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Essays on Macroeconomic Policy and Household Balance Sheets

Essays on Macroeconomic Policy and Household Balance Sheets

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Abstract

This thesis is composed of three essays on macroeconomic policy, with particular emphasis on household balance sheets. In the first chapter, I analyze the role of household borrowing conditions for the government spending multiplier. Although the financial position of households is found to be key for individual consumption responses to fiscal shocks, it may also be relevant for aggregate effects. I test this hypothesis for the U.S. using a historical sample, a novel strategy to characterize periods with different borrowing conditions, and instrumenting government purchases with two standard spending shocks. I find the spending multiplier above unity only when the economy is characterized by a larger share of households facing tighter borrowing conditions. This result is primarily driven by consumption and can be explained in connection to a positive effect on labor demand, as signaled by a tighter labor market. The findings hold when changing the shock identification scheme, the model specification, the sample period, and the calibration of the state variable.

In the second chapter, Giacomo Rella and I use novel quarterly data on the distribution of U.S. household wealth to document several facts about the distributional consequences of expansionary conventional and unconventional monetary policy. After showing the large heterogeneity in the composition of household portfolios across the wealth distribution, we use an internal instrument approach in a Bayesian VAR to show that: (i) Despite raising the wealth level of all households, monetary policy shocks shift the distribution of wealth towards the top tail. (ii) The consequences of monetary policy shocks on wealth shares are temporary and more pronounced in the case of unconventional monetary policy. (iii) The effects of monetary policy shocks across wealth groups are more heterogeneous for right-skewed distributed asset classes, such as equities and liquid assets. (iv) Using a counterfactual exercise to capture the portfolio composition channel, we show that both monetary policy shocks affect wealth inequality primarily via the stock market than through the housing market.

In the third and final chapter, I study the consequences of fiscal consolidation on the labor market and income inequality. Following the Global Financial Crisis, many economies have embarked on fiscal adjustments. However, as of today, it is not clear whether these policies may have caused significant distortions for the labor market and income inequality. I use a panel of 16 advanced economies over the period 1978-2014 to explore these effects. The findings show that (i) fiscal consolidation has a greater negative impact on the youth, in terms of unemployment and labor force participation rate. (ii) Transfers cuts imply a wealth-effect on labor supply, (iii) tax hikes have a negative impact on employment and unemployment rates, and (iv) spending cuts, targeting public sector wages and employment, adversely impact all labor market indicators analyzed. (v) Lastly, tax hikes and spending cuts have a sizable effect on income inequality, whereas the muted response to transfers cuts can be explained by the positive reaction of hours worked.

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Contents

Chapter 1

Household Debt, Borrowing Conditions, and the Government Spending Multiplier

1.1 Introduction

The global financial crisis is a striking example of how large economic downturns have the potential to shape policy debates and the direction of future research. This recession motivated a renewed interest in the effects of government interventions and drew considerable attention to the role of household debt for the macroeconomy.

After more than a decade of contributions in the fiscal policy literature, we have now abandoned the concept of a unique multiplier, invariant to the state of the economy, with an extensive number of empirical and theoretical contributions providing evidence for a state-dependent multiplier. Meanwhile, a set of influential papers have shown that household debt, growing from 16% of GDP at the end of World War II (WWII) to 100% at the onset of the global financial crisis, has important implications for the macroeconomy (Mian et al., 2013; Mian and Sufi, 2014). As a result, a large and growing body of theoretical and empirical research has studied whether differences in the financial position of households influence their consumption response to fiscal shocks (Heathcote, 2005; Huntley and Michelangeli, 2014; Misra and Surico, 2014; Cloyne and Surico, 2017; Alpanda et al., 2021). However, to the best of my knowledge, it is not clear whether inter-temporal differences in household financial conditions are relevant for the macroeconomic effects of fiscal shocks.

In this article, I fill this gap by exploring the effectiveness of government spending shocks over periods with different household borrowing conditions throughout a historical sample, and show that substantial attention should be paid to episodes in which a larger proportion of households face tighter credit conditions. The main contribution of this paper is twofold. First, I provide a novel strategy to characterize episodes with different household borrowing conditions. Specifically, to identify periods when the economy is characterized by a larger share of households facing tighter borrowing constraints, I select episodes when household debt is high and households experience reimbursement problems due to lower labor income (high unemployment slack), resulting in a lower debt capacity. In the first step, building upon previous contributions, I identify periods of high (low) debt when the debt-to-GDP ratio is above (below) its long-run trend (see Bernardini and Peersman, 2018). Then, I characterize periods with different household borrowing conditions using the amount of unemployment slack in the economy. In particular, by using the latter indicator as a proxy for the earning capacity of households, I am able to distinguish periods with higher (lower) labor income flows, which can predict a stronger (weaker) capacity to meet their debt obligations. Formally, I identify periods with high and low unemployment slack partioning the full sample using the median of the unemployment rate (5.6%).[1] Indeed, while periods of high debt identify large debt payment outflows, unemployment slack contributes by capturing lower labor income inflows. In other words, periods of *high debt-high unemployment* are characterized by a reduced capacity to generate an income stream for households, which translates into a weaker capacity to repay their (large amount of) debt. Hence, it is reasonable to think that in these periods a larger share of households face limited access to credit.[2] Overall, in this paper I propose to use the four possible combinations between high/low debt and high/low unemployment slack to characterize different borrowing conditions for households. In particular, periods of *high debt-high unemployment* are interpreted as episodes where a larger share of households experience tighter borrowing conditions and, for obvious reasons, constitute the main focus of the paper.[3]

Second, I show that the government spending multiplier can be greater than one only when borrowing conditions are tighter, with private consumption being the main driver of this result. The analysis of potential mechanisms suggests that a government spending shock boosts labor income by making the labor market tighter, which can explain the large (nondurable) consumption response. In addition, following the spending shock, I find a less responsive monetary stance, which would suggest a larger spending multiplier (see Leeper et al., 2017; Cloyne et al., 2020b, for recent contributions on this point). The advantage of using a historical sample is to have informative changes in government spending that are exogenous and big enough for their effects to be extracted from the many other economic shocks hitting the economy. This is especially relevant for state-dependent analyses, as the states should span over a sufficient portion of the sample (see Ramey and Zubairy, 2018, for a detailed discussion).

[1] As a robustness check I follow Owyang et al. (2013) and Ramey and Zubairy (2018), selecting the threshold of 6.5% in the unemployment rate.

[2] For instance, Di Maggio et al. (2022) find that higher debt levels coupled with lower wages result in lowered creditworthiness.

[3] Throughout the paper, when I say that borrowing conditions are tighter, I refer to these periods.

Related literature and contribution. Within the literature that studies the role of household financial positions for fiscal policy, Huntley and Michelangeli (2014) show that a model with liquidity constraints can predict a larger marginal propensity to consume out of a tax rebate with respect to a standard frictionless model. Jappelli and Pistaferri (2014) provide evidence that, following a debt-financed stimulus, low cash-on-hand households have a higher marginal propensity to consume. Bernardini and Peersman (2018) and Bernardini et al. (2020) find that private and household indebtedness are important determinants of the effectiveness of government spending shocks. Other contributions find that fiscal stimulus is more effective in areas with higher consumer debt (Demyanyk et al., 2019), that output and consumption multipliers are positively correlated with the share of households with negative wealth (Andres et al., 2022), that more leveraged households are more responsive to government spending shocks (Alpanda et al., 2021), and that fiscal multipliers are above (below) unity when government spending rises at the peak (trough) of the household leverage cycle (Klein et al., 2022). My paper crucially differs from previous contributions in terms of both methodology and scope. First, I identify government spending shocks by jointly exploiting the information provided by the structural VAR approach of Blanchard and Perotti (2002) (henceforth, BP), and by the narrative measure on military spending news constructed by Ramey (2011b) and extended by Ramey and Zubairy (2018) (henceforth, RZ). This is important because the two shocks tend to be relevant at different horizons. The BP shock leads to an immediate increase in government spending with peak close to impact, whereas the RZ shock leads to a delayed rise in government spending.[4]

This paper also adds evidence to the large and growing literature on the state-dependent effect of fiscal policy. On the empirical side, Perotti (1999) finds that fiscal multipliers, especially for government expenditure, are negatively related to the initial level of government debt-to-GDP. Barro and Redlick (2011) and Auerbach and Gorodnichenko (2012a, 2013) show that fiscal policy may be more effective in stimulating output during a recession, whereas Owyang et al. (2013) and Ramey and Zubairy (2018) find results in contrast with the previous authors, and no evidence that multipliers are greater than one when interest rates are near the zero lower bound. On the theoretical side, Eggertsson (2011), Woodford (2011), and Christiano et al. (2011) show that the output response to government spending shocks is much larger when the constraint of the zero lower bound on short-term nominal interest rates is binding. Canzoneri et al. (2016) find that fiscal stimu-

[4] These results should not come as a surprise because the narrative measure of Ramey and Zubairy looks at news about government spending, occurring at least several quarters before the government spending actually rises, and the Blanchard and Perotti shock is identified as the part of current government spending not explained by the other lagged control variables.

lus multipliers are larger in recessions with crowding-out effects during economic booms. More recently, some authors provide both empirical and theoretical evidence that fiscal multipliers are positive only when financed with more progressive taxation (Ferriere and Navarro, 2018), that are increasing in the share of public debt held by foreigners (Broner et al., 2021), and that, regardless of the state of the cycle, contractionary multipliers are above unity and larger than expansionary multipliers (Barnichon et al., 2022).

I contribute to this literature by showing that the macroeconomic effects of government spending shocks depend on household borrowing conditions. Specifically, when the economy is characterized by a larger share of households facing tigther borrowing constraints, an increase in government purchases not only avoids crowding out the private sector but is able to largely stimulate private activity. Only in these periods, cumulative output multipliers are above unity, with a larger contribution from (nondurable) consumption. The results are robust when removing the rationing periods of WWII, when ending the sample before the Great Recession, when adopting various calibrations for the state variable, when using different shock identification schemes, and alternative model specifications.

Roadmap. The rest of the paper is structured as follows. Section 1.2 presents the analys of household debt, and the methodology used to identify periods with different household borrowing conditions. Section 1.3 explains the empirical strategy, and Section 1.4 reports the baseline findings, with a battery of robustness checks. Section 1.5 presents the response of additional variables to explore the transmission of government spending shocks when borrowing conditions are tighter, and Section 1.6 concludes the paper.

1.2 Household Debt

In this section, I first introduce the methodology used in the literature to identify episodes of high versus low debt (e.g., Bernardini and Peersman, 2018; Alpanda and Zubairy, 2019). Then, I further characterize these periods by discriminating for households' earning capacity using the amount of unemployment slack.

I identify periods of high (low) household debt whenever the ratio of household debt-to-GDP is above (below) its long-run trend for two consecutive quarters. To extract the long-run trend, I employ the two-sided Hodrick and Prescott (HP) filter using a very high smoothing parameter ($\lambda = 10^6$), as the focus is on the highly persistent component that drifts the debt ratio.[5] The choice of a large smoothing parameter is justified by

[5]Despite the two-sided HP filter incorporating future information in constructing the trend, the one-

the presence of a robust empirical finding, named financial progress, which has largely contributed to the long-run trending behavior of the credit-to-GDP ratios in advanced economies (Schularick and Taylor, 2012). In other words, detrending the household debt-to-GDP ratio using a high smoothing parameter allows for the slow-moving factor in the ratio to increase over time along a long-run trend without necessarily raising the cost of servicing it. This empirical fact has induced the empirical literature, but also policymakers, to adopt this methodology (Basel Committee on Banking Supervision, 2010; Gourinchas and Obstfeld, 2012; Borio, 2014; Dell'Ariccia et al., 2016; Bernardini and Peersman, 2018; Alpanda and Zubairy, 2019).

Recently, Hamilton (2018) criticized the use of the HP filter, as it results in spurious dynamics that are not found in the underlying data and suggests the use of linear projections as an alternative to derive deviations from trends. However, in the absence of a clear theoretical foundation, it is just an empirical question of which indicator performs better. Drehmann and Yetman (2018, 2021) tackle this issue from a different perspective, asking which credit gap is a useful indicator for predicting financial crises, and find that no other gap measure outperforms the credit-to-GDP gap.[6] The smooth trend (red line) in Figure 1.1 shows that this methodology simply allows me to take into account the massive expansion in credit largely driven by financial innovation. This is necessary to characterize periods of high (above trend) and low (below trend) household debt. In particular, the light grey bars identify periods of high debt and the remaining (white) as low debt.

At this point, it would be desirable to differentiate the *high-debt* state into periods in which households are highly indebted but are still able to deal with their debt burden from periods when they face tighter borrowing conditions. This is because, in the presence of debt-constrained agents, government spending interventions are potentially more effective in stimulating private activity as these households display a higher marginal propensity to consume (e.g., Galí et al., 2007; Eggertsson and Krugman, 2012). While it is not straightforward to have a direct measure of borrowing constraints for a historical sample, I propose a novel strategy to discriminate for episodes marked by stricter borrowing constraints. To identify periods when the economy is characterized by a larger share of households facing binding borrowing constraints, I focus on their debt reimbursement problem, interpreted as the most extreme outcome of excessive indebtedness. Ideally, one should explore this issue by using NPLs data, which reflects one of the most direct measure of financial stress for the sector. Unfortunately, these data are only available for a

sided HP filter yields virtually identical results. The results hold when using a smaller or larger smoothing parameter (see Figures 1.I.1 and 1.I.2 in the Appendix).

[6] Defined as the deviation of the credit/debt-to-GPD ratio from a HP filtered trend with a large smoothing parameter.

short period of time and do not constitute a viable option when using a historical sample. To overcome this limitation, I rely on the unemployment rate as it signals fluctuations in labor income and, hence, is strictly related to repayment issues. Not surprisingly, Figure 1.2 indicates that fluctuations in NPLs and in the unemployment rate almost perfectly comove, with a strong positive correlation of 0.86 over the period 1984q1-2020q1.

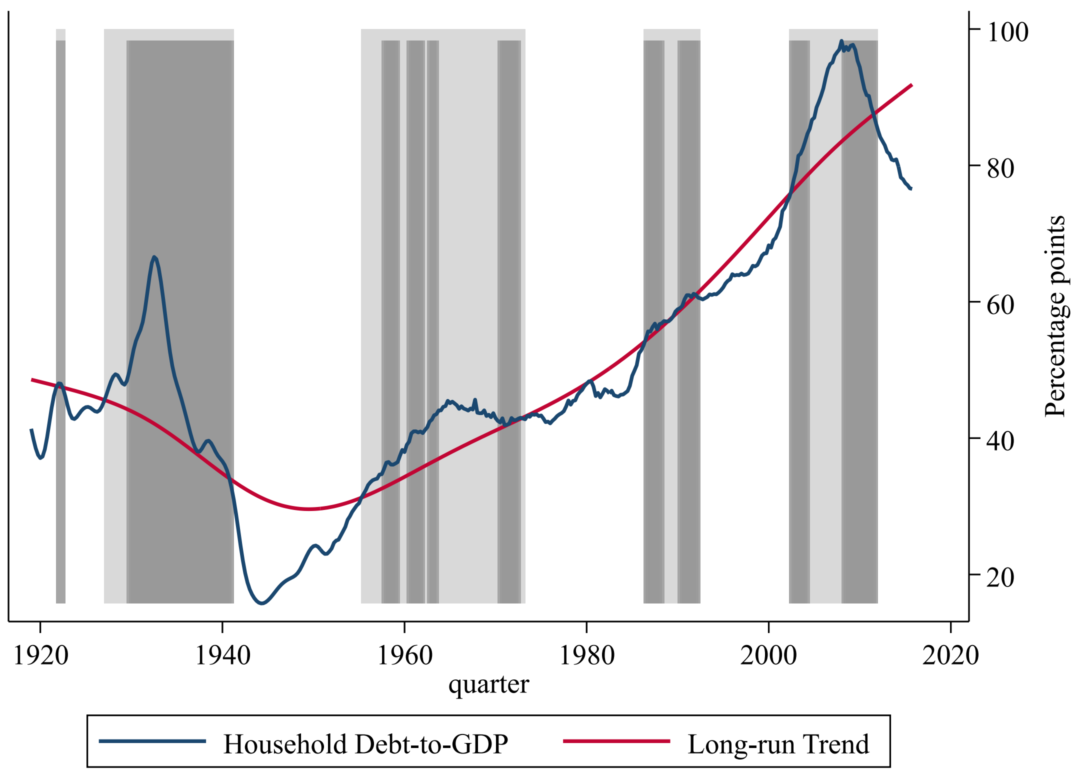

Fig. 1.1 HOUSEHOLD DEBT: IDENTIFICATION STRATEGY

Notes: The blue line is Household Debt-to-GDP, and its trend (red line) is constructed by running an HP filter with a very high smoothing parameter ($\lambda = 10^6$). The vertical light grey bands are periods of high-debt. The vertical dark grey bands are periods when the economy is characterize by tigther borrowing conditions.

Therefore, I propose to use the unemployment rate to proxy for the reduced earning capacity of households due to lower labor income flows, implying a more limited capacity to meet their debt obligations. Methodologically, I define periods characterized by tight borrowing constraints when high-debt states are associated with high unemployment rates (slack). To define periods of high and low unemployment slack, I use the median (5.6%) over the whole sample in order to equally partition the subsamples under analysis.[7] Note that the assumption of using the unemployment rate to discriminate

[7] This is a conservative choice to guarantee a minimum number of observations in each subsample. The

the earning capacity of agents is quite standard in theoretical models. For instance, *rule-of-thumb consumers* are agents that do not smooth their consumption path in the face of fluctuations in labor income (e.g., Galí et al., 2007).

