other hand, net housing wealth has the effect of making wealth inequality quickly reverting to its pre-shock level after an asset purchase shock.

5.2. Monetary policy and the corporate equities and mutual funds channel

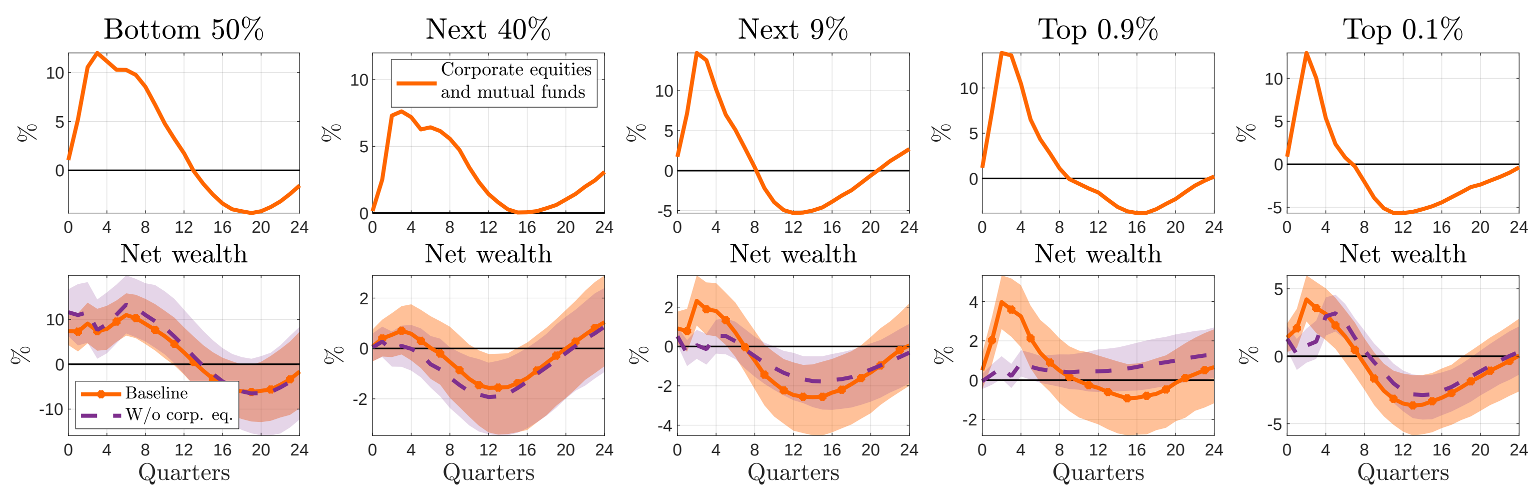
Corporate equities and mutual funds are among the most unequally distributed assets in the DFA. Between 1989 and 2019, the bottom 50% held just 1.2% of corporate equities and mutual funds. At the same, in stark contrast with real estate assets, the importance of corporate equities and mutual funds increases with as we move up in the wealth distribution (portfolio heterogeneity). Between 1989 and 2019, more than a third of total assets of the top 0.1% consisted of corporate equities and mutual funds. In comparison, this share falls to just 2.6% for the bottom 50%. Therefore, corporate equities and mutual funds can be a key factor in explaining net wealth growth at the top following a monetary policy shock and its distributional effects. Indeed, stock prices are particularly responsive to monetary policy shocks (Paul 2020) and, in models of wealth accumulation, portfolios and returns are crucial to generate wealth distributions that match the data (Hubmer, Krusell, and Smith Jr 2021).

The first row in Figure 9, Panel A, shows that corporate equities and mutual funds exhibit a short-run increase following an interest rate shock. The second row reports the response of net wealth, without corporate equities and mutual funds, together with our baseline results. For the bottom 50%, corporate equities and mutual funds do not play any role in driving the response of net wealth to an interest rate shock. In contrast, corporate equities and mutual funds are progressively more important in explaining the short-run growth of net wealth recorded by the top 50%. For the top 1%, in particular, an interest rate shock does not have any short-run effect on wealth growth after excluding corporate equities and mutual funds from net wealth. In the baseline model, we find that an interest rate shock initially reduces inequality but eventually increases it in the medium-run (Figure 10, Panel A). If corporate equities and mutual funds were excluded from net wealth, then an interest rate shock would reduce inequality, as measured by the top 1% wealth share, for longer than in the baseline. The longer reduction in inequality is mostly driven by a much smaller increase in the top 0.9% wealth share and by a larger increase in the next 9% wealth share, relative to the baseline. Moreover, the medium-run effect of an interest rate shock would be much more subdued. Therefore, the long-lasting effects of an interest rate shock on wealth inequality in the baseline heavily depend on the response of corporate equities and mutual funds.

For an asset purchase shock, the findings on the role of corporate equities and mutual funds are similar. The shock raises corporate equities and mutual funds across the board for about three years (Figure 9, Panel B, first row). Visually, the impulse response of corporate equities and mutual funds co-move with that of net wealth, both in the short and medium run. For the top 50%, the increase in this asset class explains the short-run growth in net wealth and the medium-run temporary decrease, especially for the next 9% and the top 0.9% (Figure 9, Panel B, second row). For the top 0.1%, however, corporate equities and mutual funds do not appear as the main factor driving net wealth growth after the shock. As for the interest rate shock, excluding corporate equities and mutual funds changes the effects of an asset purchase shock on inequality (Figure 10, Panel B). More specifically, the short-run increase in the top 1% wealth share is less pronounced than in the baseline scenario. In the medium-run, however, excluding corporate equities and mutual funds has the effect of making an asset purchase shock increase inequality even in the medium-run. The main reason behind this result is that, at the top, the response of corporate equities and mutual funds is positive in the short run but (temporary) negative in the medium run. Hence, excluding corporate equities and mutual funds undoes the their positive effect on wealth growth in short run as well as they negative influence in the medium run.



A. Interest rate shock



B. Asset purchase shock

FIGURE 9. Monetary policy and corporate equities

Notes: The figure shows the impulse response functions to an interest rate (Panel A) and an asset purchase (Panel B) shock. Baseline refers to the response of net wealth. W/o housing refers to the response of net wealth net corporate equities and mutual funds. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid and dashed lines are median impulse responses from the posterior distribution. Shaded areas are 68% posterior coverage bands.

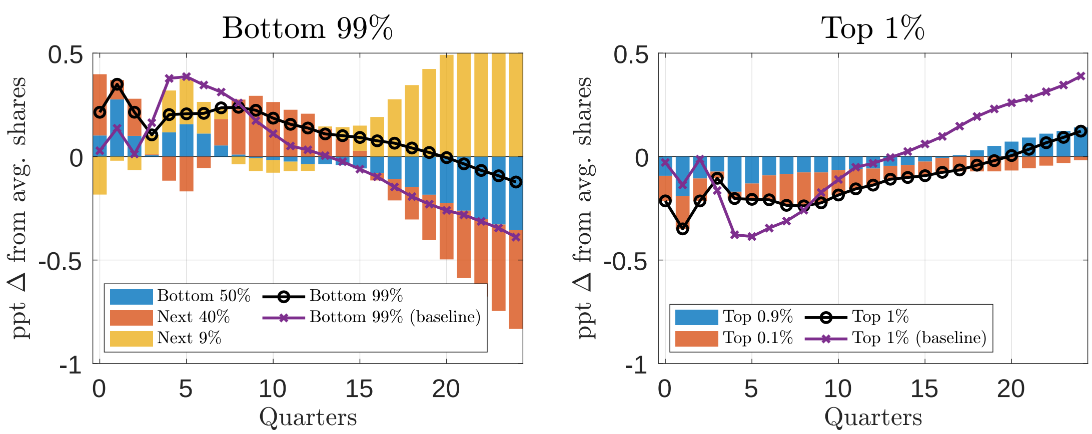
6. Sensitivity analysis

In this section, we discuss some potential pitfalls of the econometric methodology we use and show that the results are robust to deviations from our baseline specification.

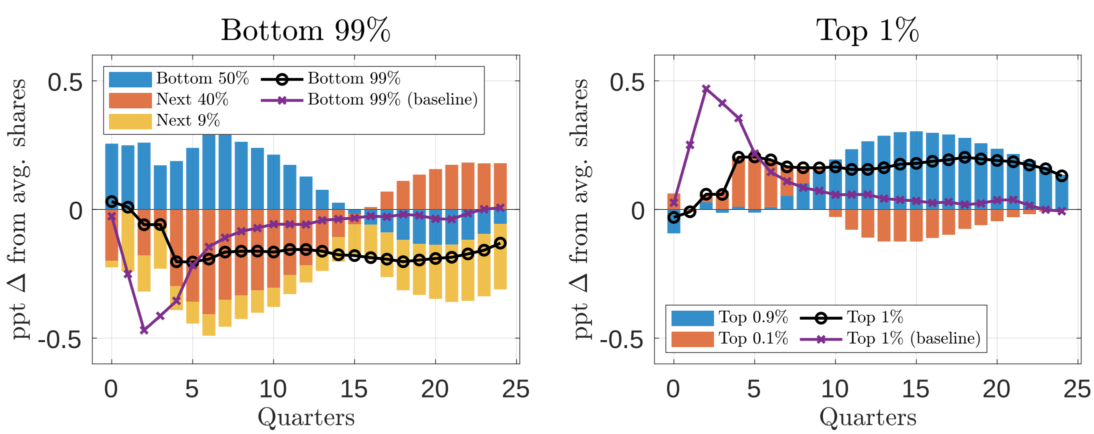
Interest rate shock. The method adopted by Jarociński and Karadi (2020) to isolate pure monetary policy surprises assumes a non-negative response of stock prices. Because stocks are an important component of household wealth, the assumption implies a specific response of wealth to the shock. We test the robustness of our findings to this assumption by using alternative measures of interest rate surprises. Specifically, we use the surprise series of Gertler and Karadi (2015), Miranda-Agrippino and Ricco (2021), and Aruoba and Drechsel (2022). Based on these alternative measures of interest rate shocks, the results remain largely unchanged as shown in Figure D.3 in Appendix D.

Asset purchase shock. The large-scale asset purchase factor of Swanson (2021) takes nonzero values in the years before the Great Recession, when the Federal Reserve did not rely on unconventional policy. To rule out the possibility that our results are driven by fluctuations in the large asset purchase factor before 2008, we set the factor to zero for the quarters before 2008. Figure D.1 and Figure D.2 in the Appendix D.1 show that neither the macroeconomic nor the distributional effects of an asset purchase shock are driven by pre-2008 fluctuations in the factor.

Model specification. To rule out that our medium-run estimates of the distributional effects of monetary policy are sensitive to using a VAR model, we increase the lags of the model and use local projections as robustness check. Figure D.4 shows that our baseline results are robust to increasing the VAR lag length to 6 and 8. As a further check,



A. Interest rate shock



B. Asset purchase shock

FIGURE 10. Changes in wealth shares: the corporate equities and mutual funds channel

Notes: The figure shows the implied response of wealth shares to an interest rate (Panel A) and an asset purchase (Panel B) shock. Vertical bars and solid lines with circles are changes in wealth shares with net wealth defined as total assets minus all debts and liabilities, net of corporate equities and mutual funds. Solid lines with crosses are changes in wealth shares with net wealth defined as total assets minus all debts and liabilities (baseline). Implied changes in wealth shares are expressed in deviation from their sample averages and using the median impulse response. See Section 4.2 for more details in the derivation of changes in wealth shares.

we estimate the dynamic effects of monetary policy shocks using local projections.[13] Figures D.5 and D.6 show that our findings are robust to using local projections.

7. Discussion

Compared to the literature, we provide new evidence on the effects of monetary policy across the wealth distribution. It is useful to compare our results with those of Feilich (2023) and Bricker et al. (2023), who use the DFA and alternative econometric methods. The inequality-increasing effect of an interest rate shock in the medium run is consistent with Bricker et al. (2023) who measure inequality using the wealth Gini index. However, we find that inequality initially falls before rising. As Feilich (2023), we finds that a large responsiveness of wealth the bottom of the distribution to an interest rate shock. Relative to these studies, we extend previous analysis of the distributional effects of monetary policy to include large-scale asset purchases and decompose the top 1%. For the US, a comparison of the inequality effects of different policies is a novel contribution to the literature.[14]

Changes in asset prices have large effects on wealth inequality (Blanchet and Martínez-Toledano 2022), and the most direct effects of monetary policy are often observed in financial markets (Paul 2020). Thus, the response of asset prices may be partly responsible for the effects of monetary policy that we show. Recently, Fagereng et al. (2022) shift the focus away from unrealized capital gains to a monetary measure of the welfare gains from changing asset prices (see McKay and Wolf, 2023, for similar argument).