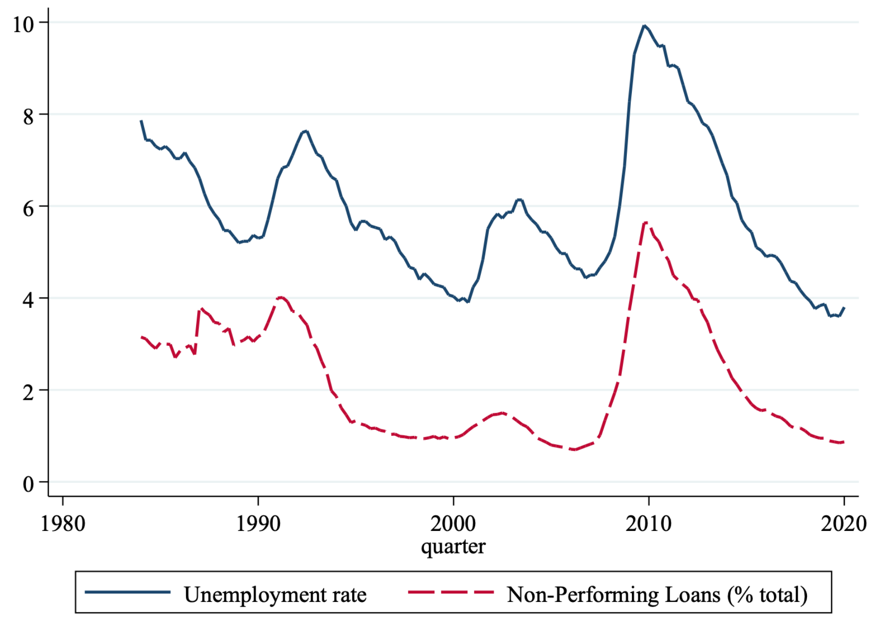

Fig. 1.2 The unemployment rate and nonperforming loans

In order to identify periods in which borrowing conditions are tighter, I now have four different scenarios. First, in the *high debt-high unemployment* state a larger share of households face limited access to credit, and this is the main focus of the analysis. Second, the *low debt-high unemployment* state, in which high unemployment slack entails a certain degree of constraints, albeit household debt is at low lev,els. Third, the *high debt-low unemployment* state, in which households hold high levels of debt but, due to their strong earning capacity, a larger share of them do not face borrowing constraints. Lastly, the *low debt-low unemployment* state, in which both unemployment slack and household debt levels are low. Note that in this paper I am able to give a specific interpretation only to the *high debt-high unemployment* scenario.

Before going forward, I test the reliability of the methodology proposed by checking the distribution of NPLs in the four identified states, as these data represent a direct way to measure financial stress for households.[8] Hence, if the proposed approach is accurate

results are robust when using the alternative threshold of 6.5% as in Owyang et al. (2013) and Ramey and Zubairy (2018). The authors selected this value based on Bernanke's announcement about policy at the time he served as chairman of the U.S. Federal Reserve.

[8]Given the limited availability of NPLs data, this robustness check is restricted to the following period: 1984q1-2015q4.

and suitable for the analysis, I should find higher values in the *high debt-high unemployment* state, followed by the *low debt-high unemployment* state, and so on. Table 1.1 presents a summary of statistics, consisting of the number of observations, mean, standard deviation, and different percentiles of the distribution. First of all, the observations are roughly equally distributed, making the comparison more informative. Then, in line with the proposed narrative, NPLs have a much higher mean (3.56) during periods classified as *high debt-high unemployment*, and lower values of 2.7 (*low debt-high unemployment*), 1.54 (*high debt-low unemployment*), and 1.33 (*low debt-low unemployment*) in the other identified states. Other than the mean, also the values in the various percentiles for the other states are coherent with the interpretation given to the four periods. Thus, Table 1.1 suggests that the proposed approach is able to correctly classify periods with different household borrowing conditions and, especially, to identify when the economy is characterized by a larger share of households facing tighter borrowing constraints.

Variable	obs	mean	sd	min	p(25)	p(50)	p(75)	max
NPLs (hd-hu)	32	3.56	1.36	1.09	2.87	3.71	4.44	5.64
NLPs (ld-hu)	39	2.70	0.83	1.23	1.98	2.90	3.15	4.29
NPLs (hd-lu)	23	1.54	1.04	0.70	0.78	0.91	2.97	3.34
NPLs (ld-lu)	34	1.33	0.60	0.94	0.98	1.11	1.33	3.16

Table 1.1 Nonperforming loans in the four identified states

Notes: The Table shows a summary statistics for NPLs in the four identified states using the proposed approach. In the parentheses, ***hd*** *stands for high debt,* ***ld*** *for low debt,* ***hu*** *for high unemployment slack, and* ***lu*** *for low unemployment slack.*

Overall, regardless of the underlying motivation (banking crises, stock market crashes, housing net worth collapses, etc.), the following periods were characterized by tighter borrowing conditions: 1922q2, from 1930q1 to 1940q4, from 1958q1 to 1959q1, 1960q4 to 1961q4, 1963q1, 1963q2, 1970q4 to 1972q2, 1986q4 to 1988q1, 1990q3 to 1992q1, 2002q4 to 2004q1, 2008q3 to 2011q3. Specifically, this methodology is able to capture salient episodes in history that characterized the most severe borrowing conditions for households. Among them: (i) The Great Depression, where households increased their indebtedness following the 1929 boom and found themselves constrained when the stock market crashed. (ii) WWII, when limited production capacity and rationing of some nondurable goods constrained household consumption and, consequently, credit creation. (iii) In 1969, aimed at limiting the large acceleration in prices, a combination of contractionary fiscal and monetary policies and bank credit control (Regulation Q) determined a temporary tightening in borrowing conditions for the following years. (iv) The 1987 stock market crash (Black Monday), when the rapid increase in household debt halt once asset prices plummeted. (v) In the early 1990s, the combination of an oil price shock,[9] the large debt accumulation, and the aggressive tightening in the monetary policy stance of the previous decade, led to stricter borrowing conditions. (vi) The stock market bubble (dot-com) and the September 11th terroristic attacks caused a drop in asset prices and higher unemployment rates, leading to tighter credit conditions. However, the increase in mortgage debt in the early 2000s was driven by the large accommodative stance of the Fed and, especially, by new financial products (mortgage-backed securities) that lowered lending standards and allowed first-time homebuyers to have access to mortgages. This boosted house prices, loosening further credit constraints. (vii) Lastly, starting from the end of 2008, the Subprime Mortgage Crisis determined an overall credit crunch and the subsequent drop in household debt.

1.3 Empirical Methodology

In this section, I present various details on the methodology used. First, I introduce the baseline identification scheme for government spending shocks. Second, I describe the way multipliers are calculated. Then, I present the empirical model and the relevance of the shocks as instruments. To investigate whether government spending multipliers vary across household borrowing conditions, I adapt Jordà's (2005) local projection method to estimate a state-dependent model for the U.S. economy using the following historical sample: 1919q1–2015q4.

1.3.1 Government Spending Shock: Identification Strategy

Generally, changes in fiscal policy are endogenous to current and future economic conditions, making the identification of exogenous movements in the fiscal variable of interest problematic. To overcome this issue, I instrument changes in government purchases using both BP and RZ shocks. First, the identification of the first shock follows the seminal contribution of Blanchard and Perotti (2002), exploiting the key identifying assumption that fiscal variables do not respond contemporaneously to changes in the economy but only with a delay of a quarter. Specifically, to identify the BP shock, I include current government spending as a regressor and control for lagged GDP, government spending, and taxes (see Ramey and Zubairy (2018) for a discussion). Second, the narrative measure of U.S. government spending shocks constructed by Ramey (2011b) and extended by Ramey

[9] It occurred in response to the Iraqi invasion of Kuwait on August 2, 1990.

and Zubairy (2018) is based on news about defense spending due to political and military events and not to the state of the economy. This strategy turns out to be particularly attractive for the identification of U.S. government spending multipliers as the former shock tends to perform well at shorter horizons, while the latter at longer horizons, as news occur at least several quarters before the actual increase in government spending. Notice that using the combination of BP and RZ to instrument changes in government spending may raise concerns about the interpretation of the implied spending multiplier. In fact, it might be that the economy responds differently to military and nonmilitary spending shocks. However, we must acknowledge that military spending is a major part of the variation in federal government expenditure (see Ramey, 2011b). In addition, Section 1.J.2 in the Appendix shows that the results are robust when using each of the two shocks individually to instrument for changes in government purchases.[10]

1.3.2 Calculating Multipliers

Given the usual practice in the literature to use the log transformation of the variables of interest (e.g., GDP), it is a common procedure to obtain the government spending multiplier using an ex post conversion, especially when using VAR models. Such methodology implies the use of the sample average of the ratio of the dependent variable, say GDP, to government spending (G), Y/G. Recently, Ramey and Zubairy (2018) raised a valid critique regarding this methodology. In fact, the authors note that using this procedure with a historical sample can cause an upward bias in estimated multipliers. Similarly, in my full sample, I deal with the same issue. GDP, but also consumption, varied significantly when using the full sample with respect to the post-WWII sample, as Y/G varies from 2 to 15 and with a mean close to 6, whereas in the post-WWII sample it varies between 4 and 7, with a mean of 5. In order to avoid this bias, I use the transformation proposed by Gordon and Krenn (2010), scaling all the NIPA variables by potential GDP rather than using their log transformation. The trend in GDP is estimated using a sixth-degree polynomial for the logarithm of GDP, from 1889q1 through 2015q4, excluding the periods from the Great Recession (1930q1) through WWII (1946q4).[11] Another benefit of setting all NIPA variables in the same units is the possibility of directly estimating multipliers. Then, a measure of the effect of government spending on output, i.e., the cumulative multiplier, is obtained cumulating GDP gain resulting from cumulative government spending over

[10] Ramey and Zubairy (2018) find very similar cumulative multipliers when using BP shock only as an instrument and when using BP and RZ jointly.

[11] The results are equivalent when using a lower-degree polynomial. I do not use the HP filter to derive the potential GDP to avoid including the years from the Great Recession to WWII.

the same period.

1.3.3 Econometric Model

I first present the linear model, assuming that spending multipliers are invariant to the state of the economy. Then, moving forward, I assess whether the government spending multiplier is a function of household borrowing conditions. To estimate impulse responses from the models outlined in the next sections, I use direct IV regressions (local projections-IV) for both the first and the second stage.

1.3.3.1 Linear Model

I use both instruments, ϵ^{RZ} and ϵ^{BP}, to instrument for the cumulative sum of real government spending between $t+1$ and $t+h$, where h is the horizon of the impulse response:

$$\sum_{j=1}^{h} g_{t+j} = \alpha_h + \varphi_h \, \epsilon_t^{RZ} + \phi_h \, \epsilon_t^{BP} + \delta_h(L) Z_{t-1} + u_{t+h} \tag{1}$$

where $\delta_h(L)$ is the polynomial in the lag operator, of order 4, and Z_{t-1} is set of lagged controls, which includes the two instruments, real GDP, and taxes. Note that ϵ_t^{BP} is simply real government spending (g_t), and that I identify the Blanchard and Perotti spending shock by including the set of controls in Z_t. From equation (3) I obtain the instrumented shock (the fitted value) at each h:

$$X_{t,h} \equiv \widehat{\alpha}_h + \widehat{\varphi}_h \, \epsilon_t^{RZ} + \widehat{\phi}_h \, \epsilon_t^{BP} + \widehat{\delta}_h(L) Z_{t-1}$$

Then, in the second stage I regress the cumulative sum of real output between $t+1$ and $t+h$ on the instrumented shock $X_{t,h}$:

$$\sum_{j=1}^{h} y_{t+j} = \alpha_h + \beta_h \, X_{t,h} + \Phi_h(L) X_{t-1,h} + v_{t+h} \tag{2}$$

where β_h ($h = 1, 2, ..., 16$) gives the cumulative response of the dependent variable at time $t+h$ to the shock occurring at time t, controlling for four lags of the instrumented shock. To construct impulse responses for each of the cumulative dependent variables $\sum_{j=1}^{h} y_{t+j}$ I use the sequence of the estimated β_h for each horizon h. The Newey and West correction for standard errors is used to deal with the presence of serial correlation in the error terms, induced by the successive leading of the dependent variable in the local projection model and of potential residual heteroskedasticity. Then, the standard errors are bootstrapped to correct for the so-called "generated regressor" problem, a situation in which an estimated variable is included as a regressor in a second regression. Indeed, given that the generated regressor is estimated, it has additional sampling variance that needs to be taken into account when calculating the variance of the final parameter estimate (see Pagan, 1984, for a detailed discussion of this issue).

1.3.3.2 The Role of Household Borrowing Conditions

To determine whether the government spending multiplier is a function of household debt and, in particular, of household borrowing conditions, I adapt the local projection framework to a state-dependent analysis. In the first stage, I use the two instruments, ϵ^{RZ} and ϵ^{BP}, to instrument for the cumulative sum of real government spending between $t+1$ and $t+h$:

$$\sum_{j=1}^{h} g_{t+j} = \alpha_h^i + \varphi_h^i \epsilon_t^{RZ} + \phi_h^i \epsilon_t^{BP} + \delta_h^i(L) Z_{t-1} + u_{t+h}^i \tag{3}$$

where the equation is the same as (1), with the difference that $i = \{High, Low\}$ (in Section 1.4.2) or $i = \{HH, HL, LH, LL\}$ (in Section 1.4.3) stands for each of the state of the economy under analysis.[12] From equation (3) I obtain the instrumented shock (the fitted value) at each h:

$$X_{t,h}^i \equiv \widehat{\alpha}_h^i + \widehat{\varphi}_h^i \epsilon_t^{RZ} + \widehat{\phi}_h^i \epsilon_t^{BP} + \widehat{\delta}_h^i(L) Z_{t-1}$$

Then, in the second stage I regress the cumulative sum of the dependent variable between $t+1$ and $t+h$ on the instrumented shock $X_{t,h}$:

$$\sum_{j=1}^{h} y_{t+j} = \alpha_h^i + \beta_h^i X_{t,h}^i + \Phi_h^i(L) X_{t-1,h}^i + v_{t+h}^i \tag{4}$$

where β_h^i ($h = 1, 2, ..., 16$) gives the cumulative response of the dependent variable at time $t+h$ to the shock occurring at time t, according to the state of the economy i, controlling for four lags of the instrumented shock. To construct impulse responses for each of the cumulative dependent variables $\sum_{j=1}^{h} y_{t+j}$ I use the sequence of the estimated β_h^i for each horizon h and the state of the economy i. As described in the previous section,

[12] HH: high debt-low unemployment, HL: high debt-low unemployment, LH: low debt-high unemployment, LL: low debt-low unemployment.

standard errors are corrected for potential heteroskedasticity and autocorrelation, as well as for the generated regressor problem. As a robustness check, I also estimate impulse responses using the one-step method introduced by Ramey and Zubairy (2018). Specifically, the only difference with my baseline model is that the one-step method includes the same set of controls in the first- and second-stage. Section 1.J.1 in the Appendix shows that the baseline findings are robust when using an alternative specification for the econometric model.

1.3.4 Instrument Relevance

The local projections-IV framework presented in the previous section requires that the set of instruments used must satisfy a series of conditions (see Stock and Watson, 2018, for an exhaustive discussion). Specifically, in this section, I evaluate the relevance of the instruments.

The standard rule of thumb proposed by Staiger and Stock (1997) states that an F-statistic below 10 indicates a potential weak instrument problem. However, this methodology assumes conditionally homoskedasticity and serially uncorrelated errors, and when using local projections we induce serial correlation in the errors. Hence, this methodology is not valid when using this framework. Several empirical contributions report the robust F-statistic as a simple way of adjusting this test for the presence of heteroskedasticity and serial correlation, and compare it to the homoskedastic critical values. Olea and Pflueger (2013), pointing out that there is no theoretical or analytical support for this methodology, propose a more appropriate test (effective F-statistic) and thresholds to apply.[13] This test is a scaled version of the nonrobust first-stage F-statistic, with critical values that have different thresholds, sometimes higher, when there is autocorrelation in the residuals. Notice that in the case where the model is just identified, the robust statistic corresponds to the (nonrobust) effective F-statistic. To test the null hypothesis that the two-stage least squares bias exceeds 10 percent of the ordinary least squares bias I use the threshold of the 5 percent critical value. Figure 1.3 shows the difference between the first-stage effective F-statistic and the critical values proposed by Olea and Pflueger (2013), with values capped at 30, highlighting the problem of weak instruments for values below zero. The statistics are reported for the linear model and the four states resulting from the proposed identification. First, the instruments used in the linear model have high relevance for the first 12 quarters. Then, only in the *high debt-high unemployment* and *low debt-low unemployment* states the instruments are strongly relevant at all horizons, with problems of

[13] This test applies only to IV regressions with one endogenous regressor.

low relevance at longer horizons in the *low debt-high unemployment* and the *high debt-low unemployment* states.

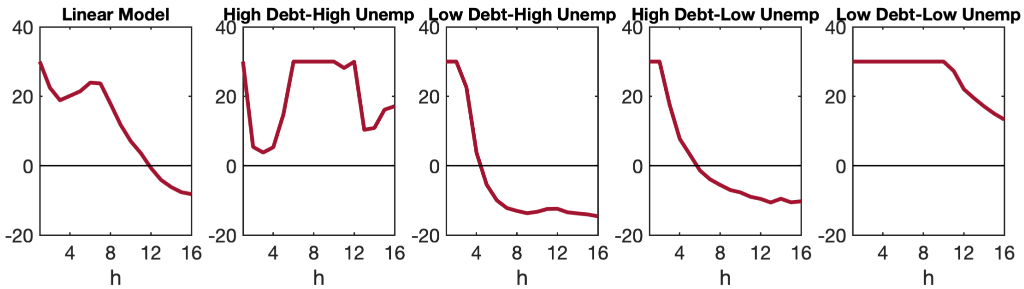

Fig. 1.3 Test of instrument relevance

Notes: Tests of instrument relevance for the four states. The lines show the difference between the effective F-statistic and the relevant threshold for the 5 percent level and are capped at 30. The effective F-statistics are from the regression of the sum of real government spending through horizon h (from 1 to 16) on the shock at time t and the controls from the first stage.