[13] Local projections are an alternative and popular method of estimating the dynamic impulse response to a shock of interest. We use traditional (Jordà 2005) and smooth (Barnichon and Brownlees 2019) local projections (see Appendix D.4 for more details).

[14] Another useful comparison is with Wolff (2021) who show that expansionary monetary policy (a reduction in the 10-year real bond rate) has an equalizing effect on the distribution of wealth. This approach, however, does not isolate unexpected monetary policy shocks from changes in interest rates.

From this perspective, higher asset prices benefit sellers rather than holders, and asset price changes redistribute welfare between sellers and buyers. Nevertheless, in models with wealth in the utility function, higher wealth from capital gains provides welfare (Michaillat and Saez 2021). Bearing in mind this debate, we show that wealthier households experience larger increases in (unrealized) capital gains following a monetary policy shock. This is consistent with Greenwald et al. (2021) who find that the secular decline in long-term real interest rates has increased financial wealth inequality because wealthier households hold long-duration assets.[15]

Unveiling the boom-and-bust response of net wealth at the bottom of the distribution following an interest rate shock is another contribution of the paper. For the bottom 50%, the main reason for the bust is that the increase in real estate is followed by a larger and more persistent increase in home mortgages. Real estate growth conflates the effects of monetary policy on house prices and on quantities. Indeed, for the bottom 50%, most of the increase in real estate following an interest rate shock appears to be due to an increase in house prices (Figure B.3 in Appendix B). On the liabilities side, the increase in home mortgages appears to be partly driven by an increase in home equity loans.[16] These results can be viewed through the lens of the financial accelerator hypothesis (Bernanke, Gertler, and Gilchrist 1999). An expansionary interest rate shock reduces the external finance premium and the cost of borrowing by raising house prices and (homeowners') housing wealth. A lower external finance premium and higher net housing wealth allow households to borrow on favorable terms through home equity

[15] In Appendix F, we provide novel evidence on how monetary policy shocks affect capital gains on different assets (real estate, corporate stocks and mutual funds, pensions, and private firms) across the wealth distribution.

[16] This is shown in Figure B.2 in Appendix B. In the DFA, home mortgages include home equity loans. We obtain an estimate of home equity loans across the wealth distribution by distributing the aggregate level of home equity loans of the household sector. We use each group's share of total mortgages as weights.

loans. In the medium term, however, higher growth of liabilities reduces net wealth. The higher marginal propensity to consume generally observed for poorer households would imply a substantial spending and output response via the financial accelerator mechanism and wealth effects. Nevertheless, the actual impact of the boom and bust in net wealth depends on various factors, such as the existing level of debt across the distribution (Alpanda and Zubairy 2019), the regional distribution of housing net wealth (Beraja et al. 2019), and the previous path of interest rates (Berger et al. 2021).

Asset purchases have heterogeneous effects on liabilities across the wealth distribution. An asset purchase shock leads to a decline in home mortgages that is permanent for the bottom 50% and temporary for the next 40%. In contrast, at the top, mortgages increase after an asset purchase shock. One possible factor explaining the divergence in mortgages responses is the segmentation of the mortgage market in the United States: mortgages need to be guaranteed and have a loan-to-value ratio at or below 80% to be purchased by the Federal Reserve. Indeed, refinancing activity increased and interest payments fell more for QE-eligible mortgages than for other mortgages (Di Maggio, Kermani, and Palmer 2020). As documented by Fuster and Willen (2010), changes in interest rates following the announcement of QE1 varied from negative to positive, reflecting various factors such as the borrower's credit score, loan-to-value ratio, and other characteristics of the loan or property. In addition, they observe a shift in refinancing activity toward borrowers with high credit scores. For borrowers with low credit scores and credit constraints, the incentive to refinance was much lower due to the presence of additional fees that made refinancing more expensive. Access to refinancing varies also along other dimensions of inequality, such as income (Agarwal et al. 2023) and race (Gerardi, Willen, and Zhang 2023) with low-income, Black and Hispanic households benefit much less from refinancing than high-income, White and Asian households. Although we cannot observe credit scores, loan-to-value ratios, and other mortgage characteristics across the wealth distribution, it is likely that low credit score, low-income, and Black and Hispanic borrowers fall predominantly outside the top 10% of the wealth distribution. Therefore, our findings on the heterogeneous effect of an asset purchase shock on mortgages across the wealth distribution are likely to reflect the degree of segmentation in the mortgage market.

Our results suggest that monetary policy shocks have persistent effects on wealth inequality. We reach the same conclusion using alternative measures of monetary policy shocks and when we increase the lag length of the model. At first glance, these results are surprising, as the dynamics of wealth inequality is generally thought to be driven by other structural factors. Bayer, Born, and Luetticke (2023), however, show that, in an heterogeneous agents New Keynesian model, an interest rate shock can have long lasting effects on wealth inequality. Moreover, in their model, shocks to investment technology affect asset prices, returns, and wealth inequality.

8. Concluding remarks

In this paper, we provide new evidence on the effects of expansionary monetary policy across the wealth distribution in the United States. Our primary data source is the Distributional Financial Accounts, which provides quarterly estimates of the distribution of household wealth. We then use VAR models and distinguish between interest rate and asset purchase policies to estimate the distributional effects of monetary policy.

The distributional impact of monetary policy depends to a large extent on the type of policy instrument and the composition of net wealth. Unexpected interest rate cuts initially reduce wealth inequality but increase it in the medium term, while asset purchase shocks increase wealth inequality, albeit temporarily. Monetary policy affects household balance sheets mainly through housing wealth and corporate equities. However, the intensity of these channels varies across the wealth distribution.

Our findings inform the debate on the distributional effects of monetary policy and macroeconomic models that place household heterogeneity at the core of the monetary policy transmission mechanism. However, whether monetary policy should take distributional considerations into account in its formulation remains an open question.

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A. Distributional Financial Accounts of the United States: additional tables and charts

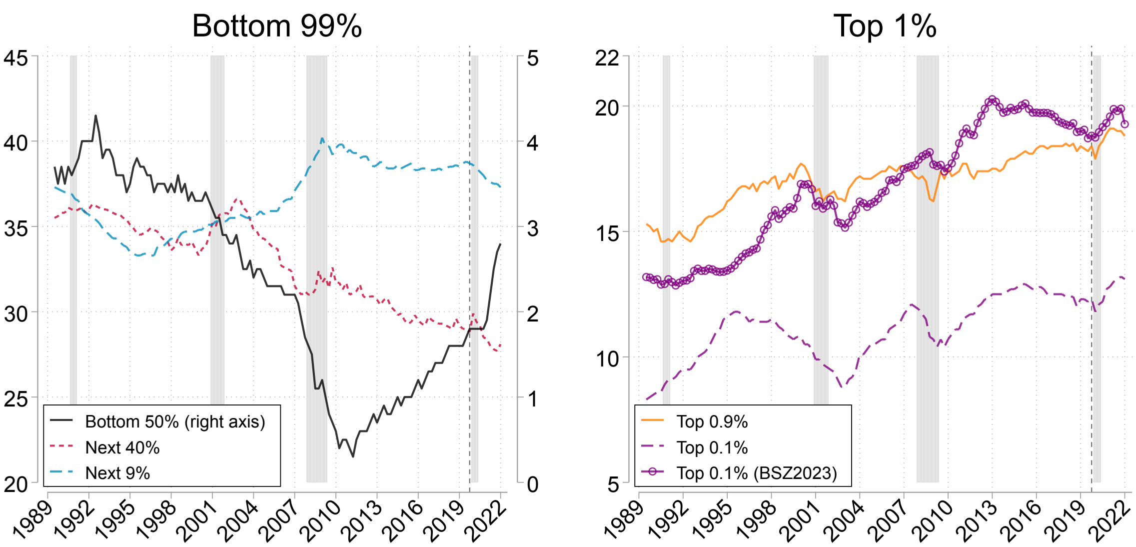


FIGURE A.1. Wealth shares (1989Q3 - 2022Q1)

Notes: The figure shows the evolution of wealth shares for the bottom 50%, next 40%, next 9%, the top 0.9%, and top 0.1% of the wealth distribution between 1989Q3 and 2022Q1. The dashed vertical lines indicate the end of the estimation sample of the empirical analysis (2019Q4). BSZ2023 refers to the series by Blanchet, Saez, and Zucman (2023). Table A.1 in Appendix B reports average wealth shares together with the distribution of balance sheet components between 1989Q3 and 2019Q4.

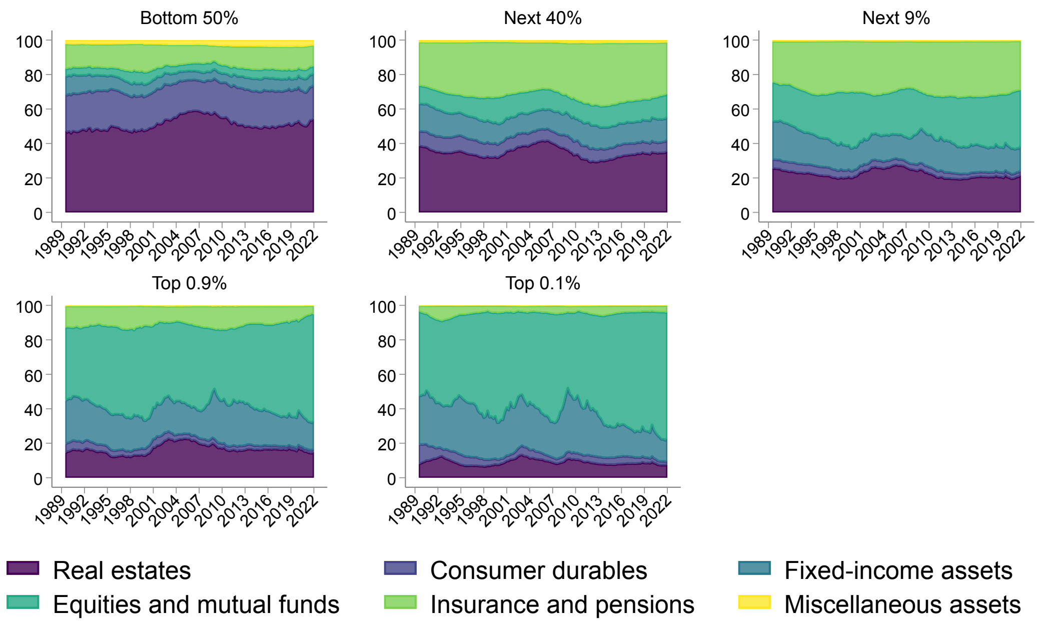


FIGURE A.2. Composition of portfolios across the wealth distribution (1989Q3 - 2022Q1)

Notes: The figure shows the composition of assets across wealth groups in the Distributional Financial Accounts. Following Bauluz, Novokmet, and Schularick (2022), we organise non-financial and financial assets in the following asset classes: real estates, consumer durable goods, fixed income assets, equities and mutual funds holdings, life insurance and pension funds, and miscellaneous assets. Fixed income assets include: checkable deposits and currency, time deposits and short-term investment, money market funds, US government and municipal securities, corporate and foreign bonds, loans. Equities and mutual funds holdings include: corporate equities, mutual fund holdings and private businesses. Insurance and pension funds include: life insurance reserves and pension entitlements.