1.4 Results

In this section, I report the empirical results for the U.S. over the historical sample from 1919q1 to 2015q4. First, the results for the unconditional output multipliers are obtained by estimating the series of equations in (2). Second, using the model in (4) with $i = \{High, Low\}$, I show that the distinction between periods of high versus low debt is not particularly significant from an economic perspective. Third, using the model in (4) with $i = \{HH, HL, LH, LL\}$, I show how the spending multiplier depends on household borrowing conditions. The results are obtained by deriving cumulative output multipliers for each of the four subsamples obtained. After that, I present the results for GDP components: real private consumption, investment, and net exports, focusing attention on the scenario when the economy is characterized by tighter borrowing constraints, i.e., *high debt-high unemployment*. Lastly, I show the responses for the components of real private consumption, estimating impulse responses for durables, nondurables, and services.[14]

1.4.1 Linear Model

Table 1.H.1 shows the estimated cumulative multipliers β_h for four years ($h = 1, 2, ..., 16$) presented in equation (2), and Figure 1.4 plots the corresponding estimates. The impulse responses, in line with previous findings, show that the output response is stable at roughly 0.6. For instance, Ramey and Zubairy (2018), using a slightly longer historical

[14] The results for all the four identified states are available in Appendix 1.C from Figure 1.I.1.

sample, find a cumulative output multiplier of 0.42 and 0.56 for, respectively, a two- and four-year horizon.

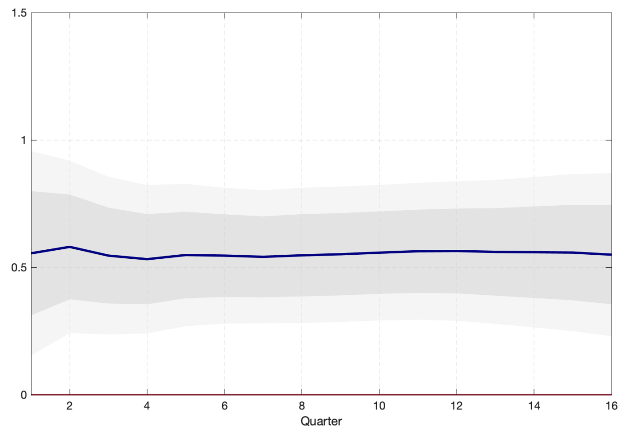

Fig. 1.4 Linear: Output multiplier

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

1.4.2 High versus Low Household Debt

In this section, I take a first step in abandoning the assumption that the government spending multiplier is invariant to the state of the economy to explore whether it varies when household debt is above or below trend level. Notice that the literature refers to periods above debt trend levels as a debt overhang. However, in this paper, I abstain from using this definition as an overhang on debt is a more extreme situation. Table 1.H.2 presents the estimates β_h^i, with $i = \{High, Low\}$ from the equations in 4, and Figure 1.5 plots the corresponding cumulative output multipliers. The findings suggest that output responds more strongly when household debt is above trend levels, albeit with estimates that are not statistically different from zero for the first 10 quarters. When household debt is below trend, cumulative multipliers are small, around 0.3, throughout the impulse response.

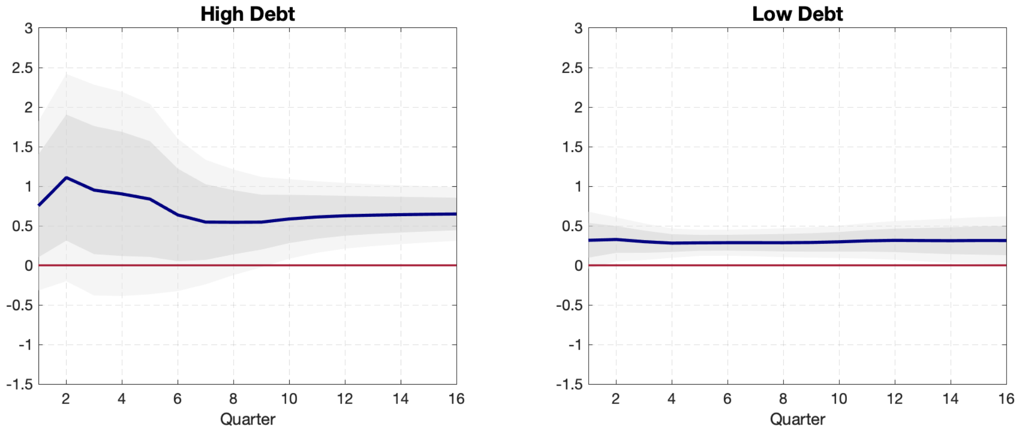

Fig. 1.5 State dependent: Output multiplier

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

1.4.3 The Role of Household Borrowing Conditions

It is very unlikely that periods of high household debt are able to characterize episodes where a larger share of households face a limited access to credit. In this section, I adopt a further disaggregation aimed at identifying periods when households face a tightening in borrowing conditions. To do so, I restrict episodes when household debt is above trend to periods of high unemployment slack. In fact, when households are highly indebted (higher debt repayment flows) during periods of high unemployment rates (lower labor income flows), a larger share of households will be subject to a tightening in borrowing constraints due to the reduction in their earning capacity when highly indebted. This analysis is motivated by the large body of literature showing that differences in household balance sheets influence the effects of fiscal policy. Specifically, households facing larger borrowing constraints have a more pronounced consumption response (e.g., Huntley and Michelangeli, 2014; Alpanda et al., 2021). The resulting four identified states are the following: *high debt-low unemployment*, *high debt-low unemployment*, *low debt-high unemployment*, *low debt-low unemployment*. First, periods of *high debt-high unemployment* are characterized by a reduced capacity to generate an income stream for households that, in turn, translates into a weaker capacity to repay their large amount of debt. Hence, in these periods, a larger share of households face tighter borrowing constraints. Second, periods of *low debt-high unemployment* could be seen as an economy with some constraints, due to low labor income inflows, but comparatively lower than the previous scenario, due to low debt levels. Third, periods of *high debt-low unemployment* are situations where households are highly indebted and a larger share do not deal with tight borrowing constraints, due to high labor income inflows. Consequently, they are able to access new credit. Lastly, *low debt-low unemployment* identifies periods where households have low debt levels and high labor income flows. Despite the effort in interpreting the four identified states, the focus of this paper is on the importance of borrowing constraints, hence on the *high debt-high unemployment* state, for the macroeconomic effects of government spending shocks.

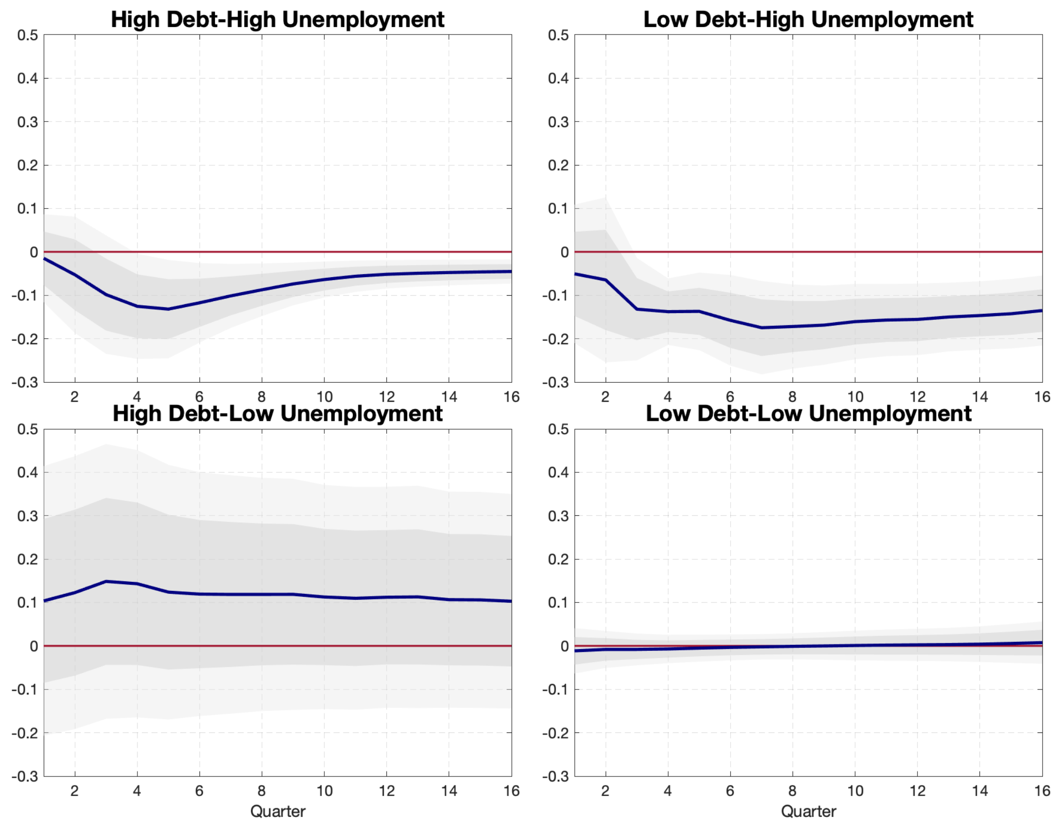

Fig. 1.6 State dependent: Household Debt per capita

Notes: Cumulative response of real household debt per capita from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

Before analyzing the impact on output, I verify the above interpretation by estimating the response of real household debt per capita. Intuitively, I would expect that states with higher (lower) household debt are more (less) likely to have additional credit creation, while states with lower (higher) unemployment slack are more (less) likely to have additional credit creation. Figure 1.6 plots the impulse responses in the four identified states. The results indicate that debt decreases in both states characterized by higher unemployment slack, as households have lower debt capacity (due to lower income flows). At first glance, the result for the *high debt-high unemployment* might seem counterintuitive, as I should have expected somehow a null response, as in the *low debt-low unemployment* state. However, the presence of tighter borrowing constraints does determine a contraction in credit creation. On the other hand, households accumulate additional credit in the *high debt-low unemployment* state, as they have strong income flows and, as expected, during periods of *low debt-low unemployment* households do not change their debt level. Overall, the impulse responses broadly confirm the interpretation given to the four identified states.

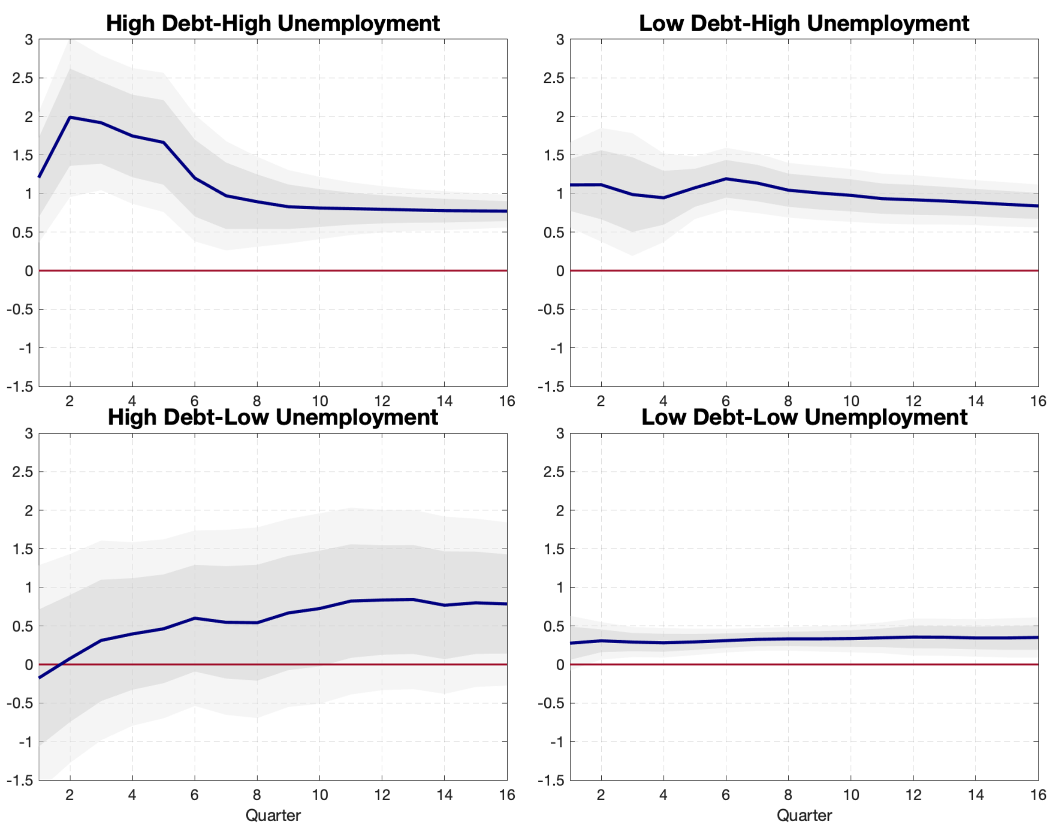

Fig. 1.7 State dependent: Cumulative output multiplier

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

Tables 1.H.3 to 1.H.6 report the estimated cumulative output multipliers for the four identified states, and Figure 1.7 plots the corresponding estimates. The impulse responses indicate that only when the economy is characterized by a larger share of households facing limited credit access, the multiplier is above unity, peaking at 2 after two quarters. On the contrary, when households have low debt levels and unemployment slack is low, multipliers are considerably small and stable at roughly 0.3. During periods of high unemployment slack and low debt levels, multipliers are relatively stable around 1. In comparison with the previous impulse response, the two states differ in the amount of labor market slack. In addition, Figure 1.I.13 in the Appendix shows that the spending multiplier is not statistically different between periods of high and low unemployment slack (see also Ramey and Zubairy, 2018). Hence, I should interpret the combination of *high debt-high unemployment* as driving the difference in output responses in the two states. This is consistent with the presence of borrowing constraints for a larger share of households, translating into a large marginal propensity to consume. Finally, the last impulse response (*high debt-low unemployment*) is of difficult interpretation. In this state, the output multiplier is increasing over time, but not statistically different from zero.[15]

1.4.4 Sensitivity Analysis

In this section, I explore the sensitivity of the findings by modifying the calibration for the state variable, and by changing the estimation sample. First of all, given that the results presented in the previous section are potentially sensitive to the specification choices made, which are not guided by theory, I explore the sensitivity of these findings using a higher threshold for periods of unemployment slack. I apply the alternative value of 6.5% as a threshold, as in Owyang et al. (2013) and Ramey and Zubairy (2018), based on Bernanke's announcement about policy at the time he served as chairman of the U.S. Federal Reserve.

Figure 1.8 plots the impulse responses for cumulative output multipliers in the four states and does not highlight significant differences with respect to the baseline results. Moreover, the findings hold when applying a lower or higher smoothing parameter for the HP filter: $\lambda = \{5{\times}10^5; 5{\times}10^6\}$ (see Figures 1.I.1 and 1.I.2 in Appendix 1.I).

The next exercises are aimed at changing the estimation sample by (i) omitting WWII, and (ii) limiting the sample to the beginning of the Great Recession. The first is based on the observations made by Gordon and Krenn (2010) and Ramey and Zubairy (2018). The authors find that while higher government spending boosted household incomes during WWII, households could not use these higher resources to purchase the goods they wanted due to the presence of price and credit controls and rationing. Thus, the

[15]The large uncertainty in estimates may be due to (i) the unprecise interpretation of these periods and (ii) the smaller sample size among the four states.

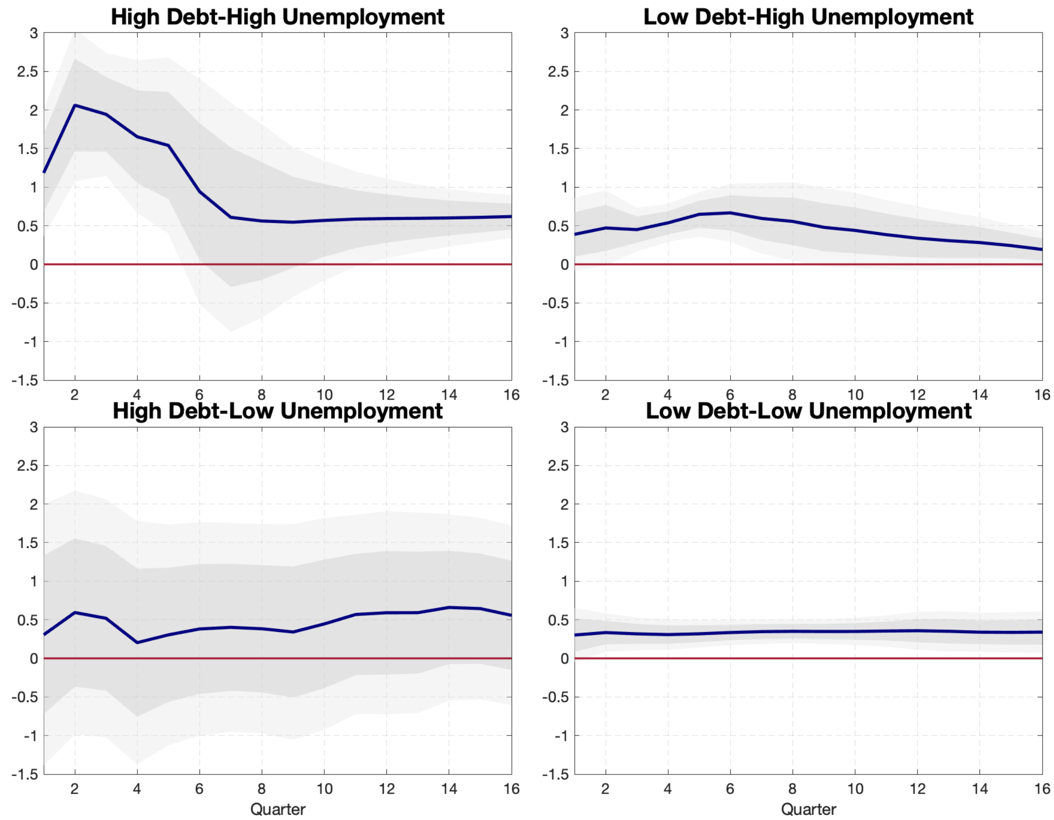

Fig. 1.8 State dependent: Cumulative output multiplier

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP, when the threshold for the unemployment slack is set to 6.5%. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

exclusion of these periods is motivated by the several restrictive policies implemented in the U.S. economy, such as rationing, capacity constraints, and production prohibitions.

The second exercise is motivated by the large deterioration in household balance sheets that occurred in the early 2000s, which led to a collapse in consumption and the resulting global recession. In removing this subsample, I aim at evaluating whether the findings are not driven by these events.

The reason for not including other subsamples, such as the post-WWII, is twofold. First, it is related to the point made by Hall et al. (2009): *"There is little hope to learn about the multipliers from any data after mid-1950s."* All of the existing evidence *"is limited in its ability to measure multipliers for the period from 1948 onward by the lack of variation in government purchases, especially in its most exogenous component, military purchases."* Thus,

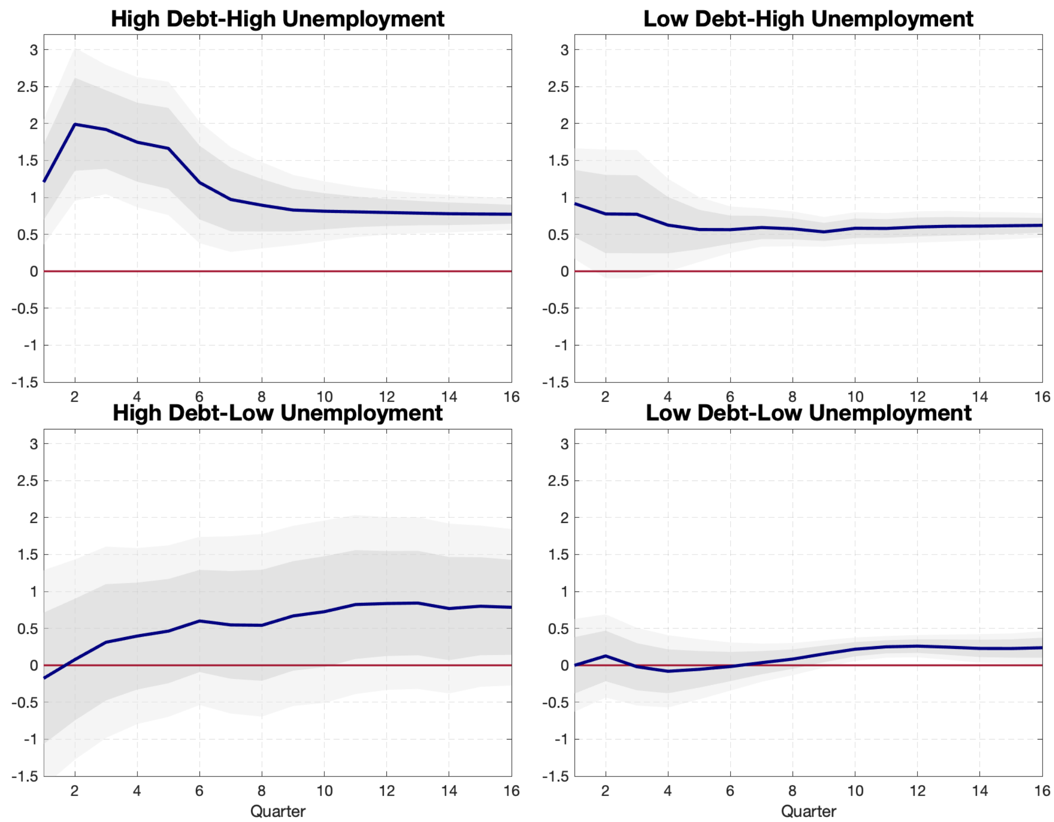

Fig. 1.9 State dependent: Cumulative output multiplier

Notes: Cumulative real output multipliers from a government spending increase to one percent of GDP when WWII (1941q3–1945q4) is excluded from the sample. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

in excluding periods of great variation in government spending, there is the risk that the subsample might not contain enough information to distinguish multipliers across states. Second, using a post-WWII sample would imply having very small samples for each of the four identified states.

Figures 1.9 and 1.10 present the results when WWII is removed from the full sample and when the sample ends before the Great Recession. The impulse responses broadly confirm the baseline results, indicating that the findings of this paper have general relevance and are not driven by WWII nor by the Great Recession.

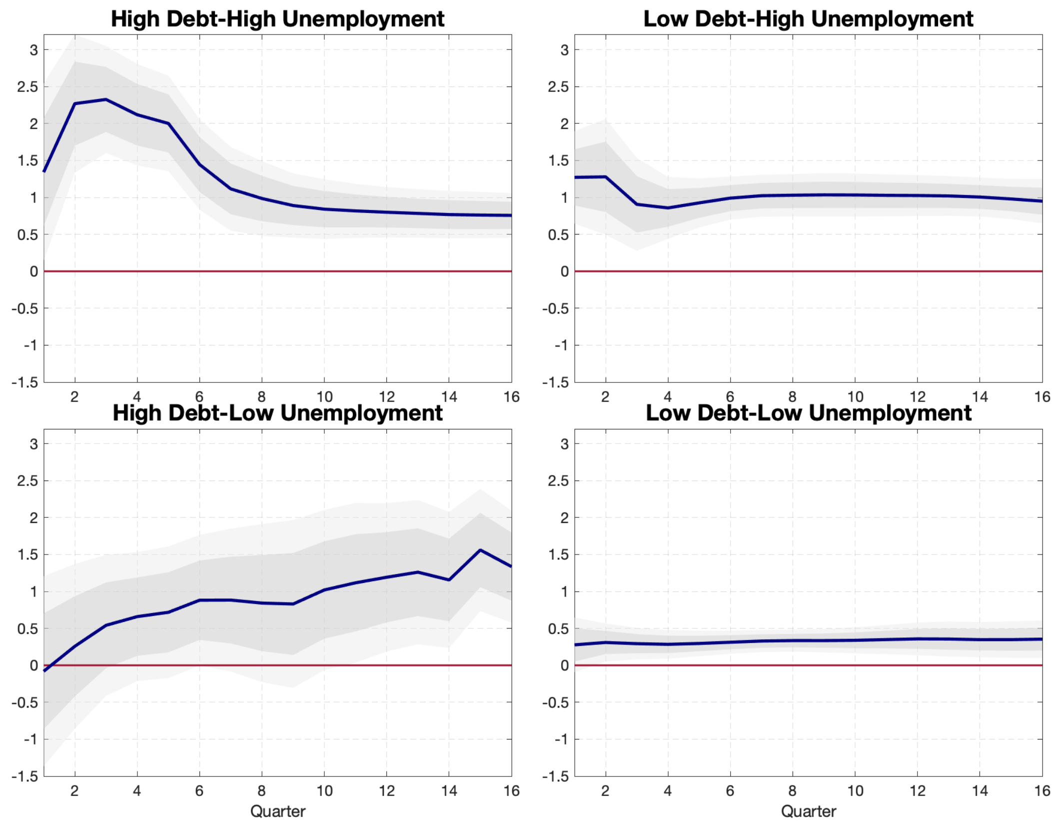

Fig. 1.10 State dependent: Cumulative output multiplier

Notes: Cumulative real output multipliers from a government spending increase to one percent of GDP when the sample ends before the Great Recession (end 2007). The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

1.4.5 GDP Components

Given the larger expansionary effects of government spending shocks in the *high debt-high unemployment* state, i.e., when the economy is characterized by a tightening in household borrowing conditions, from this section onwards I focus the analysis on this scenario.[16] Accordingly, the next set of impulse responses in Figure 1.11 plot the estimated cumulative multipliers for real consumption, investment, and net exports. The responses are all positive in the short-term, albeit of different sizes. The consumption response is highest at impact, with a cumulative multiplier of 0.83. Investment contributes in the first year, with a cumulative multiplier peaking at 0.48 in the second quarter following the shock.

[16] Results for all the four states are shown from Figure 1.I.3 to Figure 1.I.5 in Appendix 1.I.

Finally, net exports have a positive, albeit small, response, with a peak at the beginning of the second year (0.26).

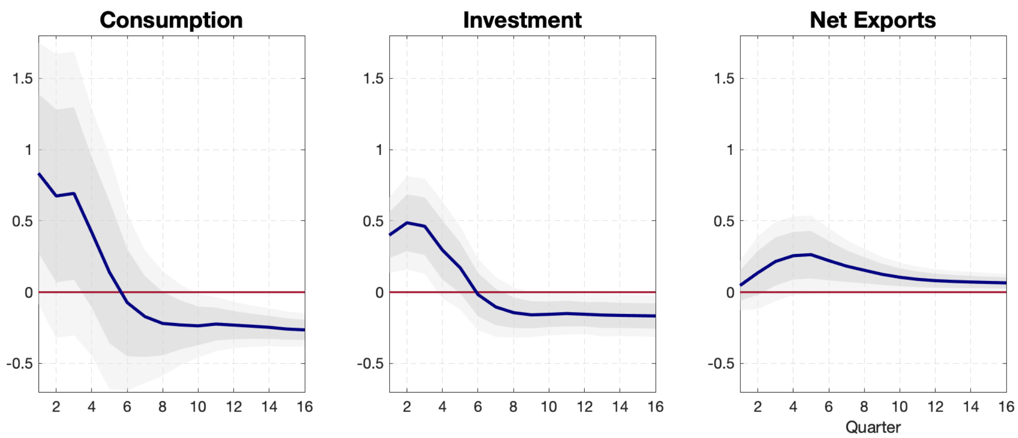

Fig. 1.11 State dependent: Cumulative multipliers

Notes: Cumulative real consumption, investment, and net exports multipliers from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

Similarly to the sensitivity analysis presented in Section 1.4.4, Figures 1.I.6 to 1.I.8 in the Appendix present the robustness checks for consumption, investment, and net exports in all four states when the threshold for the unemployment rate is set at a higher value (6.5%). The results confirm as well that the baseline findings are not sensitive to a stricter specification of the threshold value for episodes of unemployment slack.

1.4.6 Inspecting the Consumption Response

In the previous section, I show that the government spending multiplier is a function of household borrowing conditions. Specifically, I find that cumulative spending multipliers are above unity only when a large share of agents face tight borrowing constraints, and that private consumption is largely responsible for such results. In this section, I explore the relative contribution of personal consumption expenditure by estimating the response of durables, nondurables, and services. Figure 1.12 indicates that, following a government spending shock, households increase spending on non-durables and only marginally on durables, while they decrease spending on services. Note that households increase their spending on durables only when borrowing conditions are tighter and not in the other scenarios.[17] This response is coherent with the importance of financing avail-

[17] See Figures 1.I.9 and 1.I.10 in Appendix 1.I

ability when purchasing these goods (Gavazza and Lanteri, 2021). Overall, the findings presented in this section indicate that a government stimulus is significantly more effective in stimulating private activity when credit conditions are tighter, suggesting that these agents are responsible for aggregate macroeconomic effects.

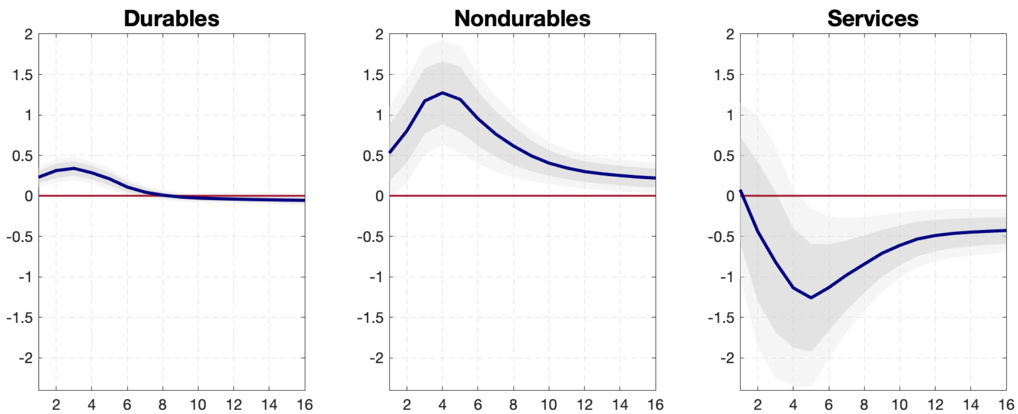

Fig. 1.12 State dependent: Cumulative multiplier

Notes: Cumulative real durable, nondurable, and services consumption multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

1.5 Potential Mechanisms

In this section, I explore potential channels of transmission for government spending shocks. To do that, I extend the model in (4) to include the effects of government spending shocks on additional relevant variables. Figure 1.13 shows the impulse responses for the following seven variables: the nominal interest rate, the inflation rate, the average marginal tax rate, the public debt-to-GDP ratio, a common indicator of labor market tightness, the unemployment rate, and the vacancy rate.[18]

The first impulse response in Figure 1.13 plots the response of the inflation rate to control for the debt-deflation amplification mechanism described by Fisher (1933).[19] The author argued that, starting from a situation of over-indebtedness, borrowers start engaging in a distress sale to raise money and repay part of their debt. As a result, they cause a contraction in the money supply, generating price level deflation, which in turn is known to increase indebtedness. However, the response of the inflation rate suggests that

[18]The indicator of labor market tightness is defined as the vacancy-unemployment ratio.
[19]The inflation rate is calculated as a YoY growth rate. Figure 1.I.12 shows that the results do not change once inflation is calculated as a MoM percentage change.

Fisher's deflation mechanism is not at work in this analysis. On the contrary, the large output response is accompanied by a 1% increase in the inflation rate.

The next response, i.e., the nominal interest rate, is motivated by the extensive number of studies that find larger fiscal multipliers when monetary policy is less activist (e.g., Nakamura and Steinsson, 2014; Leeper et al., 2017; Cloyne et al., 2020b).[20] The estimates suggest that following a government spending shock, the monetary authority does not react to the higher inflation rate, remaining passive. Hence, according to the literature that investigates interactions between fiscal-monetary policy, this should entail larger spending multipliers.

Next, the responses of the tax rate and of public debt, i.e., the financing decision for the government, are very important as multipliers crucially depend on whether the spending intervention is financed by issuing more debt or raising taxes (Baxter and King, 1993). The response of the average marginal income tax rate suggests that during a situation of higher financing frictions in the credit market, the increase in government spending is deficit-financed. However, this response may hide important dynamics as the marginal tax rate may be raised for top incomes and lowered for the bottom. In other words, the distribution of the fiscal burden consequent to the fiscal stimulus might not be homogenous across income groups. This mechanism would be in line with the evidence provided by Ferriere and Navarro (2018), where the authors find that government spending multipliers are larger when financed with more progressive taxes, that is, when the tax burden affects more heavily those at the top of the income distribution. Although it is tempting to explore this mechanism, it is not possible due to limited historical data on the marginal tax rate for different income groups.

The last three impulse responses include key labor market variables. First, I analyze a common indicator for the level of tightness in the labor market. Then, I focus on the components of this index, i.e., the unemployment and vacancy rates. The estimates indicate that increases in government purchases have a positive effect on labor demand, as signaled by a tighter labor market. Specifically, the government intervention is able to stimulate firms to open more vacancies, and to reduce the unemployment rate. This result is consistent with Blanchard and Diamond (1989), who find a negative co-movement between the vacancy rate and the unemployment rate following a positive aggregate demand shock. It should be noted that when the economy is characterized by tighter credit conditions, the positive response of the vacancy rate happens in concomitance with the peak response in the investment multiplier, suggesting an overall positive reaction of the

[20]Other contributions are: Canova and Pappa (2011); Christiano et al. (2011); Woodford (2011); Davig and Leeper (2011); Zubairy (2014).

productive sector. In sum, these findings show that an increase in government purchases raises income through its positive effect on labor demand, which can explain the large consumption response.

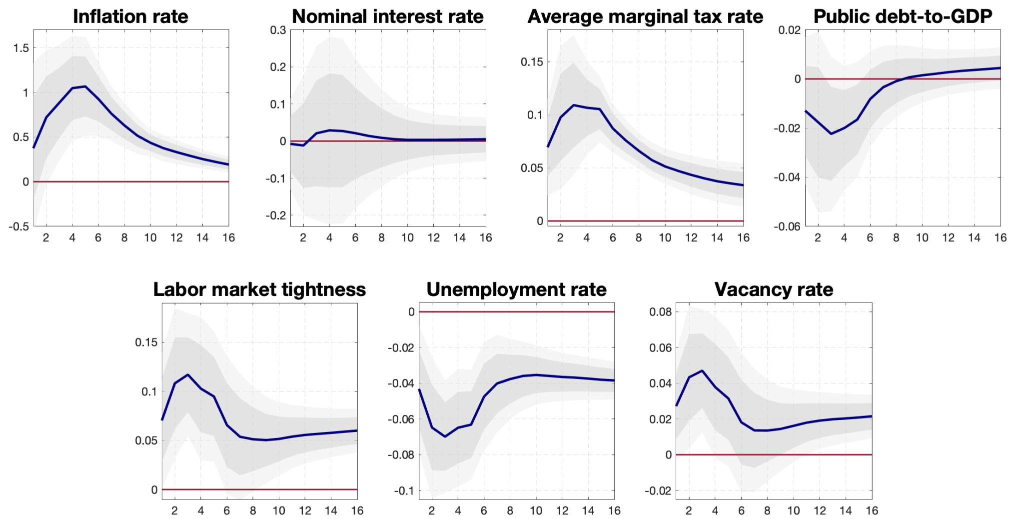

Fig. 1.13 State dependent: Potential mechanisms

Notes: Cumulative responses from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent the 90% confidence interval, based on heteroskedastic and autocorrelation (HAC) consistent standard errors.

1.6 Conclusion

The objective of this paper is twofold. First, to identify periods with different borrowing conditions, focusing on episodes characterized by tighter constraints. Second, to investigate whether the government spending multiplier is a function of different household borrowing conditions. The findings show that spending shocks are above unity only when the economy is characterized by a larger share of households facing tighter borrowing conditions. The analysis of the transmission mechanism suggests that the government intervention can stimulate labor income by making the labor market tighter. This, in turn, translates into a large response of consumption spending, mostly concentrated on nondurable goods. In addition, following a government spending shock, I find a less activist monetary policy, suggesting larger spending multipliers. Overall, the extensive robustness checks indicate that the results are not sensitive to variations in the baseline specification.

What should we take out of all this? The general lesson to be drawn from this paper is that the fiscal authority should take into account household borrowing conditions when planning a spending stimulus. Indeed, when the economy is characterized by a larger share of households facing tighter borrowing conditions, the effects of a government spending intervention are more expansionary.

Appendix to Chapter 1

1.G Data Appendix

In this Appendix, I provide a detailed list of all the macroeconomic variables used in the paper. To collect the data for the historical sample, I relied on a number of different sources. Table 1.G.1 provides information on the coverage, data source with identifiers.