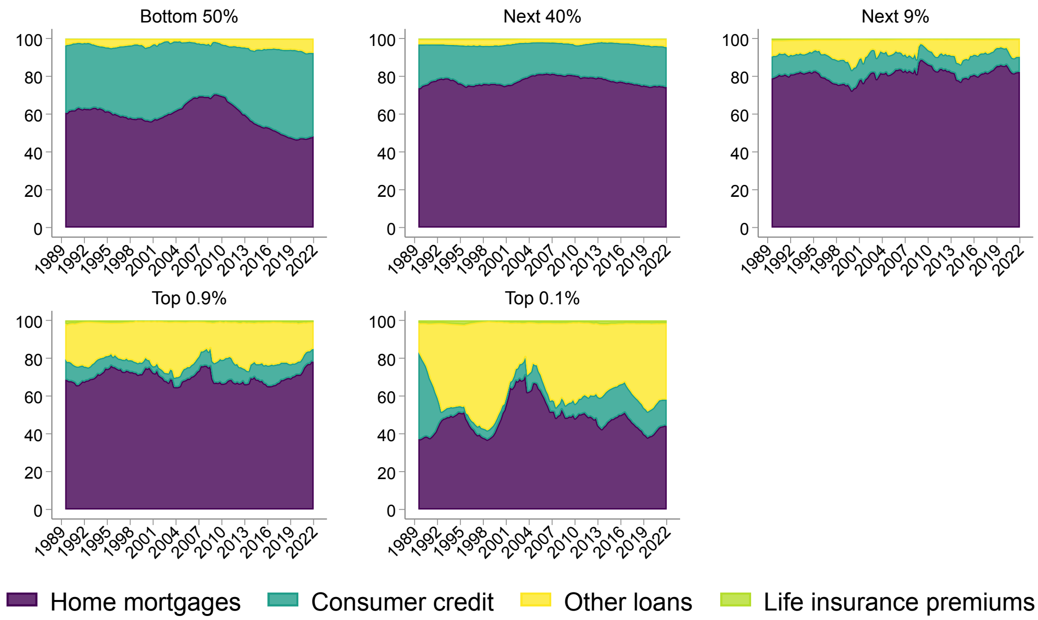


FIGURE A.3. Composition of liabilities across groups

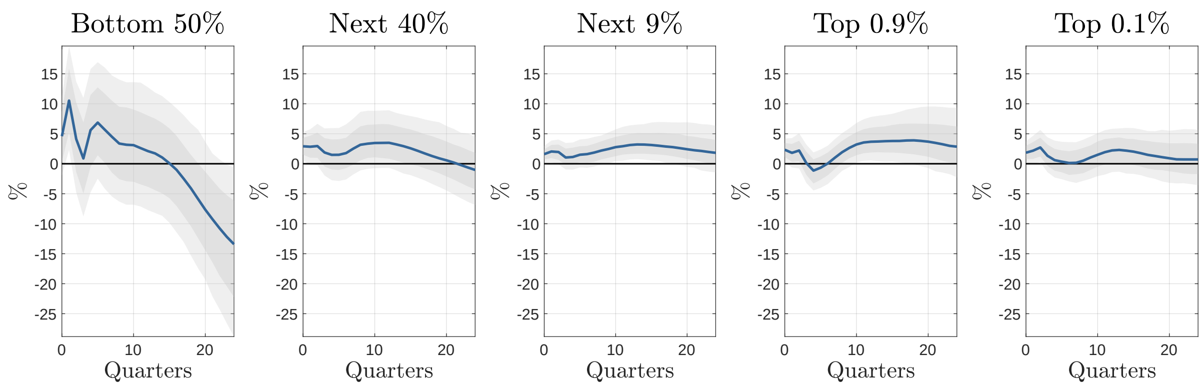
Notes: The figure shows the composition of liabilities across the wealth distribution. Each liability type is expressed as share of total liabilities. Other loans include depository institutions loans n.e.c. and other loans and advances. Life insurance premiums include deferred and unpaid life insurance premiums.

Table A.1. Distribution of assets, liabilities, and wealth (1989Q3-2019Q4)

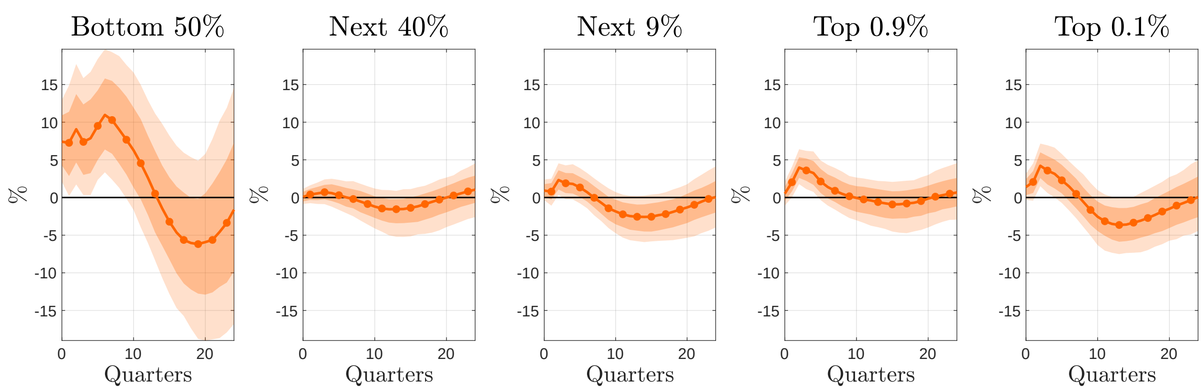
	Bottom 50%	Next 40%	Next 9%	Top 0.9%	Top 0.1%
Assets	7.07	34.59	33.83	15.01	9.49
Nonfinancial assets	15.37	44.51	27.13	9.13	3.87
Real estate	13.60	45.16	28.59	9.43	3.21
Consumer durables	22.85	41.98	20.88	7.70	6.58
Financial assets	3.00	29.72	37.14	17.90	12.24
Deposits	4.30	35.07	36.88	15.40	8.35
Corporate equities and mutual funds	1.19	15.61	35.87	27.69	19.65
Private businesses	1.76	17.14	31.99	27.05	22.06
Pension entitlements	3.43	45.18	43.22	6.65	1.53
Other assets	5.23	24.07	29.95	21.62	19.13
Liabilities	33.58	43.61	17.97	4.13	0.71
Home mortgages	28.11	47.15	20.26	4.01	0.47
Consumer credit	52.98	37.21	8.07	1.40	0.35
Other liabilities	23.00	23.96	29.29	18.26	5.48
Net wealth	2.34	33.01	36.66	16.94	11.05

Notes: The table shows average shares of wealth, assets, liabilities and their components owned or by each wealth group. The table report simple averages between 1989Q3 and 2019Q4. Other assets include US government and municipal securities, corporate and foreign bonds, loans, life insurance reserves, and miscellaneous assets. Similarly, the other liabilities are include depository institutions loans n.e.c., other loans and advances, deferred and unpaid life insurance premiums.

B. Macroeconomic and distributional effects of monetary policy: additional results



A. Interest rate shock



B. Asset purchase shock

FIGURE B.1. Effects of monetary policy on net wealth

Notes: The figure shows the impulse response functions to an interest rate (solid line) and an asset purchase (solid line with markers) shock estimated using the Bayesian VAR described in Table 2, Panel B. Net wealth is deflated using the consumer price index. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands.

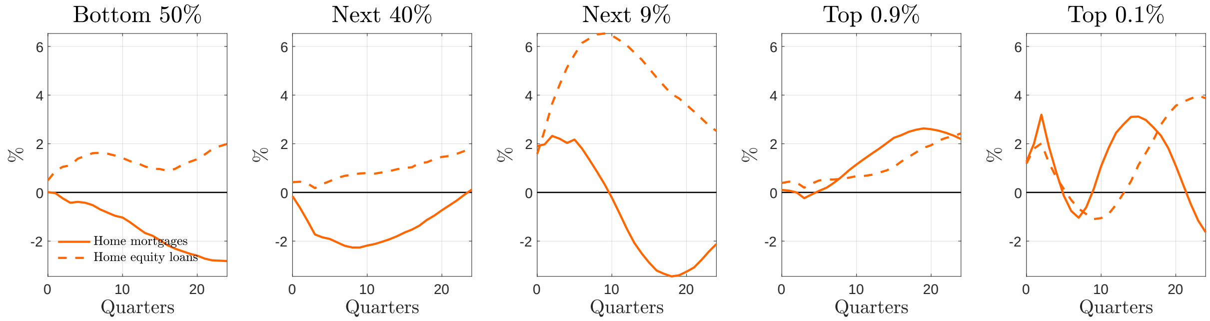


FIGURE B.2. Effects of an interest rate shock on home equity loans

Notes: The figure shows the impulse response functions to an interest rate shock estimated using the Bayesian VAR described in Table 2, Panel B. Net wealth is deflated using the consumer price index. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands.

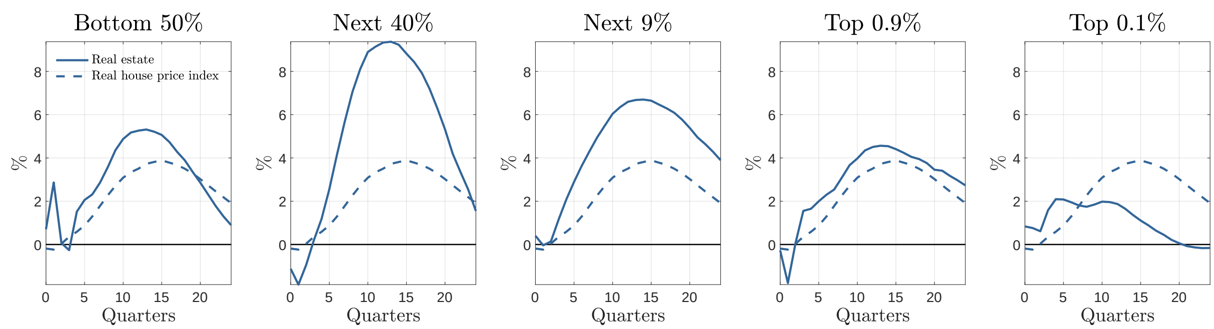


FIGURE B.3. Effects of an interest rate shock on house prices

Notes: The figure shows the impulse response functions to an interest rate shock estimated using the Bayesian VAR described in Table 2, Panel B. Net wealth is deflated using the consumer price index. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands.

TABLE B.1. Implied changes in wealth levels and shares: interest rate shock

	Bottom 50%	Next 40%	Next 9%	Top 0.9%	Top 0.1%
IMPACT					
Percent change (IRF_{ih}, %)	4.58	2.91	1.60	2.34	1.84
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	59.80	589.10	370.51	250.78	129.66
Implied share (ω_{ih}, %)	2.14	32.62	36.80	17.21	11.24
Change in share ($\Delta\omega_{ih}$, p.p.)	0.05	0.21	-0.23	0.02	-0.04
1 YEAR					
Percent change (IRF_{ih}, %)	5.60	1.48	1.13	-1.14	0.60
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	73.06	299.78	260.45	-122.68	42.34
Implied share (ω_{ih}, %)	2.19	32.60	37.12	16.85	11.25
Change in share ($\Delta\omega_{ih}$, p.p.)	0.10	0.19	0.09	-0.35	-0.03
3 YEAR					
Percent change (IRF_{ih}, %)	2.11	3.49	3.12	3.67	2.22
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	27.50	706.49	721.75	393.92	156.45
Implied share (ω_{ih}, %)	2.07	32.49	36.99	17.27	11.17
Change in share ($\Delta\omega_{ih}$, p.p.)	-0.02	0.09	-0.03	0.08	-0.11
6 YEAR					
Percent change (IRF_{ih}, %)	-13.41	-1.03	1.82	2.85	0.72
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	-174.95	-208.76	420.87	305.73	50.73
Implied share (ω_{ih}, %)	1.80	31.87	37.47	17.57	11.29
Change in share ($\Delta\omega_{ih}$, p.p.)	-0.29	-0.54	0.44	0.38	0.01

Notes: For each type of monetary policy shock, wealth group and horizon, the table reports percent change in real net wealth (IRF_{ih}, %), dollar change in real net wealth ($\bar{w}_i IRF_{ih}$, billions), implied wealth share (ω_{ih}, %), and percentage point (p.p.) change in wealth share ($\Delta\omega_{ih}$, p.p.). See the main text for more information on the computation.