Variable	Sample	Identifier	Source
Government spending	1919q4–2015q4	/	Ramey and Zubairy (2018)
Gross Domestic Product	1919q4–2015q4	/	Ramey and Zubairy (2018)
GDP price deflator	1919q4–2015q4	PGDP	Ramey and Zubairy (2018)
Unemployment rate	1919q4–2020q4	UNRATE	Ramey and Zubairy (2018) + FRED
Nonperforming Loans	1984q4–2020q4	USNPTL	FRED
Private consumption	1919q4–1946q4 1947q4–2015q4	(CD+CND+CS)× PGDP PCDG+PCND+PCESV	Gordon and Krenn (2010) FRED
Private investment	1919q4–1946q4 1947q4–2015q4	(IPDE+IRES+INRES)× PGDP PRFI+PNFI	Gordon and Krenn (2010) FRED
Private debt-to-GDP	1919q4–1951q4 1952q4–2015q4	(Cj875-Cj887)/Ca10 (TODNS-SLGSDODNS-FGSDODNS)/GDP	Carter et al. (2006) FRED
Total Private debt-to-GDP	1919q4–1951q4 1952q4–2015q4	Cj875/Ca10 (TODNS+DODFS-SLGSDODNS-FGSDODNS)/GDP	Carter et al. (2006) FRED
Household debt-to-GDP	1919q4–1951q4 1952q4–2015q4	Cj879/Ca10 CMDEBT/GDP	Carter et al. (2006) FRED
Nominal interest rate	1919q4–1946q4 1947q4–1955q4 1956q4–2015q4	R M13009USM156NNBR FF	Gordon and Krenn (2010) FRED FRED
Average marginal tax rate	1919q4–1949q4	Federal individual income tax	Barro and Redlick (2011)
	1950q4–2015q4	AMIITR (All tax units)	Mertens and Montiel Olea (2018)
Vacancy rate	1919q4–2015q4	VCR	Petrosky-Nadeau and Zhang (2021)
Labor Market Tightness	1919q4–2015q4	VCR/UNEMP	–

Table 1.G.1 Data description, coverage, and sources

Notes: Data related to different sources are stacked them on top of the other, after checking for consistency. Annual data on marginal income tax rates are assumed to do not change within the year, and after 2012 – the results are not sensitive to this modification.

1.H Tables

In this Appendix, Tables 1.H.1 to 1.H.6 report the estimated cofficients for the linear model in (2), the state-dependent model in (4) with $i = \{High, Low\}$ for high versus low debt, and the model in (4) with $i = \{HH, LH, HL, LL\}$ when differentiating between different household borrowing conditions.

Quarter	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$
β_h	0.555*	0.580**	0.546**	0.532**	0.548**	0.546***	0.541***	0.547***
	(0.244)	(0.206)	(0.188)	(0.177)	(0.170)	(0.162)	(0.159)	(0.161)
Observ.	378	377	376	375	374	373	372	371
Quarter	$h=9$	$h=10$	$h=11$	$h=12$	$h=13$	$h=14$	$h=15$	$h=16$
β_h	0.551***	0.558***	0.563***	0.564***	0.561**	0.559**	0.558**	0.550**
	(0.162)	(0.162)	(0.163)	(0.166)	(0.172)	(0.179)	(0.187)	(0.194)
Observ.	370	369	368	367	366	365	364	363

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors in parentheses.

Table 1.H.1 Cumulative output multipliers: Linear model

Quarter	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$
β_h^{High}	0.752	1.109	0.951	0.902	0.838	0.637	0.547	0.544
	(0.649)	(0.795)	(0.809)	(0.783)	(0.731)	(0.584)	(0.477)	(0.405)
Observ.	179	179	179	179	179	179	179	179
β_h^{Low}	0.317	0.327	0.299*	0.281*	0.285**	0.287**	0.287**	0.286**
	(0.219)	(0.169)	(0.140)	(0.112)	(0.0997)	(0.0993)	(0.104)	(0.110)
Observ.	199	198	197	196	195	194	193	192
Quarter	$h=9$	$h=10$	$h=11$	$h=12$	$h=13$	$h=14$	$h=15$	$h=16$
β_h^{High}	0.546	0.586	0.611*	0.627*	0.634**	0.640**	0.645**	0.649**
	(0.346)	(0.305)	(0.274)	(0.252)	(0.237)	(0.225)	(0.215)	(0.205)
Observ.	179	179	179	179	179	179	179	179
β_h^{Low}	0.289*	0.297*	0.310*	0.316*	0.313*	0.312	0.314	0.314
	(0.116)	(0.124)	(0.136)	(0.148)	(0.159)	(0.169)	(0.179)	(0.185)
Observ.	191	190	189	188	187	186	185	184

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors in parentheses.

Table 1.H.2 Cumulative output multipliers: High versus Low Debt

Quarter	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$
β_h^{HH}	1.207*	1.990**	1.918***	1.747**	1.663**	1.201*	0.971*	0.894*
	(0.514)	(0.630)	(0.531)	(0.534)	(0.548)	(0.498)	(0.430)	(0.354)
Observ.	96	96	96	96	96	96	96	96
Quarter	$h=9$	$h=10$	$h=11$	$h=12$	$h=13$	$h=14$	$h=15$	$h=16$
β_h^{HH}	0.829**	0.813***	0.804***	0.796***	0.787**	0.779**	0.775**	0.772**
	(0.288)	(0.245)	(0.207)	(0.182)	(0.165)	(0.153)	(0.141)	(0.128)
Observ.	96	96	96	96	96	96	96	96

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors in parentheses.

Table 1.H.3 Cumulative output multipliers: High Debt-High Unemployment

Quarter	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$
β_h^{LH}	1.112***	1.114*	0.987*	0.945**	1.075***	1.191***	1.136***	1.043***
	(0.337)	(0.447)	(0.483)	(0.349)	(0.246)	(0.244)	(0.236)	(0.215)
Observ.	94	94	94	94	93	92	91	90
Quarter	$h=9$	$h=10$	$h=11$	$h=12$	$h=13$	$h=14$	$h=15$	$h=16$
β_h^{LH}	1.006***	0.977***	0.934***	0.919***	0.903***	0.882***	0.859***	0.840***
	(0.213)	(0.208)	(0.196)	(0.193)	(0.184)	(0.177)	(0.174)	(0.169)
Observ.	89	88	87	86	85	84	83	82

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors in parentheses.

Table 1.H.4 Cumulative output multipliers: Low Debt-High Unemployment

Quarter	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$
β_h^{HL}	-0.176	0.0772	0.312	0.396	0.463	0.600	0.547	0.542
	(0.888)	(0.823)	(0.786)	(0.723)	(0.705)	(0.691)	(0.729)	(0.751)
Observ.	83	83	83	83	83	83	83	83
Quarter	$h=9$	$h=10$	$h=11$	$h=12$	$h=13$	$h=14$	$h=15$	$h=16$
β_h^{HL}	0.669	0.726	0.823	0.836	0.843	0.768	0.800	0.785
	(0.740)	(0.750)	(0.736)	(0.710)	(0.706)	(0.698)	(0.663)	(0.643)
Observ.	83	83	83	83	83	83	83	83

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors in parentheses.

Table 1.H.5 Cumulative output multipliers: High Debt-Low Unemployment

Quarter	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 5$	$h = 6$	$h = 7$	$h = 8$
β_h^{LL}	0.277	0.307*	0.291*	0.282*	0.293**	0.310***	0.326***	0.332***
	(0.215)	(0.147)	(0.118)	(0.116)	(0.103)	(0.0932)	(0.0895)	(0.0922)
Observ.	105	104	103	102	102	102	102	102

Quarter	$h = 9$	$h = 10$	$h = 11$	$h = 12$	$h = 13$	$h = 14$	$h = 15$	$h = 16$
β_h^{LL}	0.332***	0.336**	0.346**	0.356*	0.353*	0.344*	0.344*	0.351*
	(0.0992)	(0.108)	(0.121)	(0.146)	(0.145)	(0.147)	(0.154)	(0.158)
Observ.	102	102	102	102	102	102	102	102

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, standard errors in parentheses.

Table 1.H.6 Cumulative output multipliers: Low Debt-Low Unemployment

1.I Additional Figures

In this appendix, I include a series of additional robustness checks. Figures 1.I.1 and 1.I.2 plot the impulse responses when changing the smoothing parameter for the HP filter described in Section 1.2 to, respectively, a lower ($\lambda = 5{\times}10^5$) and a higher ($\lambda = 5{\times}10^6$) value. All the responses turn out to be very similar to those obtained in the baseline model, with the spending multiplier peaking at roughly 2 in the *high debt-high unemployment* state.

Figures 1.I.3 to 1.I.5 plot the cumulative multipliers for private real consumption, investments, and net exports, for all the four identified states of the economy. The responses of consumption highlight that only when there are some degrees of borrowing constraints in the economy, households increase their consumption following a government spending shock. Conversely, investments increase only when the economy is characterized by tighter credit conditions, with a large negative response in the *low debt-high unemployment* state. Lastly, net exports respond positively, albeit with a small magnitude, only in the *high debt-high unemployment* scenario.

Figures 1.I.6 to 1.I.11 plot the cumulative multipliers for private real consumption, investments, net exports, and for consumption components (durables, nondurables, and services) in the four scenarios, when the threshold value for periods of unemployment slack is set to a higher value (6.5%). These results are virtually consistent with the baseline findings. Lastly, Figure 1.I.12 shows that the response of inflation, using the Month-over-Month (MoM) growth rate, is in line with the baseline YoY growth rate.

To make sure that the results are not driven by periods of unemployment slack alone, I report the spending multiplier in periods of high and low unemployment slack. In accordance with Ramey and Zubairy (2018), Figure 1.I.13 shows that multipliers in the two states are small and below unity. Hence, periods of high unemployment slack alone are not able to explain the baseline state-dependent findings of this paper.

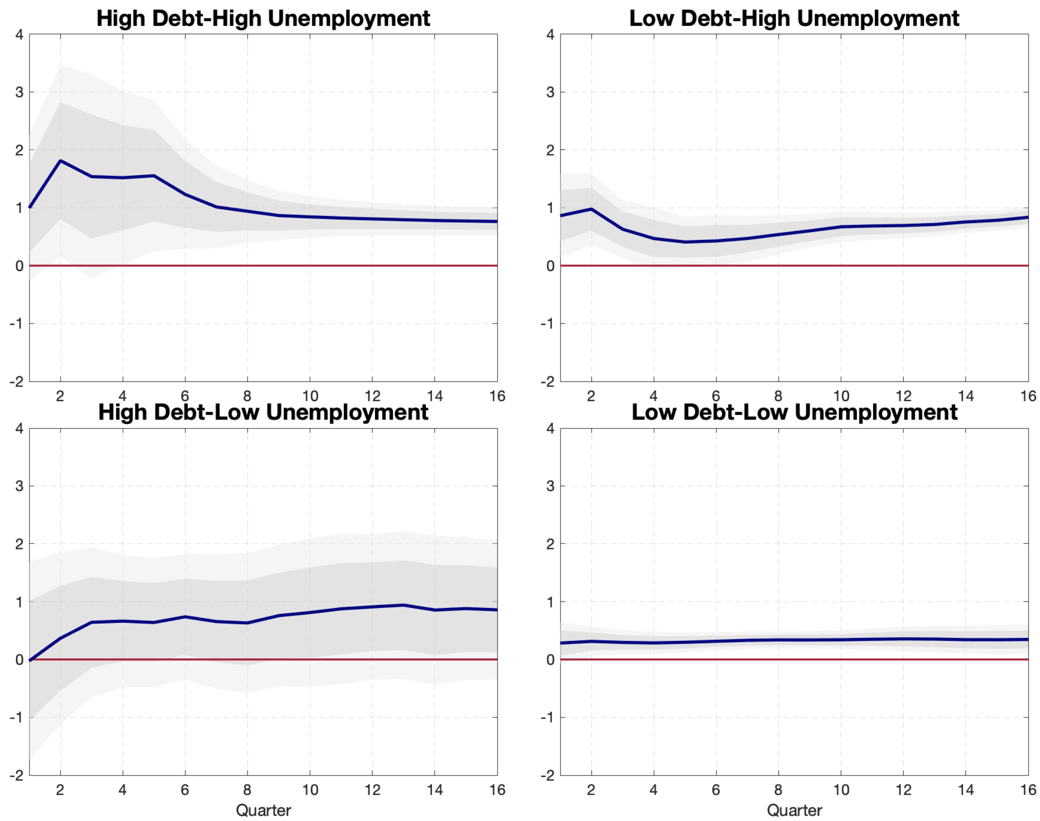

Fig. 1.I.1 State dependent: Cumulative output multiplier

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP, when the smoothing parameter for the HP filter is set to a lower value ($\lambda = 5{\times}10^5$). The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

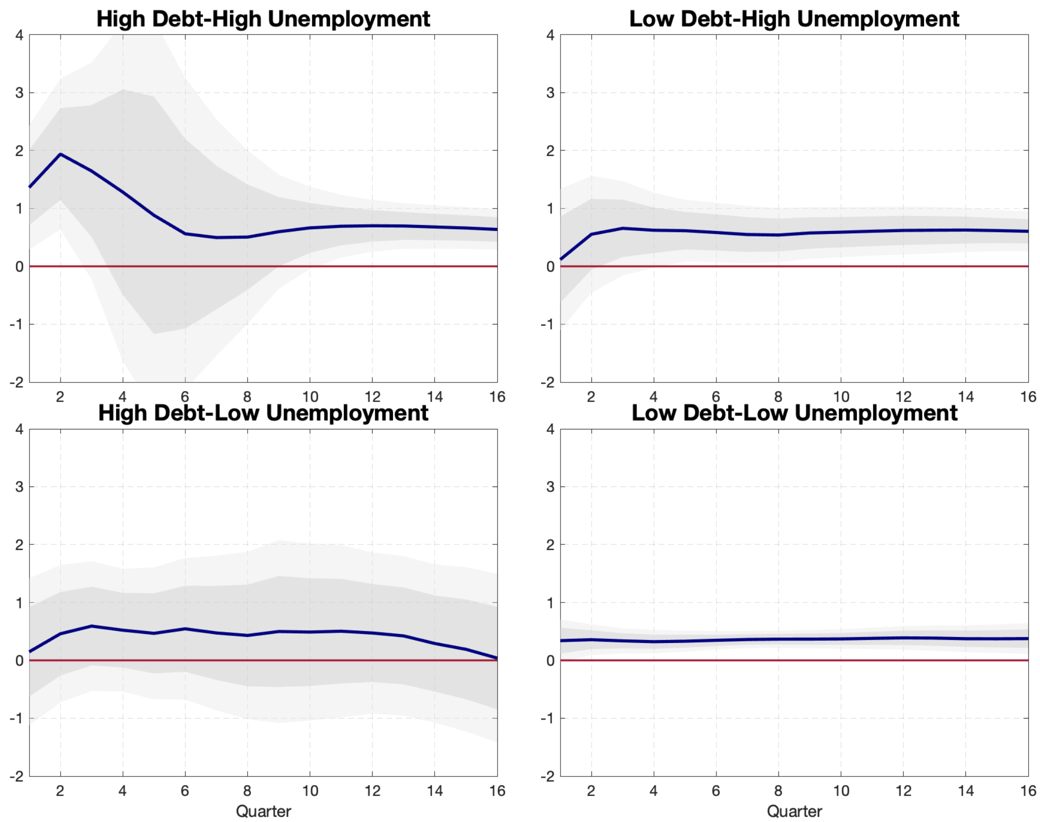

Fig. 1.I.2 State dependent: Cumulative output multiplier

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP, when the smoothing parameter for the HP filter is set to a higher value ($\lambda = 5{\times}10^6$). The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

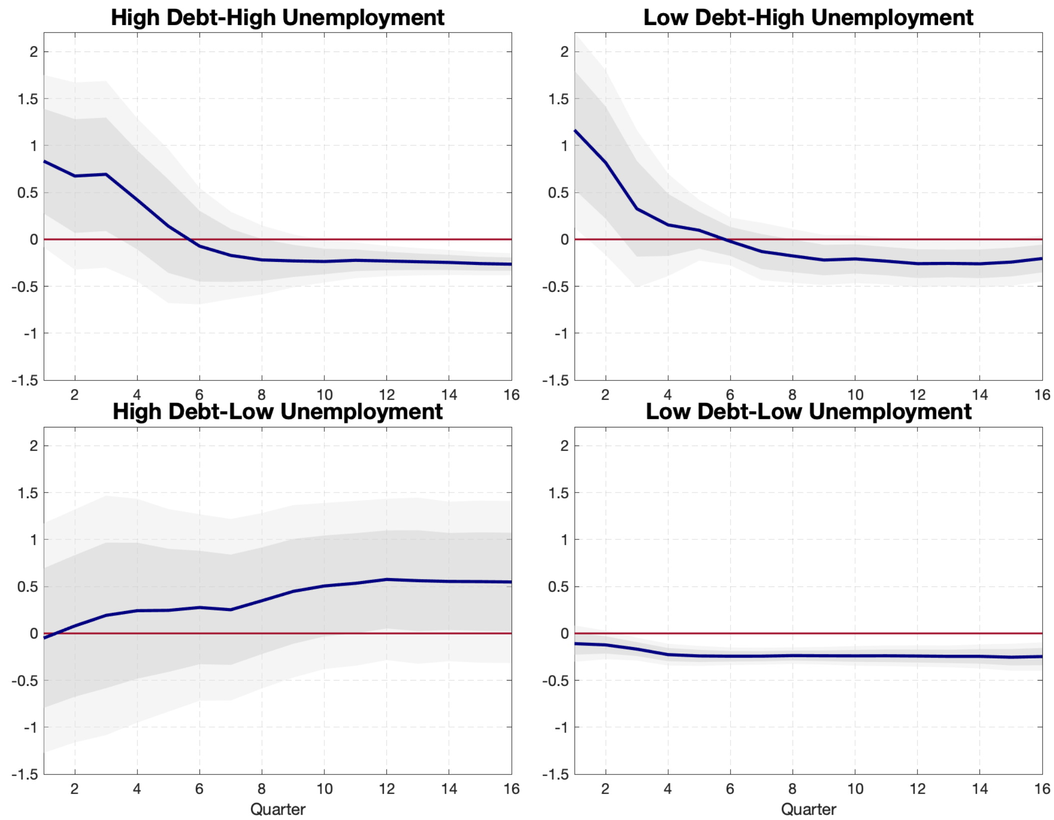

Fig. 1.I.3 State dependent: Cumulative consumption multiplier

Notes: Cumulative real consumption multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