TABLE B.2. Implied changes in wealth levels and shares: asset purchase shock

	Bottom 50%	Next 40%	Next 9%	Top 0.9%	Top 0.1%
IMPACT					
Percent change (IRF_{ih}, %)	7.41	0.07	0.92	0.51	1.39
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	96.67	15.12	211.96	54.23	97.78
Implied share (ω_{ih}, %)	2.23	32.19	37.08	17.15	11.35
Change in share ($\Delta\omega_{ih}$, p.p.)	0.14	-0.22	0.06	-0.04	0.07
1 YEAR					
Percent change (IRF_{ih}, %)	7.87	0.58	1.81	3.25	3.14
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	102.62	117.84	417.31	348.62	221.23
Implied share (ω_{ih}, %)	2.21	31.98	36.98	17.42	11.42
Change in share ($\Delta\omega_{ih}$, p.p.)	0.12	-0.43	-0.05	0.22	0.13
3 YEAR					
Percent change (IRF_{ih}, %)	2.62	-1.56	-2.47	-0.39	-3.50
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	34.20	-316.15	-569.82	-42.26	-246.79
Implied share (ω_{ih}, %)	2.18	32.49	36.79	17.44	11.09
Change in share ($\Delta\omega_{ih}$, p.p.)	0.09	0.09	-0.24	0.25	-0.19
6 YEAR					
Percent change (IRF_{ih}, %)	-1.62	1.04	0.06	0.66	0.05
Dollar change ($\bar{w}_i IRF_{ih}$, bil.)	-21.13	211.25	12.82	71.30	3.61
Implied share (ω_{ih}, %)	2.05	32.60	36.88	17.23	11.24
Change in share ($\Delta\omega_{ih}$, p.p.)	-0.04	0.19	-0.14	0.04	-0.04

Notes: For each type of monetary policy shock, wealth group and horizon, the table reports percent change in real net wealth (IRF_{ih}, %), dollar change in real net wealth ($\bar{w}_i IRF_{ih}$, billions), implied wealth share (ω_{ih}, %), and percentage point (p.p.) change in wealth share ($\Delta\omega_{ih}$, p.p.). See the main text for more information on the computation.

C. Econometric methodology: additional results and details

C.1. Bayesian VAR

We estimate the following VAR model using Bayesian techniques and standard macroeconomic priors:

$$\underset{n\times 1}{\mathbf{y}_t} = \underset{n\times 1}{\mathbf{c}} + \sum_{j=1}^{p} \underset{n\times n}{\mathbf{B}_j}\, \mathbf{y}_{t-j} + \underset{n\times 1}{\mathbf{u}_t} \quad \text{with} \quad \mathbf{u}_t \sim \mathcal{N}\left(\underset{n\times 1}{\mathbf{0}}, \underset{n\times n}{\mathbf{\Sigma}}\right) \tag{C.1}$$

where $\mathbf{y}_t$ is a $(n \times 1)$ vector of endogenous variables, $\mathbf{c}$ is a $(n \times 1)$ constant vector, $\mathbf{B}_j$ are $(n \times n)$ matrices of parameters with $j = 1, \ldots, p$, $\mathbf{u}_t$ is a $(n \times 1)$ vector of innovations with zero mean and variance-covariance matrix $\mathbf{\Sigma}$. Time is indexed by $t = 1, \ldots, T$, each time period is a quarter, and the lag length is $p = 4$. We estimate VAR coefficients using a Normal-Inverse Wishart prior, which takes the following form:

$$\Sigma \sim \mathcal{W}^{-1}(\Psi, \nu) \tag{C.2}$$

$$\beta | \Sigma \sim \mathcal{N}(b, \Sigma \otimes \Omega) \tag{C.3}$$

where β is a vector containing all the VAR parameters ($\beta \equiv vec([c, B_1, \ldots, B_p]')$. Ψ is diagonal with elements ψ_i which are chosen to be a function of the residual variance of the regression of each variable on its own first p lags, and the degrees of freedom of the Inverse-Wishart are set so that the mean of the distribution exists and is equal to $\nu = n + 2$. In addition, the parameters in equation (C.2) are specified acoording to the moments for the distribution of the coefficients in the VAR model (C.1) defined by the

Minnesota priors:

$$\mathbb{E}\left[(B_i)_{jk}\right] = \begin{cases} \delta_j & i = 1, j = k \\ 0 & otherwise \end{cases} \qquad \mathbb{V}ar\left[(B_i)_{jk}\right] = \begin{cases} \frac{\lambda^2}{i^2} & j = k \\ \frac{\lambda^2}{i^2}\frac{\sigma_k^2}{\sigma_j^2} & otherwise \end{cases} \tag{C.4}$$

where $(B_i)_{jk}$ represents the element in row (equation) j and column (variable) k of the matrix of coefficients B at each i lag, with $i = 1, \ldots, p$. In the case of $\delta_j = 1$, then the random walk prior is strictly imposed on all variables; however, for those variables for which this prior is not suitable we set $\delta_j = 0$. The variance of the elements in B_i is assumed to be proportional to the relative variance of the variables and to the inverse of the square of the lag (i^2). Finally, the hyperparameter λ, which controls the overall tightness of the priors, is set according to Giannone, Lenza, and Primiceri (2015), which treats it as an additional parameter of the model that is estimated in spirit of the hierarchical modeling.

C.2. Unit-variance shock estimation procedure

A shock is invertible if it is a linear combination of contemporaneous VAR residuals. To test the validity of this assumption, we use the theoretical result of Forni, Gambetti, and Ricco (2022), which shows that if the shock is not invertible, then it is a function of current and future VAR residuals. Formally, the test is performed by projecting the instrument (z_t) on the current value and the first r leads of the Wold residuals η_t:

$$z_t = \sum_{k=0}^{r} \lambda_k^{'} \eta_{t+k} + \nu_t \tag{C.5}$$

The invertibility test is an F-test for the significance of the regressors, where the null hypothesis is $H_0 : \lambda_0 = \lambda_1 = \cdots = \lambda_r = 0$ against the alternative that at least one of the coefficients is nonzero.

If the invertibility assumption holds, which is the case in our Proxy VAR, the Wold residuals, say ϵ_t, can be written as a linear combination of the structural shocks, say η_t. The external instrument identification allows us to obtain covariance restrictions from proxies for the latent structural shock of interest, in line with the relevance and exogeneity conditions (see Stock and Watson 2018). We proceed with the first-stage regression by projecting the instrument z_t onto the Wold residuals. Formally:

$$z_t = \delta^{'} \epsilon_t + \nu_t \tag{C.6}$$

Forni, Gambetti, and Ricco (2022) show that if the shock is fundamental we can obtain an estimate of the standardized unit-variance structural shock i as:

$$\hat{\eta}_{it} = \frac{\hat{\delta} \hat{\epsilon}_t}{std(\hat{\delta}^{'} \hat{\epsilon}_t)} \tag{C.7}$$

The result of the test indicates that the shock is invertible (see Table C.1).

TABLE C.1. Invertibility test.

	Number of leads r						
	$r = 2$	$r = 3$	$r = 4$	$r = 5$	$r = 6$	$r = 7$	$r = 8$
P-value	0.030	0.082	0.113	0.078	0.058	0.040	0.020

Notes: The table shows the p-values for each regression including the current value and up to r leads of the Wold residuals. Values above the confidence level (1%) indicates that the shock is invertible.

C.3. Building an informationally-robust asset purchase shock

To build an informationally-robust asset purchase shock, we follow Miranda-Agrippino and Ricco (2021) and *purge* the large-scale asset purchase factor of Swanson (2021) according to a two step procedure.

(a) To control for the private information of the Federal Reserve, we project the large-scale asset purchase factor on Greenbook forecasts and on forecast revisions for real output growth, inflation (GDP deflator), and the unemployment rate at FOMC meeting frequency. We rely on the GDP deflator to measure inflation and use only nowcasts for the unemployment rate. These controls are collected in the vector x in the following regression:

$$MPF_m = \alpha_0 + \sum_{i=-1}^{3} \beta_i \underbrace{F_m^{cb} x_{q+i}}_{\text{Forecast}} + \sum_{i=-1}^{2} \phi_i \underbrace{\left[F_m^{cb} x_{q+i} - F_{m-1}^{cb} x_{q+i}\right]}_{\text{Forecast revisions}} + \widehat{MPF}_m \tag{C.8}$$

where $F_m^{cb} x_{q+i}$ denotes Greenbook forecasts for the vector of variables x at horizon $q + i$ that are produced prior to each meeting, and $F_m^{cb} x_{q+i} - F_{m-1}^{cb} x_{q+i}$ denotes revisions to forecasts between consecutive FOMC meetings.

(b) To account for the slow absorption of information by economic agents, we aggregate the residual series from the equation above $\widehat{MPF}_m$ to a quarterly frequency and estimate the following regression:

$$\widehat{MPF}_t = \alpha + \sum_{j=1}^{4} \psi_j \widehat{MPF}_{t-j} + \hat{s}_t^{LSAP} \tag{C.9}$$

The series of residuals $\hat{s}_t^{LSAP}$ is then used as internal instrument in the VAR.

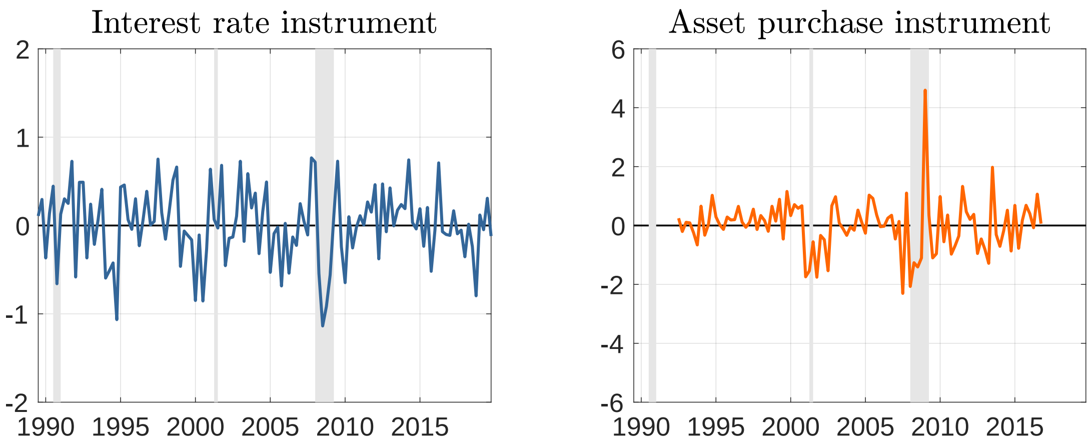


FIGURE C.1. Shocks

Notes: This figure plots the monetary policy shocks used as internal instruments in the VAR models (see Section 3 for more information).

D. Macroeconomic and distributional effects of monetary policy: sensitivity analysis

D.1. Restricted asset purchase shock

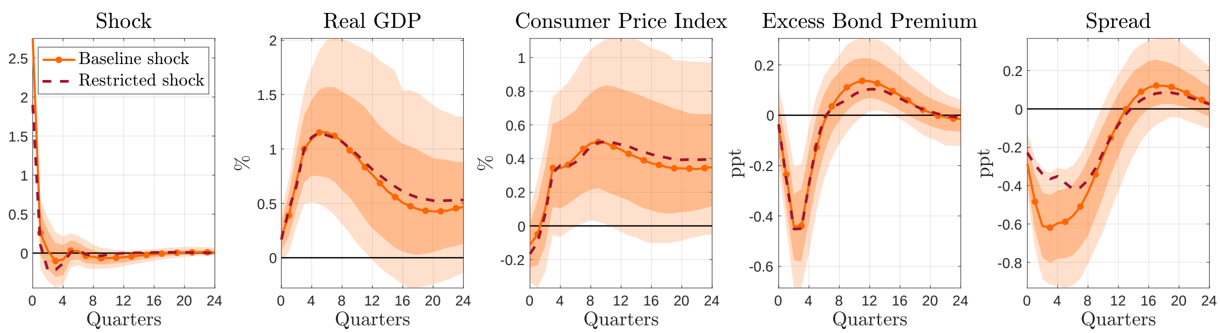


FIGURE D.1. Macroeconomic effects of an asset purchase shock: robustness

Notes: The figure shows the impulse responses to a baseline asset purchase shock (solid line with markers) and the restricted asset purchase shocks (dashed line) from a Bayesian VAR described in Table 2, Panel A. The restricted shocks restrict pre-2008 observation to zero. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid and dashed lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands. (omitted for the restricted).

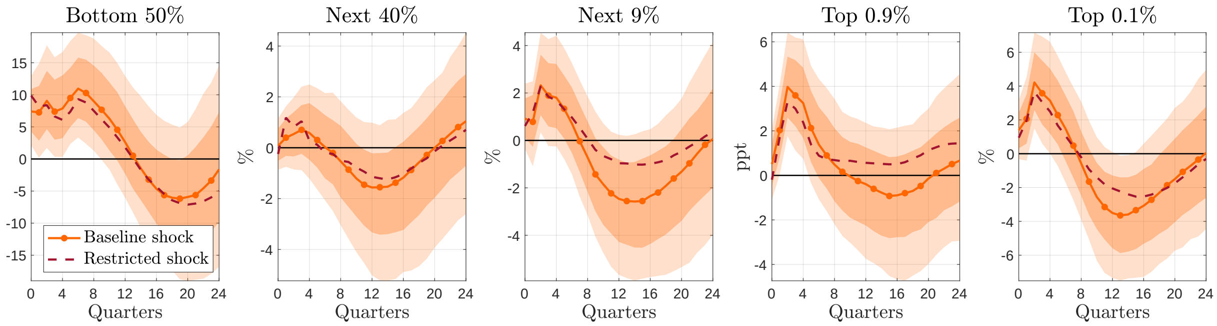


FIGURE D.2. Effects of asset purchase shock on net wealth: robustness

Notes: The figure shows the impulse responses to a baseline asset purchase shock (solid line with markers) and the restricted asset purchase shocks (dashed line) from a Bayesian VAR described in Table 2, Panel B. The restricted shocks restrict pre-2008 observation to zero. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid and dashed lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands. (omitted for the restricted).

D.2. Interest rate shocks: robustness to alternative identification assumptions

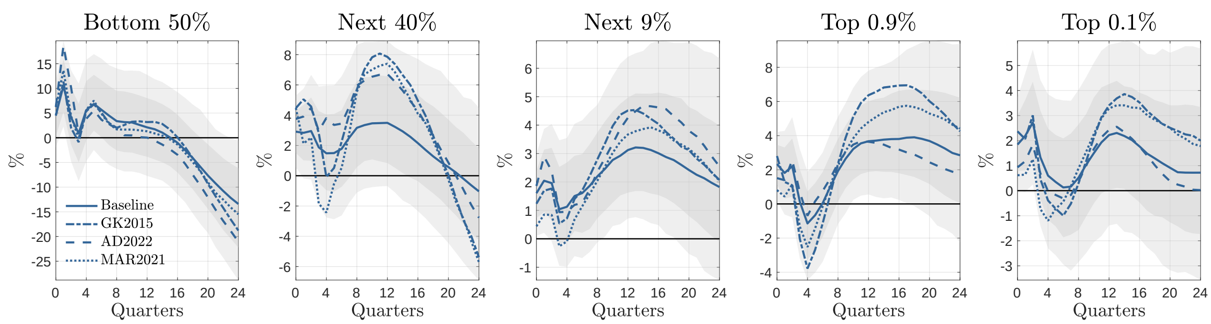
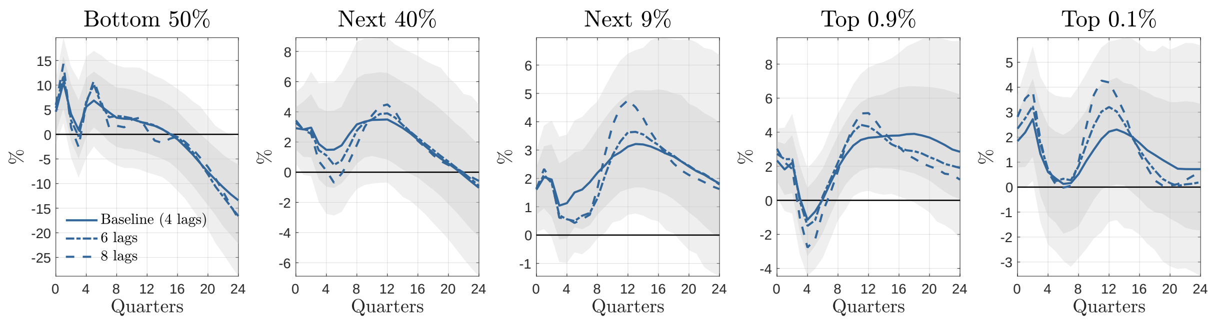


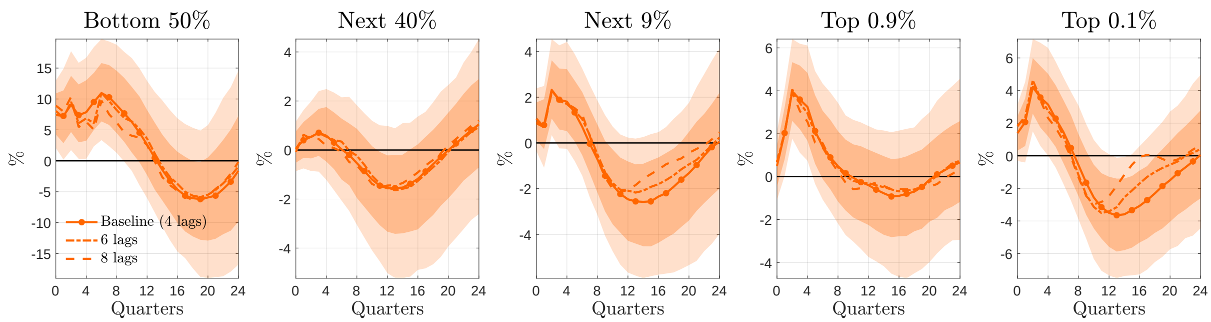
FIGURE D.3. Alternative interest rate shocks

Notes: The figure shows the impulse response functions to the baseline interest rate shock (solid line) and to alternative shocks estimated using the Bayesian VAR described in Table 2, Panel B. Baseline is Jarociński and Karadi (2020), GK2015 is Gertler and Karadi (2015), AD2022 is Aruoba and Drechsel (2022), MAR2021 is Miranda-Agrippino and Ricco (2021). For MAR2021 we use the extended series by Degasperi and Ricco (2021). Net wealth is deflated using the consumer price index. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands.

D.3. Model specification: robustness to lag length choice



A. Interest rate shock



B. Asset purchase shock

FIGURE D.4. Effects of monetary policy on net wealth: robustness

Notes: The figure shows the impulse response functions to an interest rate (solid line) and an asset purchase (solid line with markers) shock estimated using the Bayesian VAR described in Table 2, Panel B. Baseline refers to the model with 4 lags. Net wealth is deflated using the consumer price index. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands.

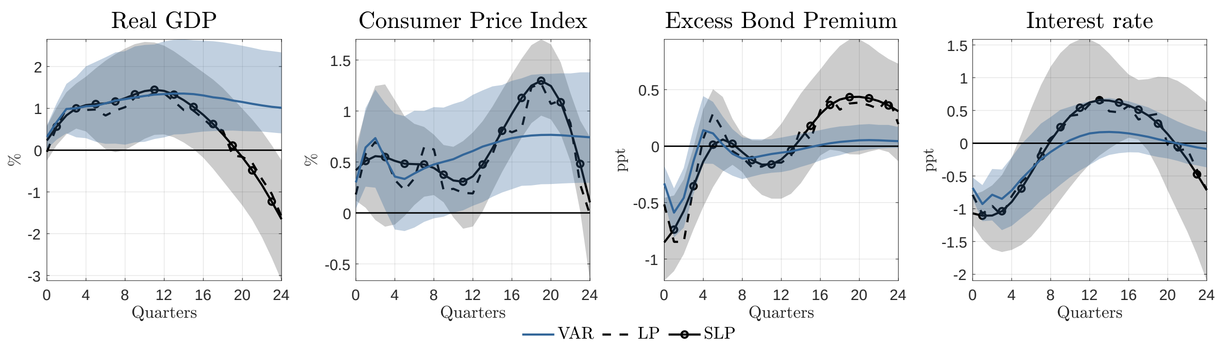
D.4. Model specification: robustness to model choice

In a local projection framework, the impulse response function is the series of regression coefficients β_h associated with the set of h-step ahead predictive regressions.

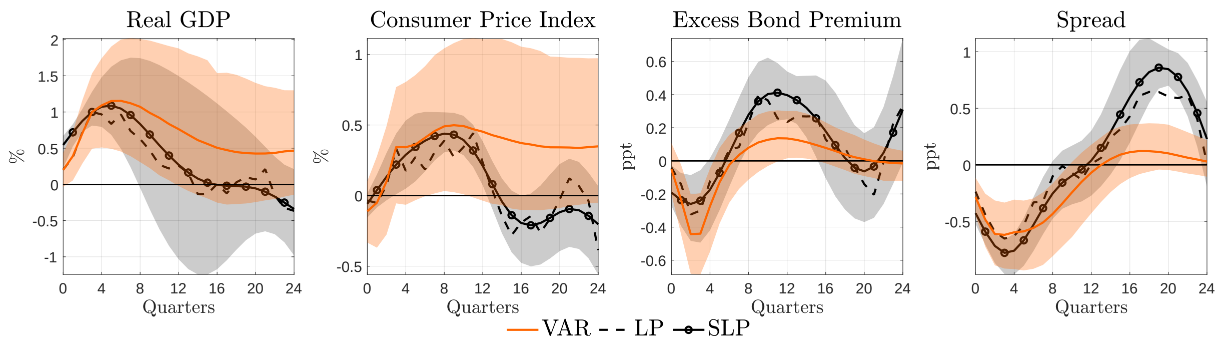
Formally:

$$y_{t+h} = \alpha_h + \beta_h \hat{s}_t^j + \Phi_h(L) x_{t-1} + u_{t+h} \quad \text{with} \quad h = 0, 1, 2, \ldots, 24 \tag{D.1}$$

where y is a dependent variable of interest (e.g., real net wealth), x is a vector of control variables, $\Phi(L)$ is a polynomial in the lag operator, and $\hat{s}^j$ is a monetary policy surprise with $j = \{R, LSAP\}$. Because impulse responses estimated with local projections are often less precise and erratic, we estimate a smooth local projection version of equation (D.1) following the approach of Barnichon and Brownlees (2019). In both cases, we keep the specification of the local projection as close as possible to the baseline VAR models.



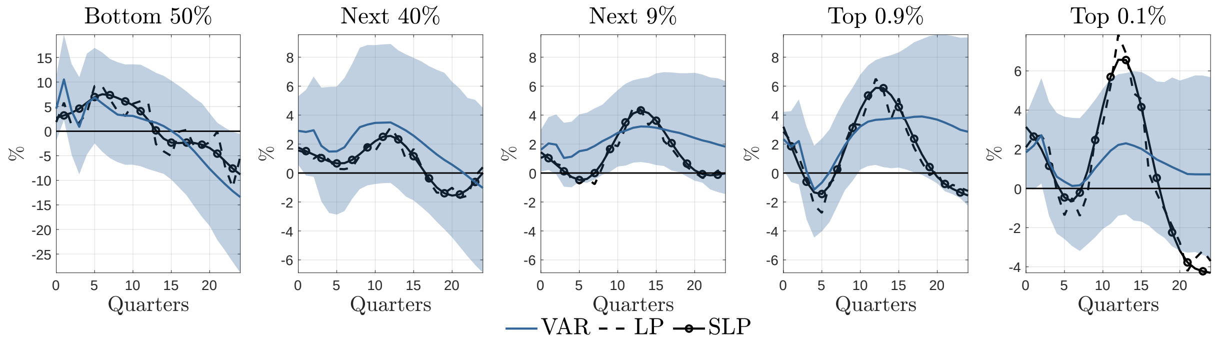
A. Interest rate shock



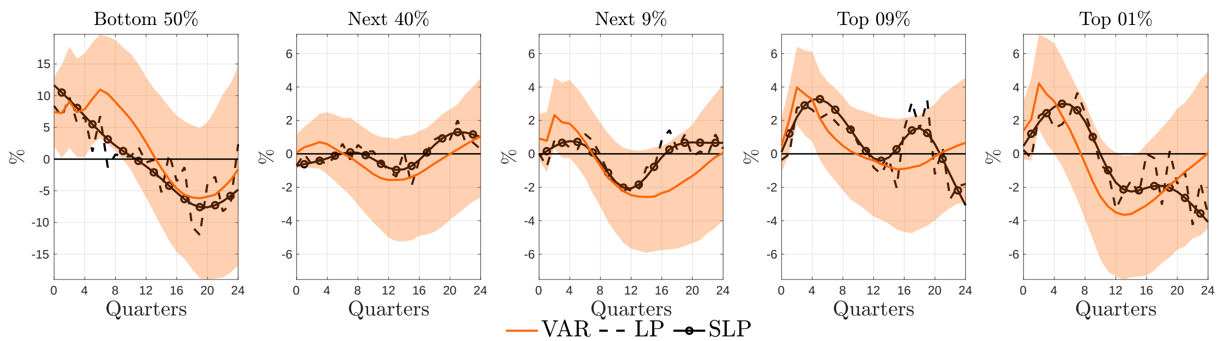
B. Asset purchase shock

FIGURE D.5. Macroeconomic effects of monetary policy: robustness

Notes: The figure shows the impulse response functions to an interest rate (Panel A) and an asset purchase (Panel) shock estimated using the Bayesian VAR described in Table 2, Panel B, and local projections. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands. LP is Local Projections (dashed black line) and SLP is Smooth Local Projections (solid black line with markers). Impulse responses are normalized to generate a 1% response of real GDP. Shaded areas are 90% posterior coverage bands and are shown for the baseline VAR.