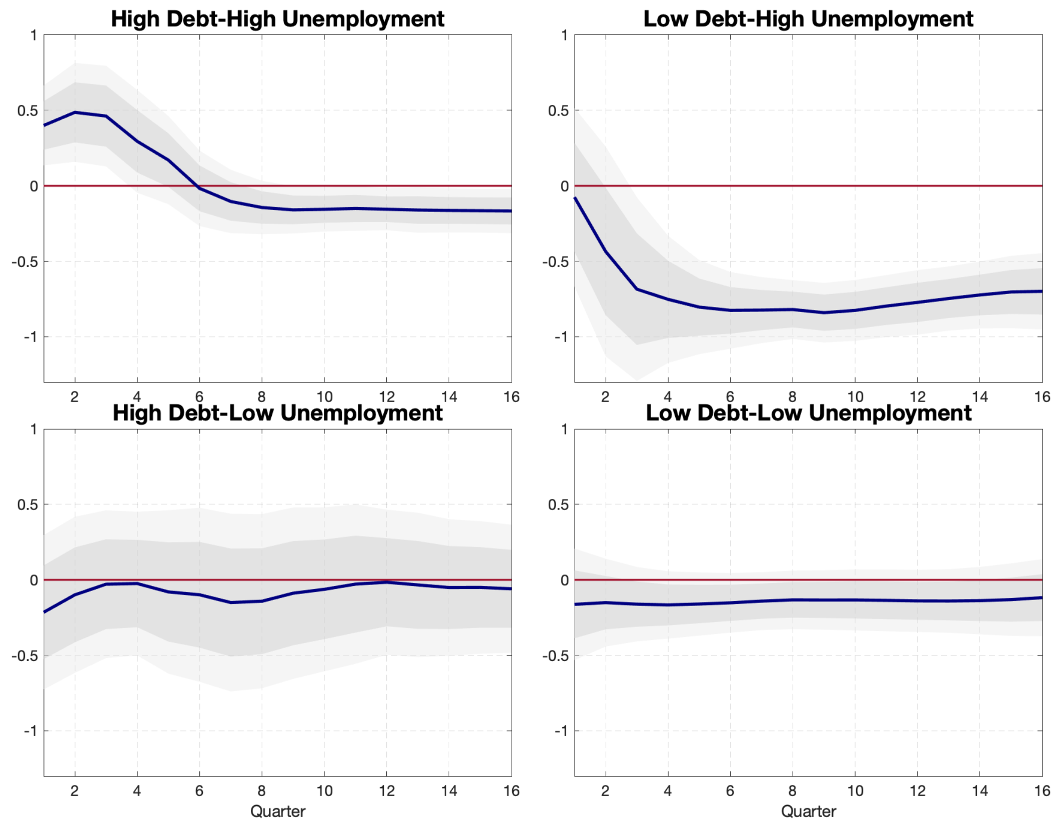

Fig. 1.I.4 State dependent: Cumulative investment multiplier

Notes: Cumulative real investment multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

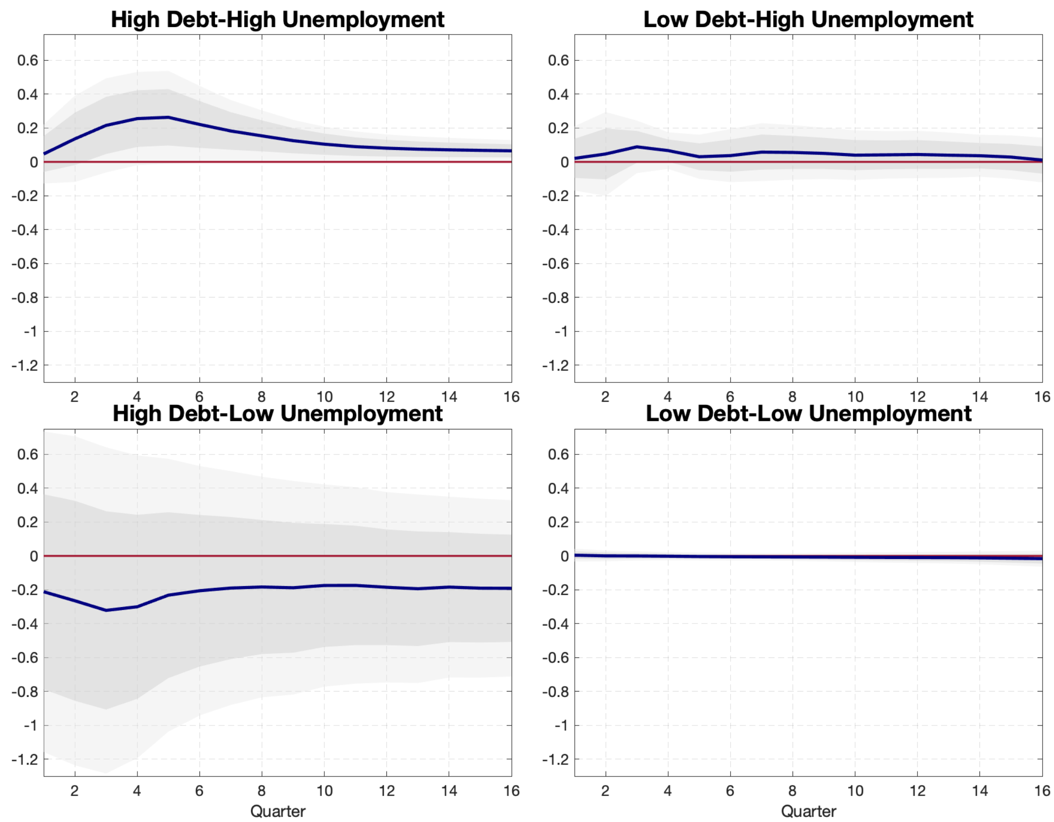

Fig. 1.I.5 State dependent: Net export multiplier

Notes: Cumulative real net export multipliers from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

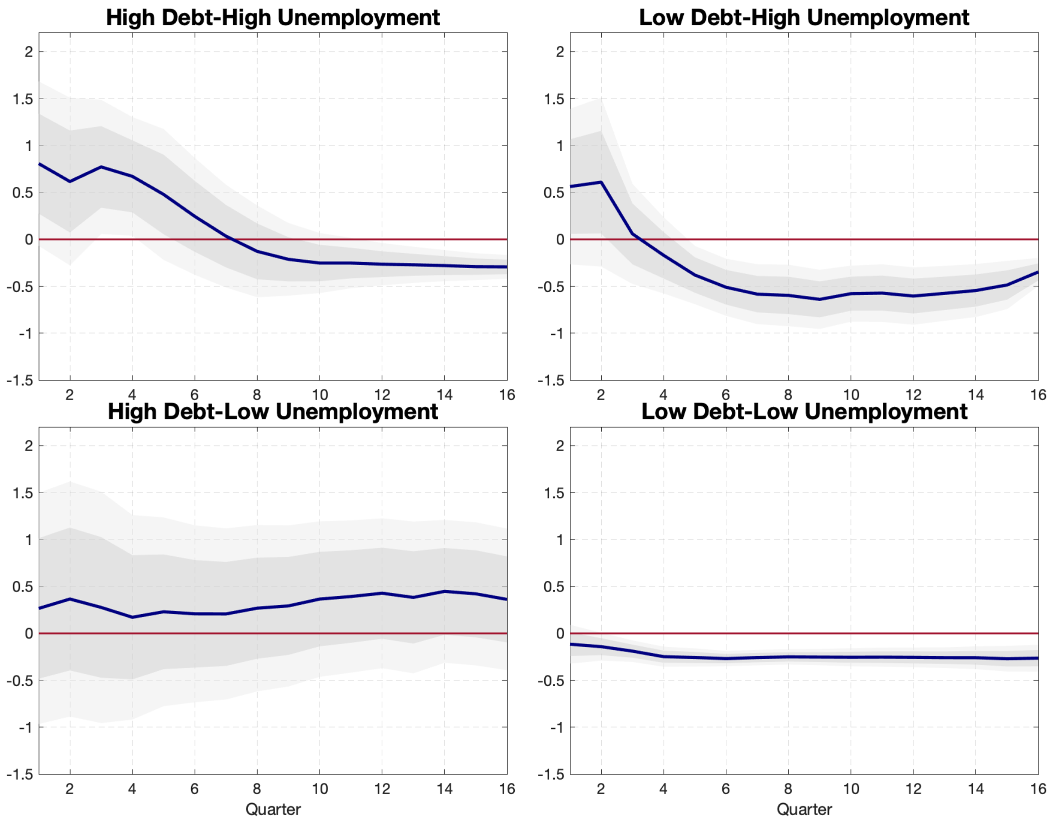

Fig. 1.I.6 State dependent: Cumulative consumption multiplier

Notes: Cumulative real consumption multiplier from a government spending increase to one percent of GDP, when the threshold for the unemployment slack is set to 6.5%. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

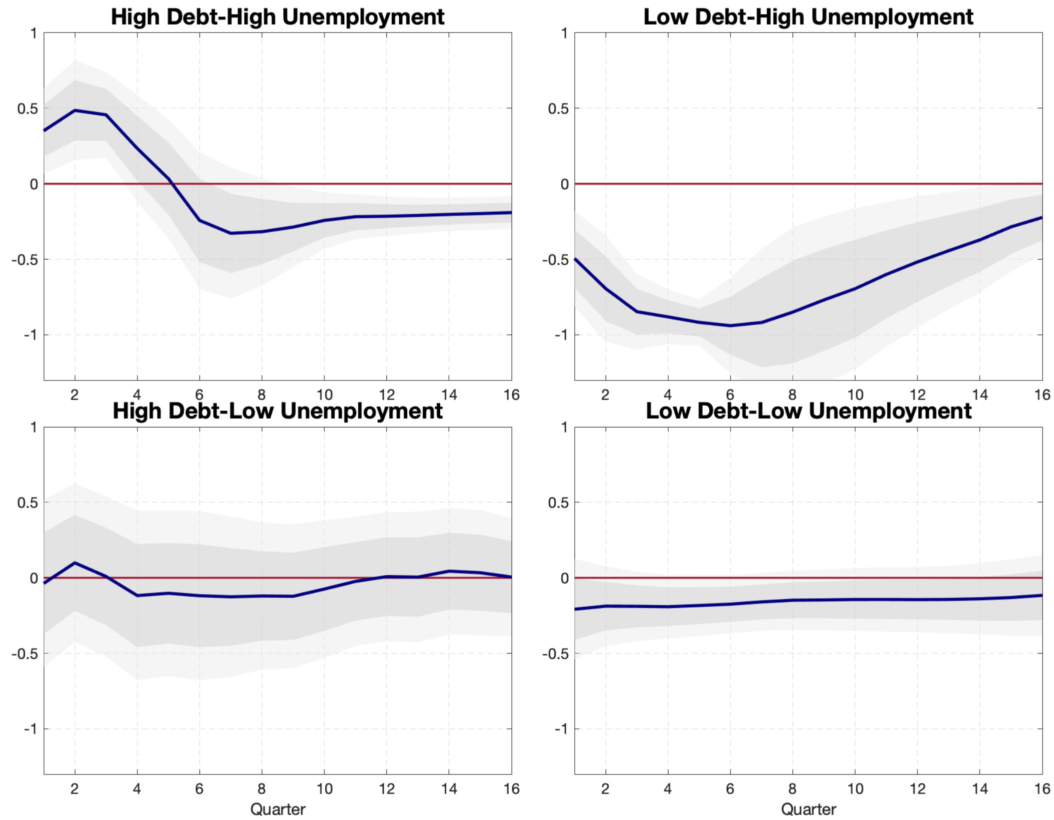

Fig. 1.I.7 State dependent: Cumulative investment multiplier

Notes: Cumulative real investment multiplier from a government spending increase to one percent of GDP, when the threshold for the unemployment slack is set to 6.5%. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

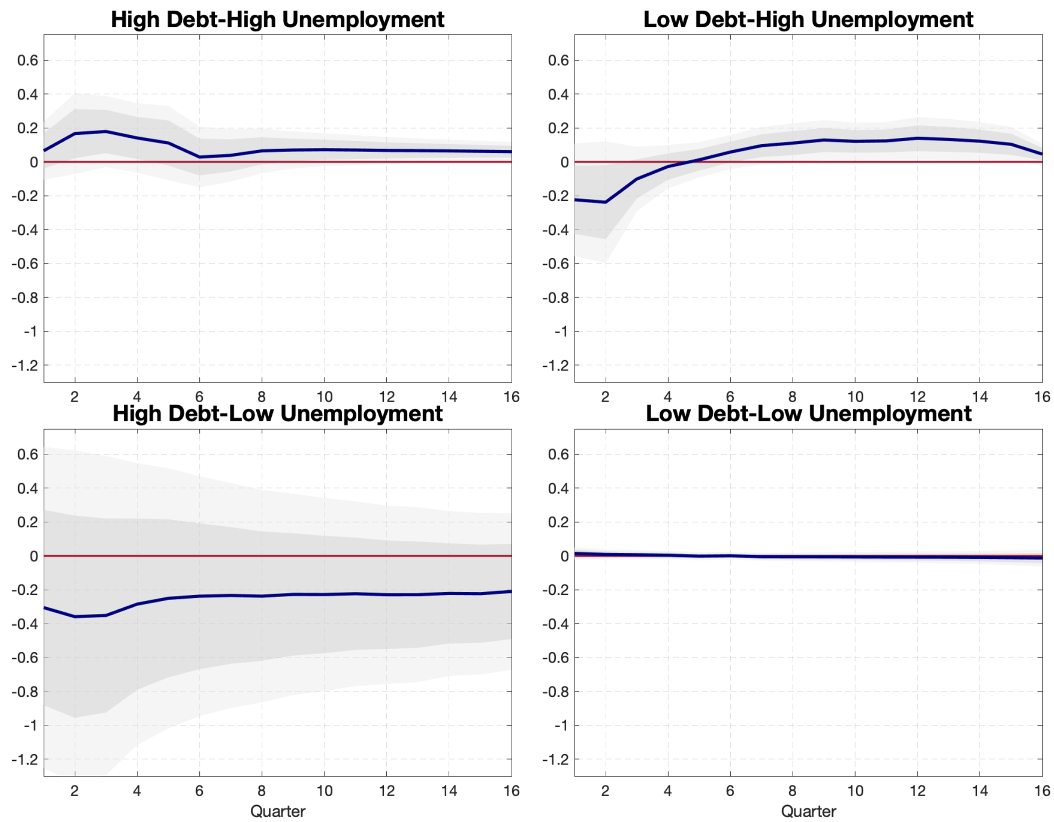

Fig. 1.I.8 State dependent: Cumulative net export multiplier

Notes: Cumulative real net export multiplier from a government spending increase to one percent of GDP, when the threshold for the unemployment slack is set to 6.5%. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

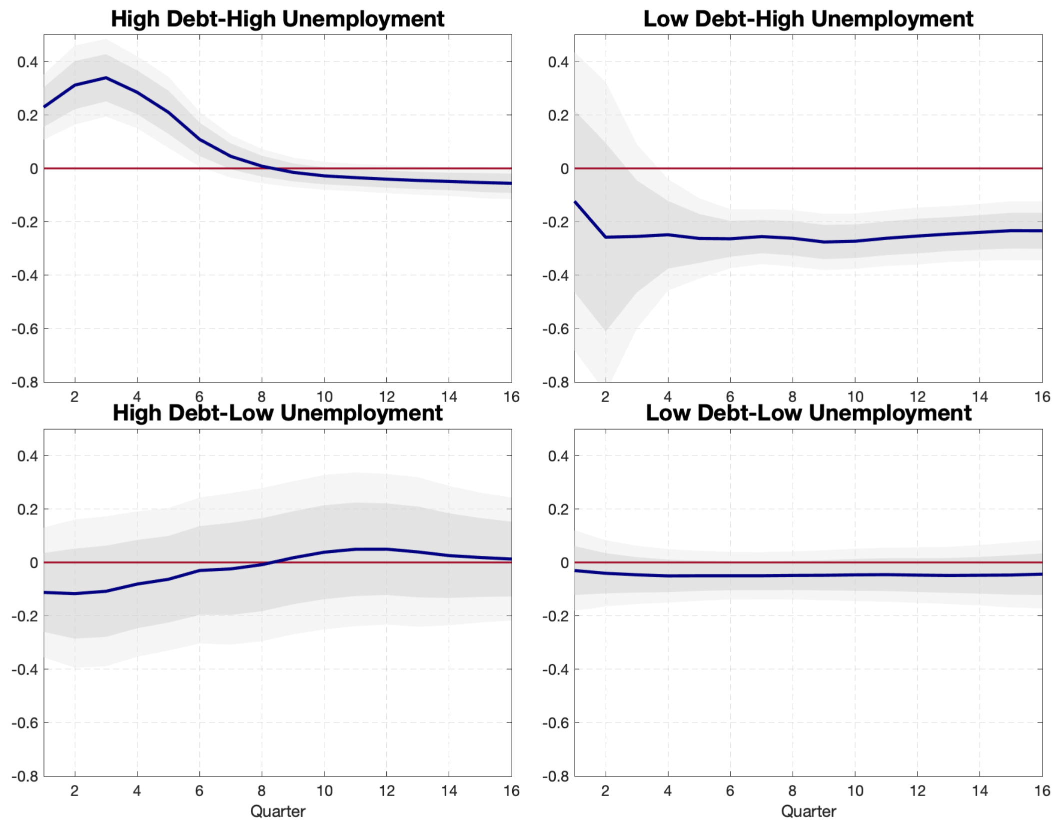

Fig. 1.I.9 State dependent: Cumulative durable consumption multiplier

Notes: Cumulative real durable consumption multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