A. Interest rate shock



B. Asset purchase shock

FIGURE D.6. Effects of monetary policy on net wealth: robustness

Notes: The figure shows the impulse response functions to an interest rate (Panel A) and an asset purchase (Panel) shock estimated using the Bayesian VAR described in Table 2, Panel B, and local projections. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Solid lines are median impulse responses from the posterior distribution. Shaded areas are 68% and 90% posterior coverage bands. LP is Local Projections (dashed black line) and SLP is Smooth Local Projections (solid black line with markers). Impulse responses are normalized to generate a 1% response of real GDP. Shaded areas are 90% posterior coverage bands and are shown for the baseline VAR.

E. Beyond net wealth: the effect of monetary policy on balance sheets

The documented changes in net wealth across the wealth distribution due to monetary policy shocks are potentially influenced by several factors, including asset accumulation, disinvestment, borrowing, debt repayment, and asset price fluctuations. To varying degrees, these factors contribute to the channels through which monetary policy affects aggregate consumption, output, and prices, as predicted by both new and traditional theories analyzing the transmission mechanism of monetary policy (e.g., Bernanke and Gertler 1995; Mishkin 1995; Kaplan and Violante 2018; Kaplan, Moll, and Violante 2018). In this section, we use the rich information on balance sheets available in the DFA to show that monetary policy also has heterogeneous effects on assets and liabilities across the wealth distribution.

Figures E.1 and E.2 plot the responses of asset and liability components across the distribution of wealth in response to an interest rate shock and an asset purchase shock, respectively. This analysis focuses on four time horizons: the initial impact, one year, three years, and six years after the shock. The height of each bar in both figures (first row) roughly corresponds to the growth in total assets induced by monetary policy.[17]

The housing sector plays a crucial role in the transmission of monetary policy to the broader economy (Mishkin et al. 2007; Cloyne, Ferreira, and Surico 2020; Amromin, Bhutta, and Keys 2020), and house prices have a significant impact on home equity and total net wealth (Kuhn, Schularick, and Steins 2020; Mian, Rao, and Sufi 2013). Following an interest rate shock, all wealth groups experience a sluggish increase in real estate that

[17] Note that a direct comparison between the impulse responses depicted in Figure E.1 and Figure E.2 with Figure 3 and Figure 5 is not feasible due to the exclusion of certain asset components, such as government, municipal and corporate bonds, insurances, miscellaneous assets, and other liabilities that are not classified as home mortgages or consumer credit.

peaks about three years after the shock (see Figure E.1). On the liabilities side, however, the response of home mortgages to an interest rate shock is more heterogeneous across the distribution. While there is a lagged increase in mortgage debt for all groups, the bottom 90% of the distribution experiences a disproportionately larger growth in debt, especially the bottom 50%. Consequently, while the transmission of interest rate policy to the housing market contributes to the expansion of gross wealth through both the appreciation and accumulation of real estate, the simultaneous growth of debt acts as a countervailing force, leading to a contraction of net wealth for the bottom 90%. Instead, an asset purchase shock has mixed effects on real estate and home mortgages across the wealth distribution (see Figure E.2). Real estate assets show a modest increase in the short run, followed by a decline for all wealth groups three years after the shock. On the liabilities side, an asset purchase shock reduces home mortgages for the bottom 90%. Six years after the shock, however, the reduction extends to all groups, except the next 40%.

Corporate equities and mutual funds exhibit significant inequality in their distribution, and the returns generated by these assets play a crucial role in shaping wealth inequality (Hubmer, Krusell, and Smith Jr 2021). Despite persistent differences in magnitude, we find limited heterogeneity in the patterns of responses to both interest rate and asset purchase shocks across wealth groups. Following an interest rate shock, most of the immediate increase in total assets for all wealth groups can be attributed to the response of corporate equities and mutual funds, likely driven by the impact of monetary policy on the stock market (see Figure E.1). In the medium run, corporate equities and mutual funds continue to account for a significant portion of the variation in total assets over time for most groups, particularly for the top 0.9%. Similarly, corporate equities and mutual funds play a crucial role in driving asset growth after an asset purchase shock (see Figure E.2). In this case, however, the impulse response exhibits a cyclical pattern, peaking about a year after the shock (panel B) and then declining over the medium term, temporarily for the next 49% (panels C and D).

In addition to corporate equities, private businesses are another important component that drives asset growth following a monetary policy shock. Private businesses encompass a wide range of assets, including non-publicly traded business assets and real estate owned by households for rental purposes. It is important to note that the valuation of private businesses can be complex. For instance, while real estate assets such as rental properties are valued at market value, the valuation of business assets reported in the DFA is the average of market value and cost basis (Batty et al. 2021). For the top 90% of the wealth distribution, an interest rate shock has a positive impact on private businesses, especially in the medium term (see Figure E.1, panels B to D). Conversely, for the bottom 50% and the top 10% of the distribution, the response of private businesses to an asset purchase shock shows a cyclical pattern, with a short-term increase followed by a decline in the medium term (see Figure E.2). For the next 40% of the distribution, private businesses experience a temporary decline for most of the horizon considered.

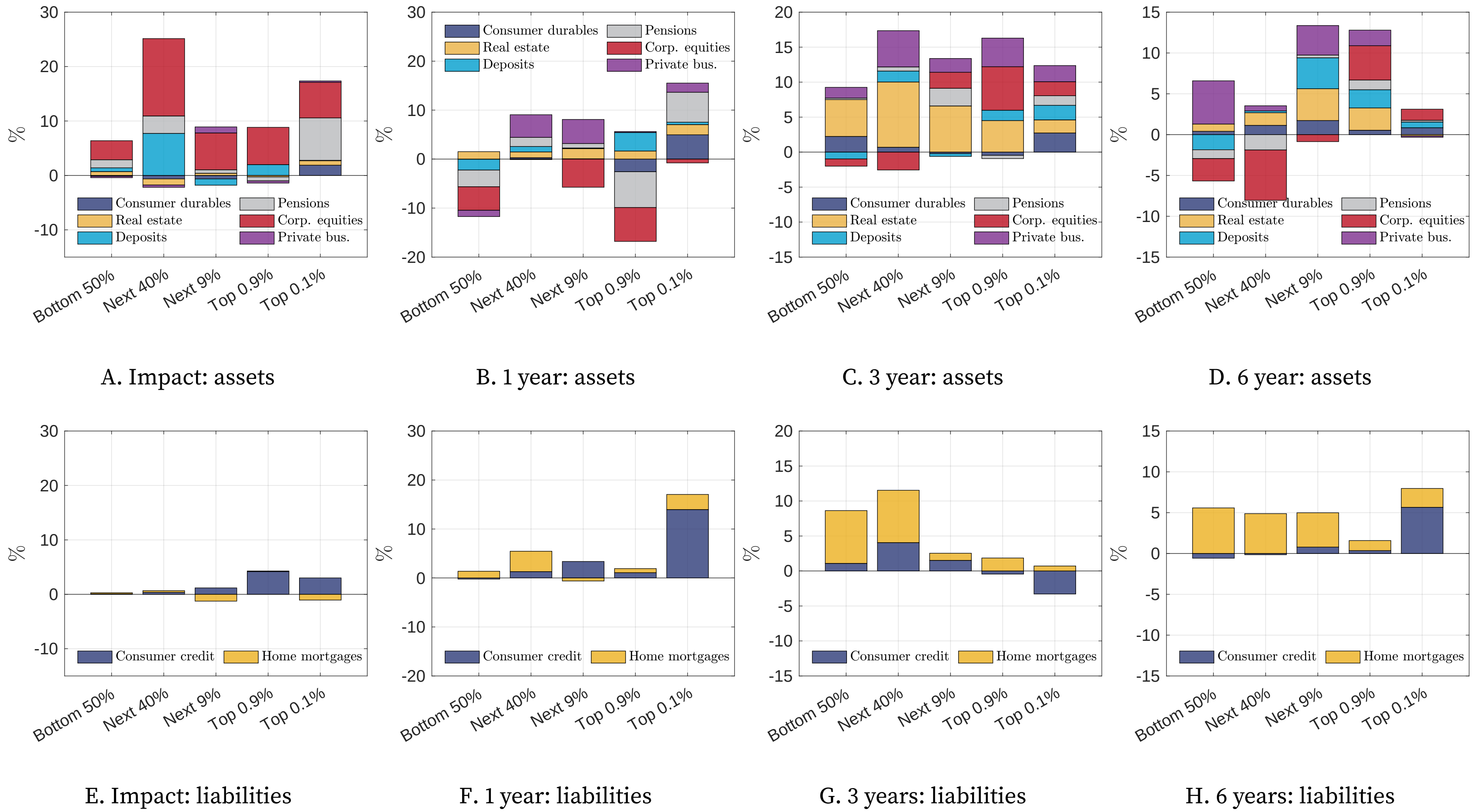


FIGURE E.1. The effects of an interest rate shock across the balance sheet: selected horizons

Notes: Impulse response functions to an interest rate shock estimated using Bayesian VAR described in Table 2, panel B. Stacked bars correspond to the median impulse responses from the posterior distribution. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Balance sheet components are deflated using the consumer price index.

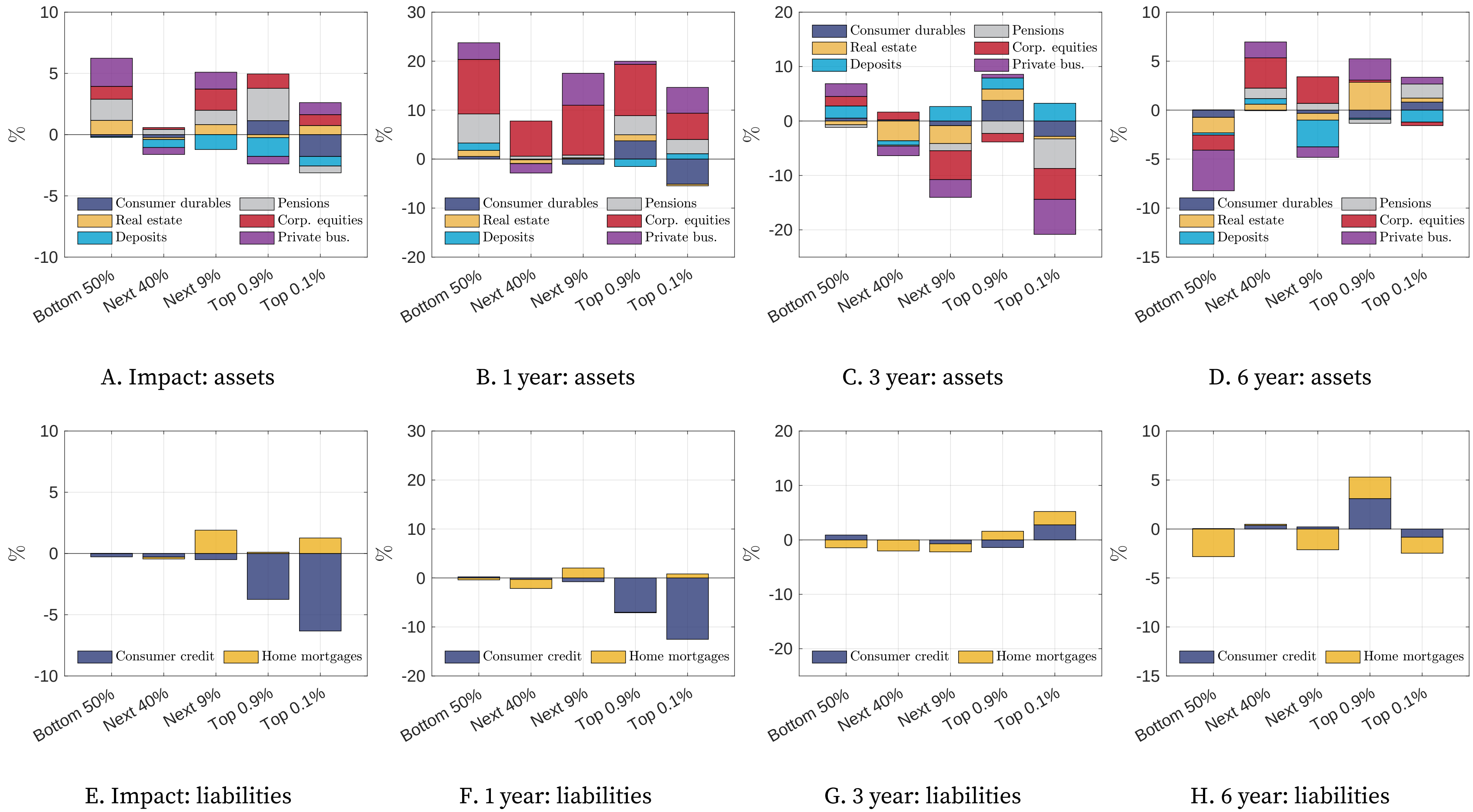


FIGURE E.2. The effects of an asset purchase rate shock across the balance sheet: selected horizons

Notes: Impulse response functions to an asset purchase shock estimated using Bayesian VAR described in Table 2, panel B. Stacked bars correspond to the median impulse responses from the posterior distribution. Impulse responses are normalized to generate a 1% response of real GDP after 3 quarters. Balance sheet components are deflated using the consumer price index.