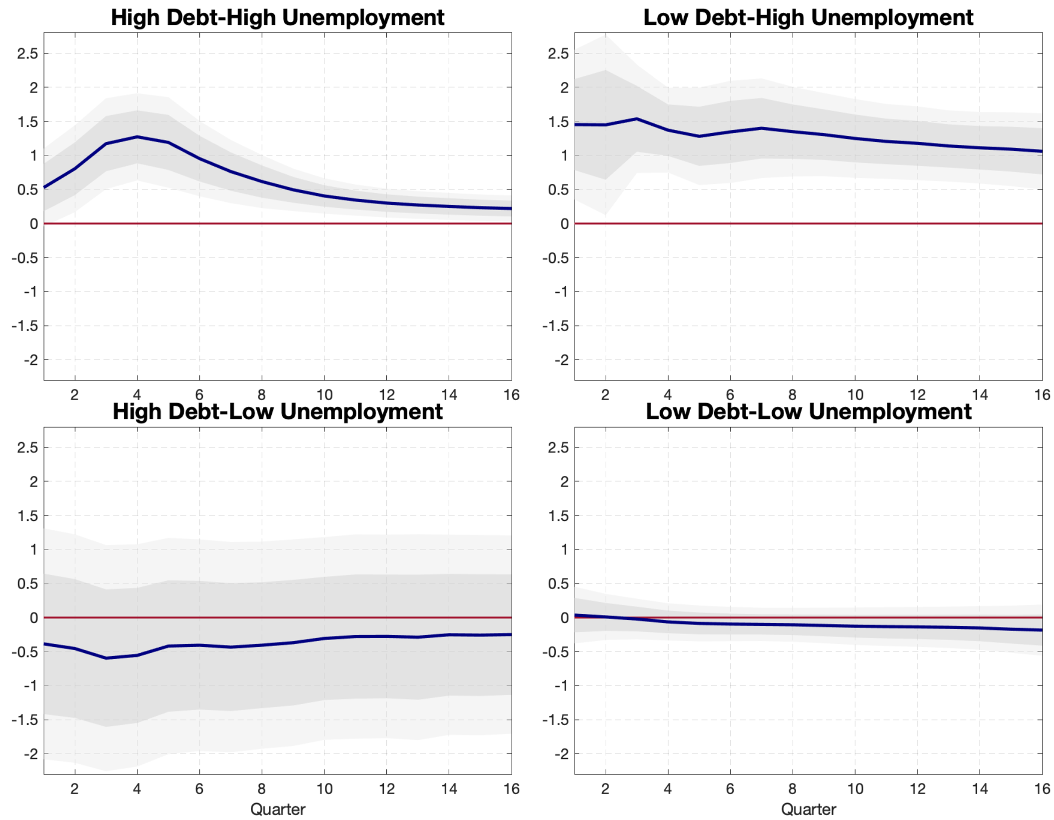

Fig. 1.I.10 State dependent: Cumulative non consumption multiplier

Notes: Cumulative real nondurable consumption multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

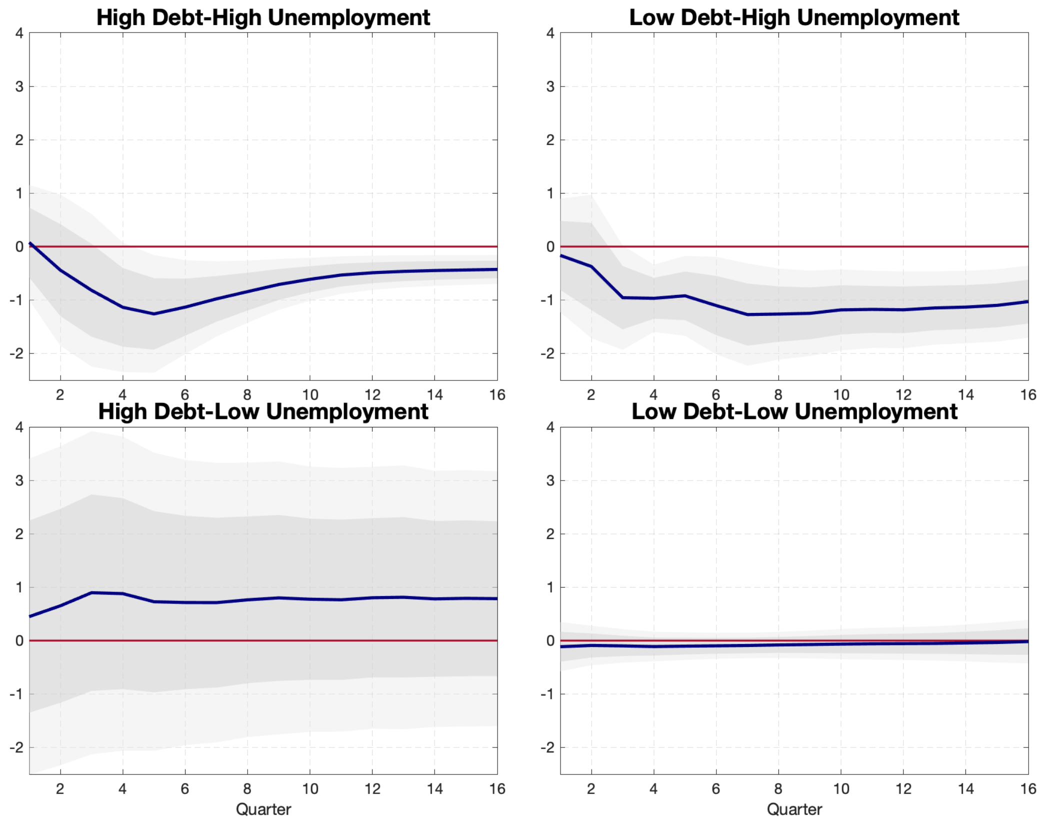

Fig. 1.I.11 State dependent: Cumulative services consumption multiplier

Notes: Cumulative real services consumption multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

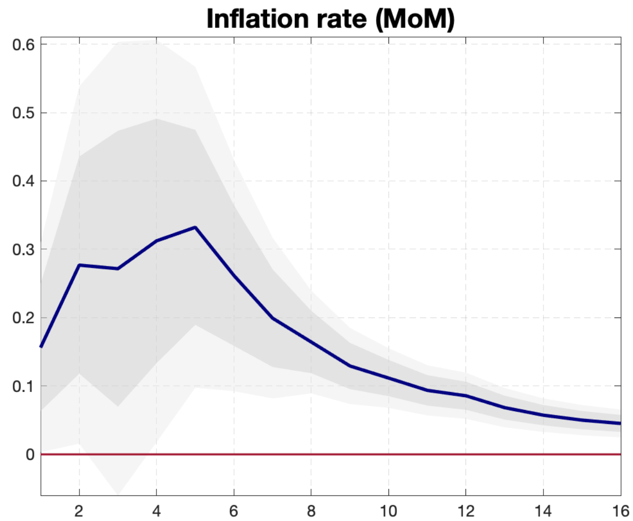

Fig. 1.I.12 State dependent: Inflation reponse

Notes: State-dependent response of the inflation rate (MoM) from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

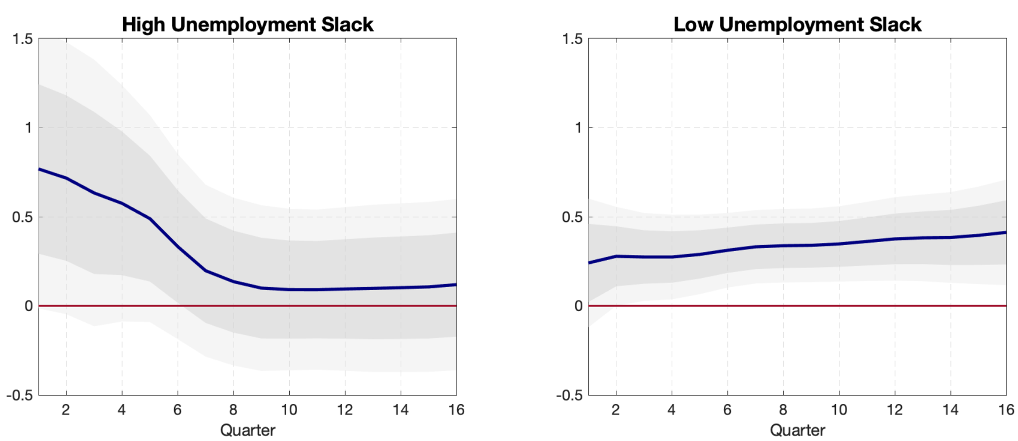

Fig. 1.I.13 State dependent: Cumulative output multiplier (Unemployment slack)

Notes: Cumulative output multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

1.J Model specification and shock identification

In this section I perform a number of sensitivity checks concerning an alternative specification for the econometric model, and different identification schemes for government spending.

1.J.1 Model specification: one-step IV method

The first check concerns the model specification. I follow the one-step IV methodology introduced by Ramey and Zubairy (2018), that differs to the model presented in Section 1.3.3 only for the second-stage. In fact, the one-step IV include the same covariates in the first- and second-stage of the estimation. As a result, the instrument relevance is the same as for the baseline model (see Figure 1.3). Formally, the one-step equation is given by:

$$\sum_{j=1}^{h} y_{t+j} = \gamma_h^i + m_h^i \sum_{j=0}^{h} g_{t+j} + \Psi_h^i(L) Z_{t-1} + v_{t+h} \tag{5}$$

where $m_{i,h}$ ($h = 1, 2, ..., 16$) gives the cumulative response of the dependent variable at time $t + h$ to the shock occurring at time t, according to the state of the economy $i = \{HH, HL, LH, LL\}$. To construct impulse responses for each of the cumulative dependent variables $\sum_{j=1}^{h} y_{t+j}$ I use the sequence of the estimated $m_{i,h}$ for each horizon h and the state of the economy i. The sum of the government spending variable from t to $t + h$, $\sum_{j=1}^{h} g_{t+j}$, is instrumented using the two shocks, RZ and BP. The polynomial in the lag operator, $\Psi(L)$, is of order 4, and Z_{t-1} is a set of controls, which include lags of GDP, government spending, taxes, and the narrative shock. This is equivalent to the identification strategy proposed by Blanchard and Perotti (2002). Figure 1.J.1 plots the impulse responses in the four identified states. The results turn out to be very similar to the baseline findings (see Figure 1.7), with the cumulative spending multiplier above unity only when the economy is characterized by a larger share of households facing tight borrowing constraints (*high debt-high unemployment*).

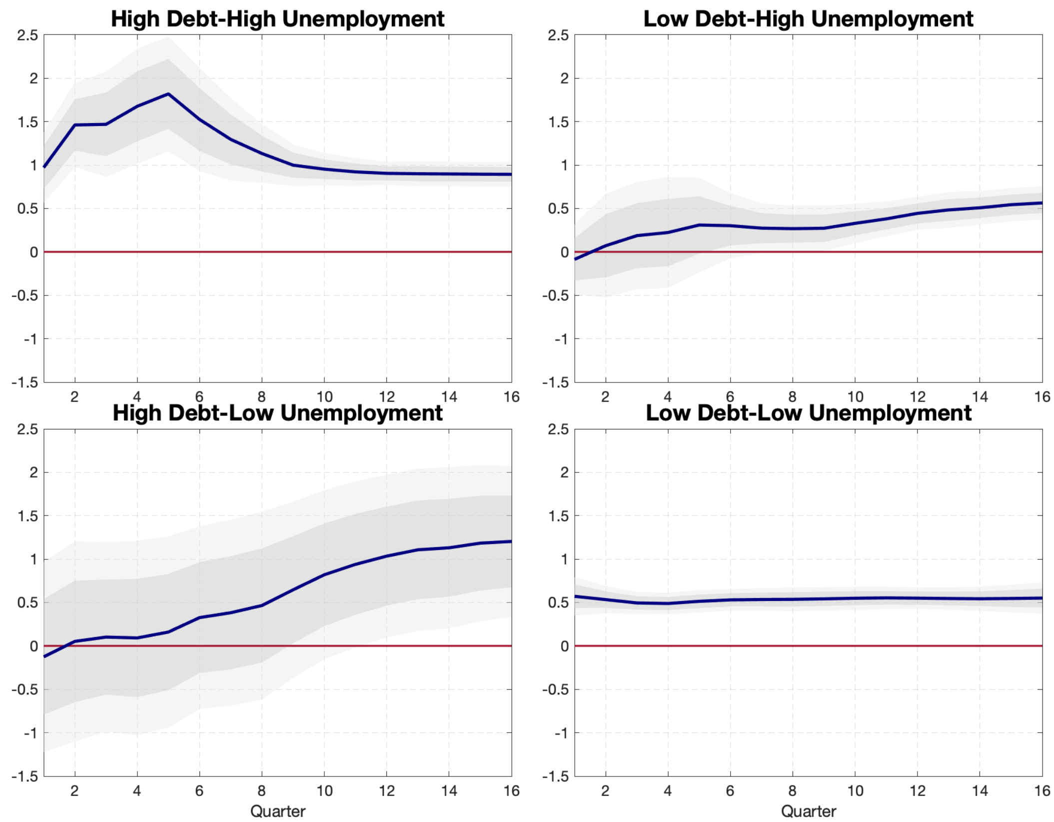

Fig. 1.J.1 State dependent: Cumulative output multiplier

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP, estimated using the one-step IV method. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

Next, as for the baseline analysis, I present the impulse responses for GDP components, and then for consumption durables, nondurables, and services. Figures 1.J.2 and 1.J.3 show that cumulative multipliers for real consumption, investments, net exports, durables, nondurables, and services are in line with the baseline findings (see Figure 1.11).

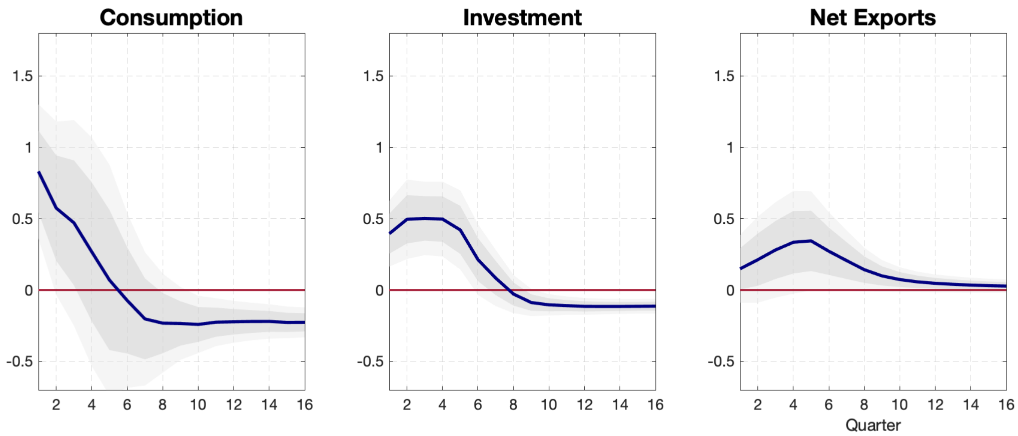

Fig. 1.J.2 State dependent: Cumulative multipliers

Notes: Cumulative real consumption, investment, and net exports multipliers from a government spending increase to one percent of GDP, estimated using the one-step IV method. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

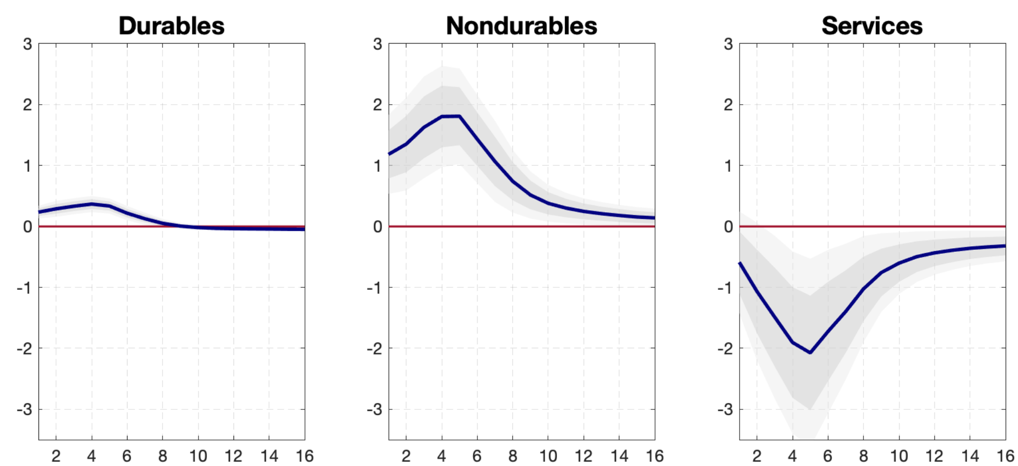

Fig. 1.J.3 State dependent: Cumulative multipliers

Notes: Cumulative real durable, nondurable, and services consumption multiplier from a government spending increase to one percent of GDP, estimated using the one-step IV method. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

Lastly, the next set of impulse responses assess the robustness of the potential mechanisms presented in Section 1.5. The findings confirm the presence of the labor market tightness mechanism, and the less activist monetary regime.

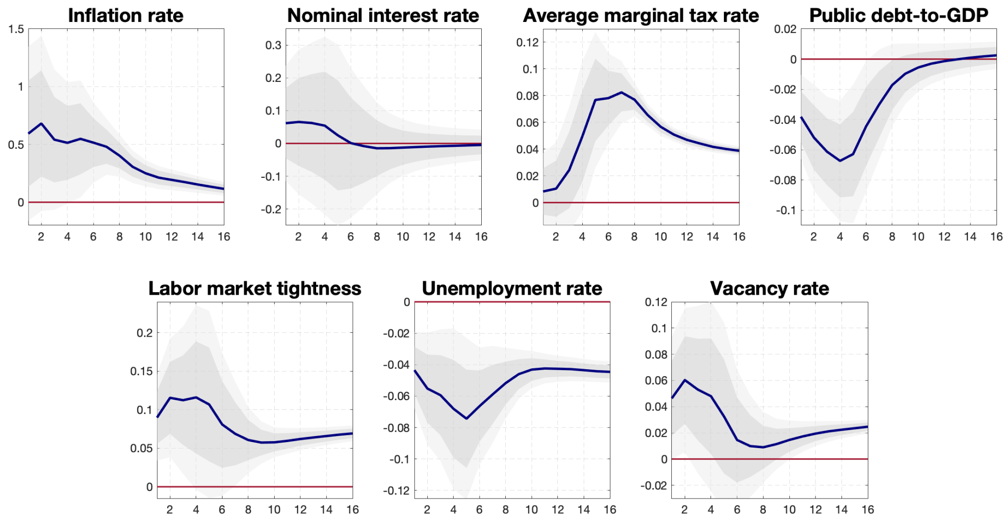

Fig. 1.J.4 State dependent: Potential mechanisms

Notes: Cumulative responses from a government spending increase to one percent of GDP, estimated using the one-step IV method. The government spending shock is instrumented using both the defense news shock and the Blanchard-Perotti shock. The bands represent the 90% confidence interval, based on heteroskedastic and autocorrelation (HAC) consistent standard errors.