F. Monetary policy and heterogeneous capital gains

The role of asset prices in shaping the dynamics of wealth and its distribution has been widely recognized in the literature (Blanchet and Martínez-Toledano 2022). At the same time, the most direct effects of monetary policy are often observed in financial markets (Bernanke and Kuttner 2005). In this Appendix, we examine the relationship between monetary policy, asset prices, and unequal wealth growth across the distribution. In particular, we show that the effects of monetary policy on capital gains are highly heterogeneous across wealth groups, with wealthier households experiencing larger increases in capital gains following both shocks.

F.0.1. Measuring capital gains

To emphasize the role of capital gains in the dynamics of wealth accumulation, we consider a simple law of motion for net wealth where W_t^i is net wealth of group i at time t:

$$W_{t+1}^i = W_t^i + \Pi_t^i + O_t^i. \tag{F.1}$$

where Π_t^i are total capital gains of group i between time t and $t+1$, and O_t^i captures any other factor that affects wealth at time t, such as savings, other returns, dividends, and any other unobserved factor. In addition, we assume that capital gains and other factors affecting wealth accumulation occur simultaneously. This law of motion can be extended to any gross asset A_j^i on the balance sheet of group i:

$$A_{jt+1}^i = A_{jt}^i + \Pi_{jt}^i + O_{jt}^i. \tag{F.2}$$

In this equation, A^i_{jt} is the level of asset j for group i at time t, Π^i_{jt} are capital gains or losses generated by that asset between time t and $t+1$, and O^i_{jt} captures any other factor contributing to the accumulation of that specific asset. Equations F.1 and F.2 show that capital gains resulting from changes in asset prices contribute to the accumulation of both net wealth and asset accumulation. However, the magnitude of capital gains or losses depends on the exposure to a particular asset, which can be measured by the share of that asset in total assets. As a result, capital gains from changes in the price of a particular asset should be heterogeneous due to differences in portfolio composition across groups.

To better illustrate the role of portfolio composition, let's consider the standard formula used to calculate capital gains. Assuming that wealth group i holds a portfolio of J assets denoted by $\{A^i_{jt}\}_{j=1}^{J}$ at time t, the total (dollar) capital gains between time t and $t+1$ can be computed as $\Pi^i_t = \sum_{j=1}^{J} \Pi^i_{jt} = \sum_{j=1}^{J} \left({p_{jt+1}}/{p_{j,t}} - 1 \right) A^i_{jt}$, where p_{jt} is the price index for asset j. This formula is commonly used in the literature to calculate asset-specific capital gains and to assess their role in wealth accumulation (Kuhn, Schularick, and Steins 2020). However, extending this formula to total capital gains requires the choice of a price index for each asset on the balance sheet, including assets that are not traded in financial markets or for which there is no market price readily available.

In this study we use a different approach to overcome the limitation of choosing a price index for each asset on the balance sheet. To calculate capital gains, we begin by noticing that at the aggregate level, changes in any asset j between the beginning of time t and the beginning of time $t+1$ can be decomposed as follows:

$$A_{jt+1} - A_{jt} = F_{jt} + R_{jt} + V_{jt}, \tag{F.3}$$

where F_{jt} represents transactions, which capture the exchange of assets, R_{jt} represents revaluations, which measure holding gains and losses (capital gains), V_{jt} represents other volume changes, which capture other events (e.g., natural disasters). This decomposition separates the economic flow that reflects the change in asset levels over time, into its constituent components. In the context of national accounts, (F.3) also applies to aggregate wealth, where R_t represents changes in wealth due to nominal holding gains and losses.

To estimate total capital gains, we allocate the aggregate revaluation R_t to different wealth groups using their respective wealth shares as weights:

$$\Pi_t^i = \left(\frac{W_t^i}{W_t}\right) R_t, \tag{F.4}$$

where Π_t^i is the capital gains for group i at time t, W_t^i is the wealth of group i at time t, and W_t is aggregate wealth. We obtain the aggregate revaluation R_t from Table R.101 of the Financial Accounts of the US, which provides information on changes in aggregate net wealth resulting from holding gains and losses recorded on all financial and non-financial asset on the aggregate household balance sheet. This approach allows us to estimate total capital gains without assuming a specific price index for each asset class on the balance sheet, as is typically done in other studies (Kuhn, Schularick, and Steins 2020). In Appendix F.2, we provide additional details on the estimation of capital gains. Figure F.3 compares the capital gains on real estate and on corporate equities and mutual funds obtained using the traditional formula with our approach of distributing the aggregate revaluation. We find that the two measures of capital gains are qualitatively similar, although the traditional approach underestimates capital gains on corporate equities and mutual funds.

In Figure F.1, the left panel shows the feature of scale dependence in capital gains, indicating that wealthier households tend to experience higher capital gains relative to poorer households. The graph shows the average capital gains to total assets across the wealth distribution from 1989 to 2022. To avoid distorting the ratio for groups with

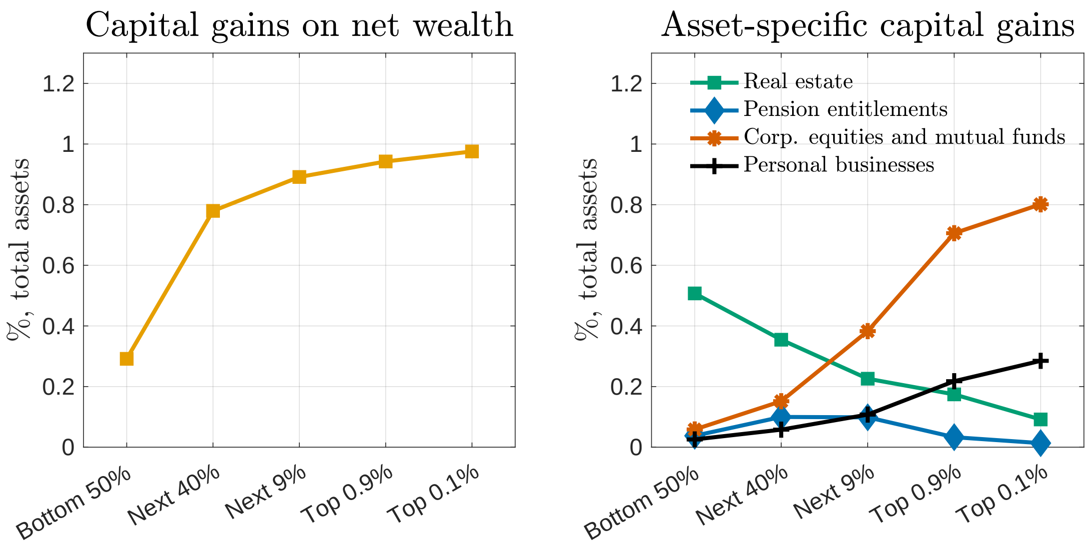


FIGURE F.1. Scale dependence (average capital gains to total assets, 1989-2022)

Notes: The figure plots average capital gains on (lagged) total assets for each wealth group. The average is computed over the full sample (1989-2022). For the computation of capital gains see the main text.

minimal wealth, capital gains are normalized to total assets (or gross wealth). The formula for capital gains to total assets, $\pi_t^i = \frac{\Pi_t^i}{A_{t-1}^i}$, quantifies the "income" generated per dollar of assets. However, it should not be interpreted as a return on assets because dividends, realized capital gains, and debt service costs are not observed. The right panel of Figure F.1 plots the average capital gains from a selected set of asset classes. Not surprisingly, the magnitude of capital gains (relative to total assets) is larger for wealth groups whose portfolios are predominantly composed of the asset class in question. For example, as we move toward the top of the distribution, where the importance of real estate declines, the magnitude of capital gains generated by real estate holdings also declines. Scale dependence in returns to wealth can contribute to wealth inequality (Piketty 2014) and has also been confirmed by studies using data from Norway (Fagereng et al. 2020), Sweden (Bach, Calvet, and Sodini 2020) and the US (Xavier 2021).

F.1. Monetary policy and heterogeneous capital gains

Interest rates and asset purchase shocks can affect wealth inequality through their impact on capital gains. When interest rates are lowered, the discount rate falls, leading to an increase in the present value of future cash flows generated by assets. Similarly, central bank asset purchase programs can reduce long-term yields and increase the valuation of long-lived assets. Depending on the composition of households' portfolios and the sensitivity of their assets to monetary policy, these changes in asset prices can have heterogeneous effects across the wealth distribution. As a result, if asset prices are the only channel through which monetary policy affects wealth, when interest rates are cut or asset purchase programs are implemented, wealth tends to increase more for households at the top of the wealth distribution than for those at the bottom.[18]

We quantify the role of monetary policy in generating heterogeneous capital gains across the distribution by estimating a VAR model augmented with capital gains on total assets ($\pi_t^i = \frac{\Pi_t^i}{A_{t-1}^i}$) for wealth group i (Table F.1). We estimate a separate model for each monetary policy type, with identification and estimation following the approach outlined in Section 3.

Figure F.2 plots the effect of monetary policy on capital gains, expressed as a share of total assets, across the wealth distribution and at three different time horizons: the immediate impact, six months after the shock, and one year after the shock. The results show that the effects of monetary policy become more pronounced as we move up the wealth distribution. Note that for an interest rate shock, the peak response is immediate, while for an asset purchase shock it is delayed by a few quarters. Interestingly, most of

[18] It is important to note that the measures of capital gains used in this paper, which are based on revaluation data from national accounts, do not directly account for the heterogeneous composition of portfolios. However, the ratio of capital gains to total assets does reflect the underlying portfolio heterogeneity. In particular, $\pi_t^i = \Pi_t^i/A_{t-1}^i = \sum_1^J \left(A_{jt}^i/A_{t-1}^i\right)\left(R_{jt}/A_{jt-1}\right)$, where $\left(A_{jt}^i/A_{t-1}^i\right)$ reflects the exposure of group i to asset j and this exposure differs across groups (portfolio heterogeneity).

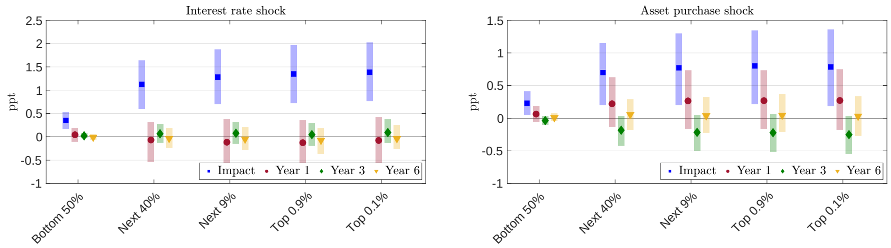
TABLE F.1. Models and variables description

	Series	Unit	Source
Panel A: *Baseline models with capital gains*			
1	Policy shock:		
	Conventional shock ($\hat{s}_t^R$)		Sections 3.1
	Unconventional shock ($\hat{s}_t^{LSAP}$)		Sections 3.2
2	Real GDP	BoC 2012$	Bureau of Economic Analysis
3	Consumer price index	2015 = 100	Bureau of Economic Analysis
4	Excess bond premium	Percent	Gilchrist and Zakrajšek (2012)
5	Interest rate or spread:		
	1-year Treasury Rate	Percent	McCracken, Ng et al. (2021)
	Term spread	Percent	McCracken, Ng et al. (2021)
6	Capital gains, bottom 50%	%, total assets	Own estimates (Section F)
7	Capital gains, next 40%	%, total assets	Own estimates (Section F)
8	Capital gains, next 9%	%, total assets	Own estimates (Section F)
9	Capital gains, top 0.9%	%, total assets	Own estimates (Section F)
9	Capital gains, top 0.1%	%, total assets	Own estimates (Section F)

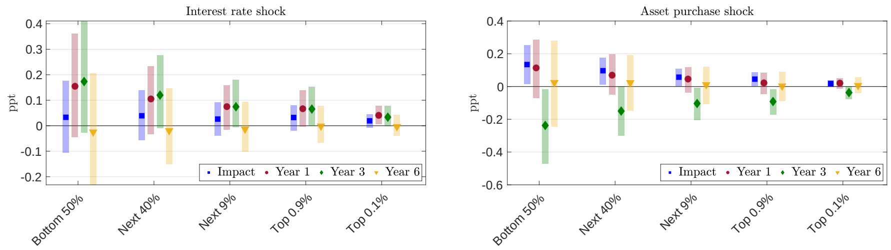
Notes: DFA is Distributional Financial Accounts. Bil. is billions. Capital gains are computed using wealth shares from the Distributional Financial Accounts and nominal holding gains and losses on aggregate wealth from Table R.101 of the Financial Accounts of the United States. See Section F for a detailed treatment of the estimation of capital gains.

the heterogeneity in the response of capital gains to monetary policy shocks is observed between the bottom 50% and the top 50% of the wealth distribution. These disparities in the response of capital gains to monetary policy shocks persist over time and, as expected, their magnitude diminishes over the medium run.

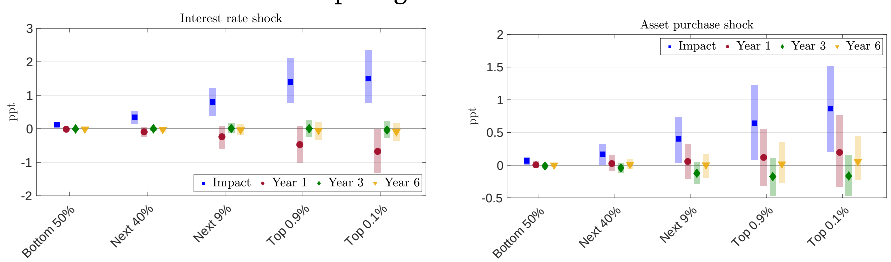
If there were no differences in the composition of households' portfolios, the impact of monetary policy shocks on capital gains would be homogeneous across the wealth distribution, with no distributional consequences through asset prices. In reality, however, this is not the case. Capital gains are scale dependent, meaning that wealthier households tend to experience higher capital gains. The effects of monetary policy shocks on capital gains also exhibit scale dependence, with wealthier households experiencing larger increases in capital gains following these shocks, with these differences reflecting heterogeneity in portfolio composition across the wealth distribution. In particular, households holding long-term and price-sensitive assets, such as the top 1%,



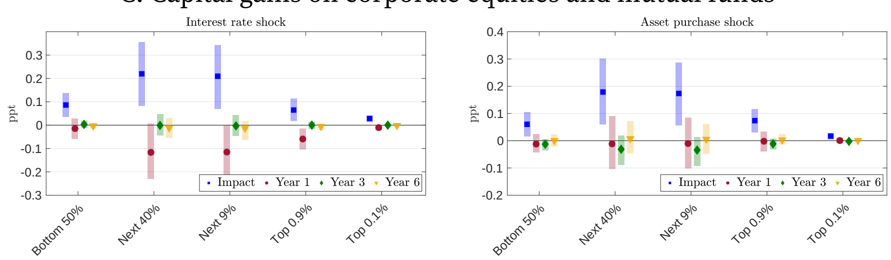
A. Capital gains on net wealth



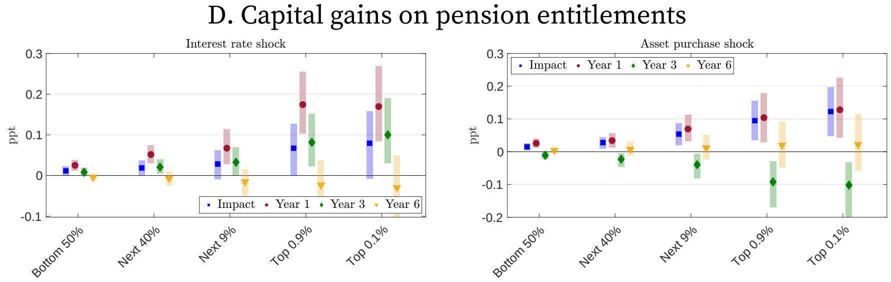
B. Capital gains on real estate



C. Capital gains on corporate equities and mutual funds



D. Capital gains on pension entitlements



E. Capital gains on private businesses

FIGURE F.2. Monetary policy and capital gains

Notes: This figures plots the response of capital gains (as share of total assets). Impulse responses for each wealth group are retrieved from a baseline VAR model augmented with capital gains to total assets for each wealth group. Impulse responses are scaled to imply a 1% response of real GDP. Intervals are 68% posterior coverage bands.

tend to experience larger capital gains following a monetary policy shock (Greenwald et al. 2021).

F.2. Estimating capital gains: further details

In this Appendix, we provide further details on the original series used to obtain capital gains. To compute group-specific total capital gains (that is, capital gains on net wealth), we use the following formula:

$$\Pi_t^i = \left(\frac{W_t^i}{W_t}\right) R_t. \tag{F.5}$$

where W_t^i/W_t is the share of wealth owned by wealth group i and R_t is aggregate capital gains. For capital gains on net wealth, R_t is computed as:

- **Total capital gains (capital gains on net wealth)** = Households and Nonprofit Organizations: Assets Less Liabilities with Revaluations, Revaluation (FR158000005Q) - Nonprofit Organizations; Equipment, Current Cost Basis, Revaluation (FR165015205Q) - Nonprofit Organizations; Nonresidential Intellectual Property Products, Current Cost Basis, Revaluation (FR165013765Q).

To compute group- and asset-specific capital gains (that is, capital gains on specific asset classes), we use the following formula:

$$\Pi_{j,t}^i = \left(\frac{A_{j,t}^i}{A_{j,t}}\right) R_{j,t}. \tag{F.6}$$

where $A_{j,t}^i/A_{j,t}$ is the share asset j owned by wealth group i and $R_{j,t}$ is aggregate capital gains generated by asset j. More specifically, $R_{j,t}$ is computed as:

- **Capital gains from holding real estate** = Households and Nonprofit Organizations; Real Estate at Market Value, Revaluation (FR155035005Q).

- **Capital gains from holding corporate equities and mutual funds** = Households and Nonprofit Organizations; Corporate Equities; Asset, Revaluation (FR153064105Q) + Households and Nonprofit Organizations; Mutual Fund Shares; Asset, Revaluation (FR153064205Q).

- **Capital gains from private businesses** = Households and Nonprofit Organizations; Proprietors' Equity in Noncorporate Business, Revaluation (FR152090205Q).

- **Capital gains from holding pension entitlements** = Households and Nonprofit Organizations; Pension Entitlements; Asset, Revaluation (FR153050005Q).

F.3. Comparing estimates of capital gains

In this Appendix, we compare our method of estimating capital gains with the traditional formula used in the literature for obtaining asset specific capital gains (Kuhn, Schularick, and Steins 2020). We focus on real estate and on corporate equities and mutual funds. Let RE identify real estate while CE identify corporate equities and mutual funds such that j is alternatively RE or CE, we compute capital gains as follows:

$$\Pi^i_{j,t} = \left(\frac{A^i_{j,t}}{A_{j,t}}\right) R_{j,t} \quad \text{: revaluation-based capital gains generated by asset } j \tag{F.7}$$

$$\tilde{\Pi}^i_{j,t} = \left(\frac{p_{j,t+1}}{p_{j,t}} - 1\right) A^i_{j,t} \quad \text{: price-based capital gains generated by asset } j \tag{F.8}$$

where $A^i_{j,t}$ is the stock of asset j held by group i, $A_{j,t}$ is the aggregate stock of asset j held by the household sector, $R_{j,t}$ is the aggregate revaluation (or capital gain) on asset j according to the Revaluation Accounts (see above), $p_{j,t}$ is the (real) price index of asset j which is assumed to be common across groups. The price index is the Case-Shiller house price index for real estate and S&P 500 index for corporate equities and mutual funds. To ease interpretation and comparison, we work with capital gains expressed as share of total group-specific group, that is:

(F.9) $$\pi^i_{j,t} = \frac{\Pi^i_{j,t}}{A^i_t}$$: revaluation-based capital gains generated by asset j

(F.10) $$\tilde{\pi}^i_{j,t} = \frac{\tilde{\pi}^i_{j,t}}{A^i_t}$$: price-based capital gains generated by asset j

In Figure F.3, we compare the two approaches in estimating average capital gains on real estate (left panel) and corporate equities and mutual funds (right panel). Both the revaluation-based and price-based approaches yield quantitatively similar results for average capital gains on real estate. In contrast, the two approaches diverge in measuring capital gains on corporate equities and mutual funds with the divergence increasing across the wealth distribution. This happens because the price-based measure is not able to capture the influence of mutual funds and of equity prices not tracked by the S&P 500 index. This finding suggests that previous studies may have had underestimated the magnitude of capital gains across the wealth distribution if a price index like the S&P 500 index is used.

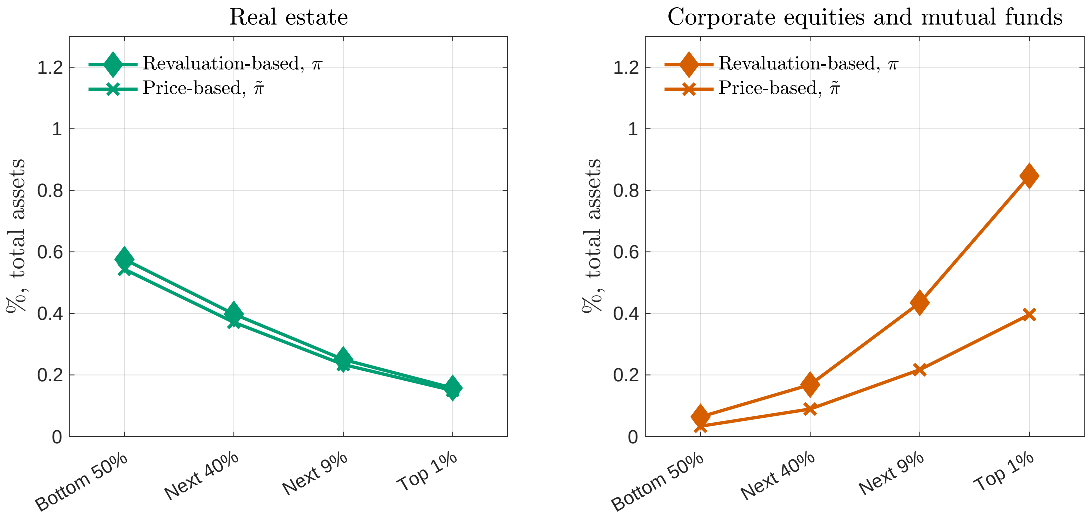


FIGURE F.3. Comparing estimates of capital gains: revaluation-based vs. price-based approach

Notes: The figure compares two measures of average capital gains (as share of lagged total assets) from holding real estate assets (left panel) and corporate equities and mutual funds (right panel) for the household sector as a whole. Averages are obtained for the 1989-2022 period.