1.J.2 Alternative shock identification schemes

Ramey and Zubairy (2018) highlight that using both shock (BP and RZ) as instruments may come at a cost of exogeneity, as the BP shock may be anticipated even when controlling for lags of RZ. In addition, there may be correlation between the measurement error in the series of government spending with the BP shock. Hence, the second check concerns the use of different identification schemes. Specifically, I use both shocks separated to instrument for government spending. Figures 1.J.5 and 1.J.6 plot the cumulative responses for GDP in the four identified states using, respectively, the BP and RZ shock as instrument. Figures 1.J.7 and 1.J.8 plot the cumulative responses for GDP components for the high debt-high unemployment state. Overall, all the results indicate that the baseline findings hold when adopting a different identification scheme, with the only marked deviation from the baseline findings being the response of investment when using the RZ shock.

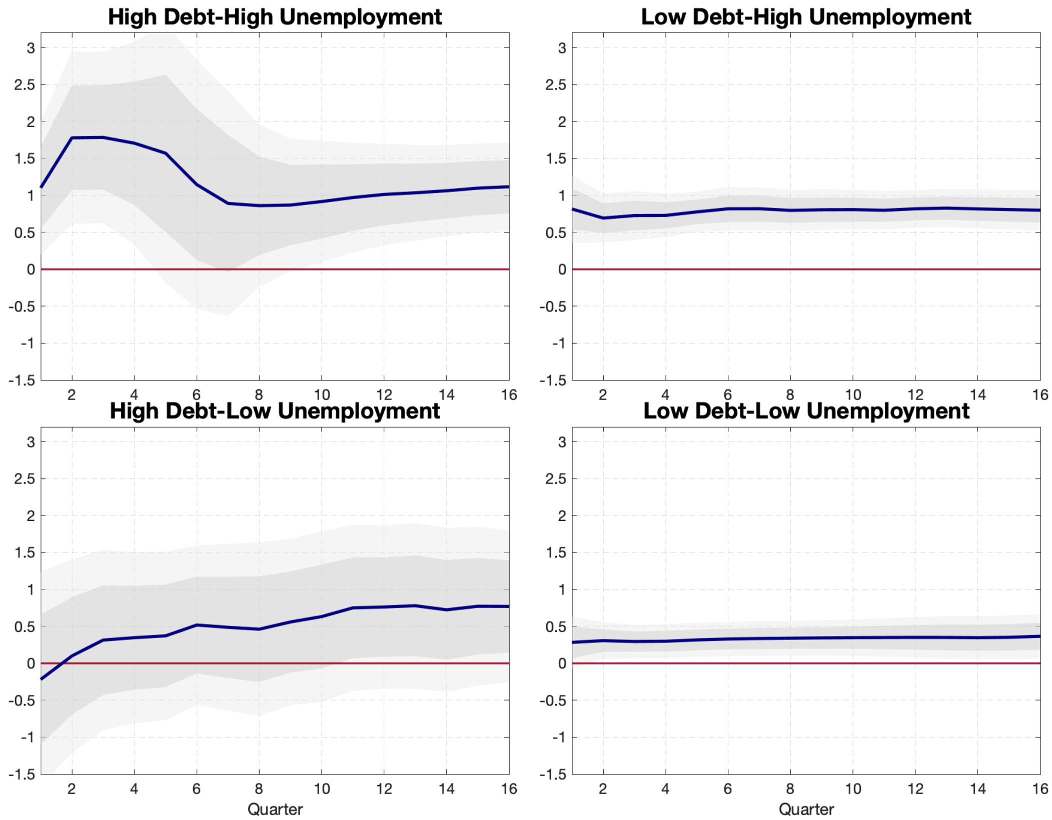

Fig. 1.J.5 State dependent: Cumulative output multiplier (BP shock)

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

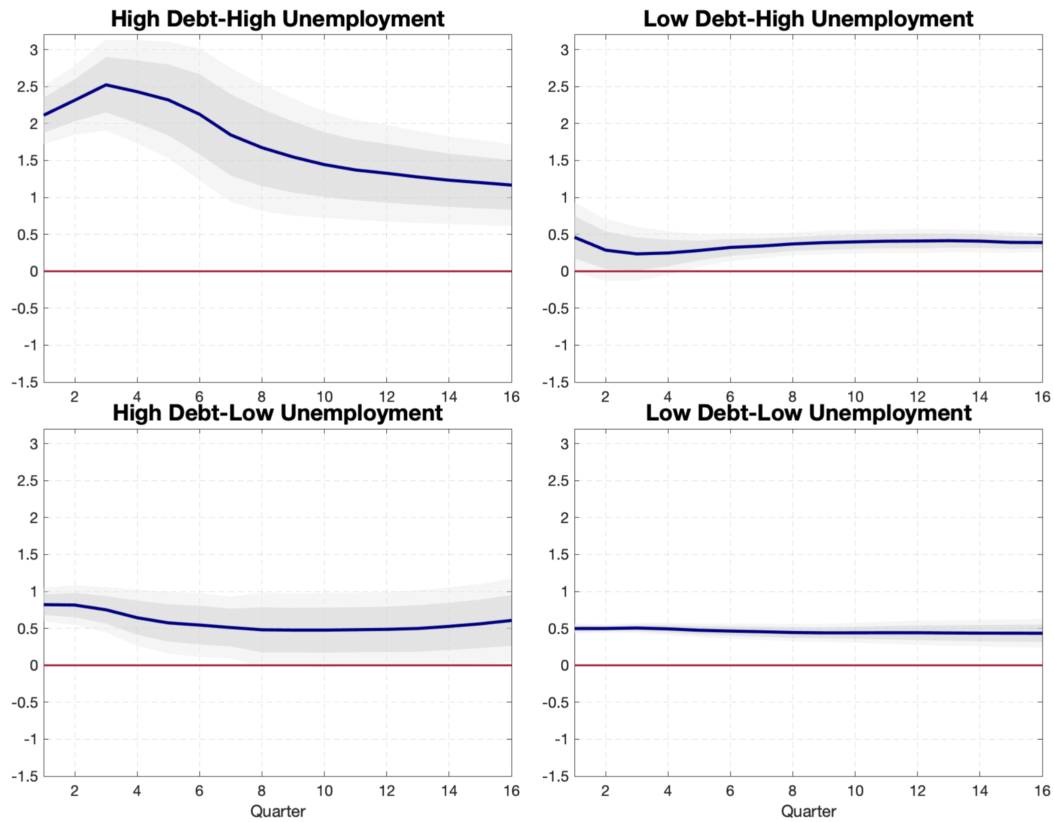

Fig. 1.J.6 State dependent: Cumulative output multiplier (RZ shock)

Notes: Cumulative real output multiplier from a government spending increase to one percent of GDP. The government spending shock is instrumented using the defense news shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

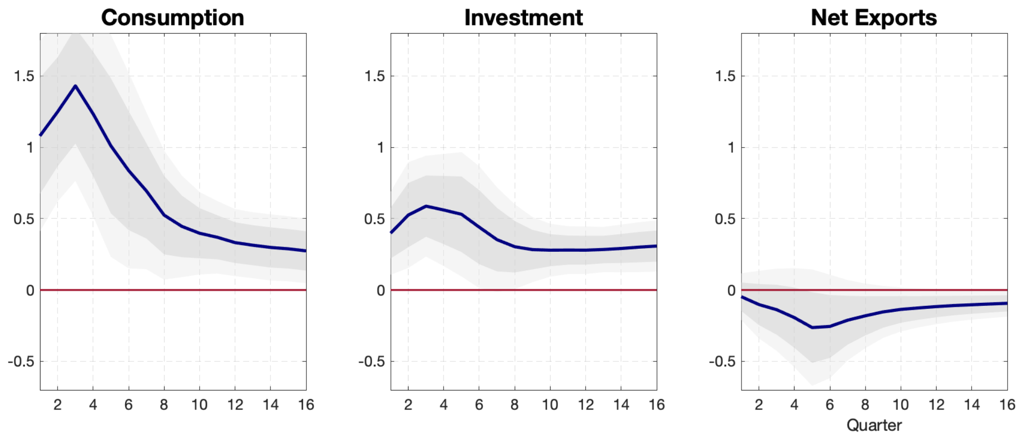

Fig. 1.J.7 State dependent: Cumulative multipliers (BP shock)

Notes: Cumulative real consumption, investment, and net exports multipliers from a government spending increase to one percent of GDP. The government spending shock is instrumented using the Blanchard-Perotti shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

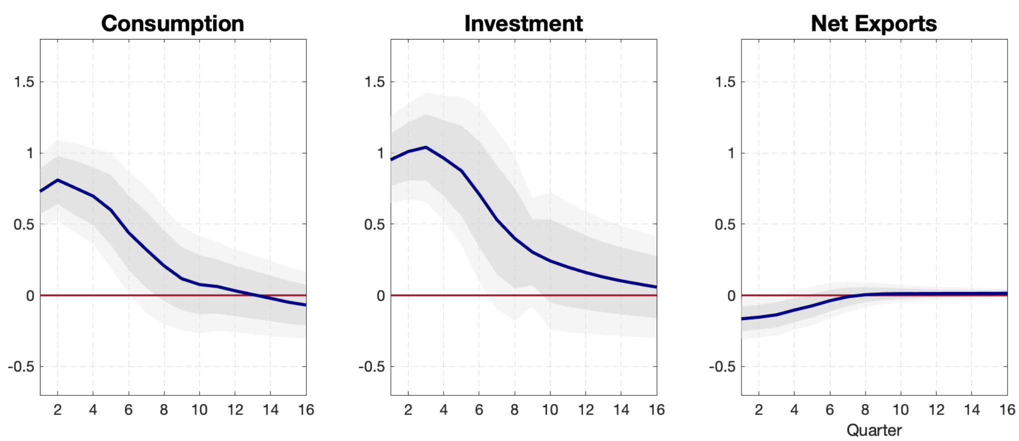

Fig. 1.J.8 State dependent: Cumulative multipliers (RZ shock)

Notes: Cumulative real consumption, investment, and net exports multipliers from a government spending increase to one percent of GDP. The government spending shock is instrumented using the defense news shock. The bands represent 90% and 68% confidence intervals, based on HAC-robust standard errors.

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Chapter 2

Monetary Policy, Asset Prices, and the Distribution of Wealth in the U.S.

Joint with Giacomo Rella.

2.1 Introduction

Since the Global Financial Crisis, unconventional monetary policy tools, such as asset purchases, have become increasingly important in the conduct of monetary policy. In the U.S., the Federal Reserve purchase programs involve buying government bonds, mortgage-backed securities, and other agency bonds. Despite these tools contributing to reducing long-term rates and easing financial conditions (Swanson, 2021), they raise concerns about the distributional consequences of conventional and unconventional monetary policy. Expansionary monetary policy, it is argued, would advantage asset-owners because low interest rates and asset purchases boost asset prices and, in turn, generate capital gains. Since assets are unequally distributed among households, expansionary monetary policies could potentially fuel income and wealth inequality.

Understanding the distributional effects of monetary policy, however, is complex as the interaction of many channels of transmission makes it difficult to assess the net effect on inequality (Coibion et al., 2017). Take, for example, an interest rate cut. On the one hand, it boosts asset prices, advantaging asset-owners who are at the top of the wealth distribution. On the other hand, it stimulates job creation from which low- and middle-class households benefit the most (Bergman et al., 2022). Another difficulty with understanding the distributional effects of monetary policy is data availability. While a rapidly growing body of the literature has investigated the role of monetary policy for income inequality in the U.S. and abroad (e.g., Amberg et al., 2021), the empirical evidence for wealth inequality is scarce. This paper fills this gap by using the Distributional Financial Accounts (DFA, hereafter) of the United States (Batty et al., 2020), which provide new quarterly measures on the distribution of household wealth, assets, and liabilities since 1989. For conventional monetary policy, we rely on the (pure) federal funds rate shock of Jarociński and Karadi (2020), while for unconventional monetary policy, we use the large-scale asset purchase shock of Swanson (2021).

We find that expansionary monetary policy shocks raise the wealth of all households across the distribution, with households in the Bottom 50% receiving the largest percentage increase. Despite raising the wealth levels of all groups, expansionary monetary policy shocks shift the distribution of wealth towards the top tail. A federal funds rate shock redistributes wealth towards the tails of the distribution, especially for the Top 1%. A shock to asset purchases, instead, unequivocally redistributes wealth towards the Top 1%. However, changes in wealth shares in response to monetary policy shocks are not permanent.

The heterogeneous responses of wealth levels across groups are driven by changes in both assets and liabilities. The benefits of expansionary monetary policy shocks on the level of assets are increasing in the wealth distribution, with the conventional shock leading to more persistent effects, though smaller, than its unconventional counterpart. By contrast, the heterogeneous responses of liabilities across groups depend on the type of shock. For instance, the bottom (top) tail benefits the most from a fall in liabilities due to the conventional (unconventional) policy shock. Delving into assets, we find substantial heterogeneity in the effects of monetary policy shocks across groups and asset classes. Money market fund shares and corporate equities provide two stark examples of heterogeneous gains and losses. On the one hand, monetary policy shocks lead to a similar percentage increase in holdings of corporate equities across wealth groups. However, because this asset class is very concentrated in the top tail, the same percentage increase leads to larger gains for the top of the distribution. On the other hand, monetary policy shocks lead to different percentage increases in holdings of money market fund shares across wealth groups. These heterogeneous responses, coupled with the right-skewed distribution of money market fund shares, imply that monetary policy shocks induce very large differences in gains and losses across the distribution. This is especially true for asset purchase shocks.

Lastly, we provide evidence for the portfolio composition channel of monetary policy. Heterogeneous portfolios make the wealth distribution highly sensitive to changes in asset prices, regardless of the influence of saving on the accumulation of wealth. We show that the unequal exposure of household portfolios to house and stock prices explains differences in wealth growth across groups. As asset prices are highly responsive to federal funds rate and asset purchases shocks, we test whether monetary policy has been responsible for differences in wealth growth across groups since 2008. A counterfactual exercise reveals that monetary policy appears to have a greater impact on wealth inequality via the stock market rather than through the housing market.

Related literature and contribution. Our paper adds new empirical evidence on the distributional effects of monetary policy, a hotly debated topic in academic, policy, and public debates. Relative to previous studies, we improve our knowledge on this topic by (i) considering both conventional and unconventional monetary policy, (ii) using novel data with detailed household balance sheet information for different wealth groups, (iii) providing evidence of the portfolio composition channel of monetary policy, and (iv) distinguishing between the influence of house and stock prices in contributing to wealth inequality.

High and increasing levels of income and wealth inequality have caught the attention of monetary policymakers (Bernanke, 2015; Draghi, 2016; Yellen, 2016; Honohan, 2019; Del Negro et al., 2022). As Schnabel (2021), member of the Executive Board of the European Central Bank, points out in a recent speech: *"Economic and social inequality is one of the biggest challenges facing societies worldwide. [...] Central banks are no longer considered bystanders in this discussion."* In a similar vein, complicit the increasing availability of distributional data, a rapidly growing literature is investigating the consequences of monetary policy for income and wealth inequality. Results, however, are mixed and studies on the effects of monetary policy on wealth inequality are comparatively underdeveloped (see Colciago et al., 2019; Kappes, 2021, for surveys). Across countries, contractionary monetary policy leads to higher income inequality (Furceri et al., 2018) or lowers it by reducing the share of national income held by the Top 1% (El Herradia and Leroyb, 2021). Other studies find that a monetary tightening generates higher inequality in labor earnings and consumption (Mumtaz and Theophilopoulou, 2017; Coibion et al., 2017). In studies using administrative data, expansionary monetary policy either increases income, consumption, and wealth inequality (see Andersen et al., 2021, for Denmark) or leads to a U-shaped response of total income across the distribution (see Amberg et al., 2021, for Sweden). Moreover, the ECB non-standard monetary policy are found to reduce income inequality while having neglible effects on wealth inequality (Casiraghi et al., 2018; Lenza and Slacalek, 2021). For the U.S., Bartscher et al. (2021) find that expansionary monetary policy increases employment of black households more than that of white households but it worsens the wealth gap between black and white households. Similarly, Albert and Gómez-Fernández (2021) conclude that accomodative monetary policy contributes to increase wealth inequality and it advantages the tails of distribution. Lastly, Feilich (2021) finds that monetary policy tightenings are especially harmful for households in the bottom tail of the distribution. Of this literature, the last paper is the most similar to ours, as we both use the Distributional Financial Accounts. However, our contribution differs in terms of methodology and scope. First, we consider both conventional and unconventional monetary policy in a VAR framework. Second, we provide evidence of the portfolio composition channel of monetary policy using a different approach based on a counterfactual analysis and distinguishing between the role of house and stock prices for wealth inequality.

This paper is more generally related to the large literature documenting the impact of monetary policy on various asset prices. A standard result is that a surprise federal funds rate cut raises stock prices (Bernanke and Kuttner, 2005; Gürkaynak et al., 2005; Swanson, 2021; Bauer and Swanson, 2022) and decreases both term premia and credit spread (Gertler and Karadi, 2015). Asset purchases, instead, have larger effects on long-term rates (Swanson, 2011; Krishnamurthy and Vissing-Jorgensen, 2012).

A recent strand of the literature places heterogeneous household balance sheets at the center of transmission mechanism of monetary policy (Kaplan et al., 2018; Auclert, 2019; Slacalek et al., 2020). In Heterogeneous Agents New-Keynesian (HANK) models, for example, the heterogeneity of households' portfolios and income sources imply that the real effects of monetary policy shocks are amplified or damped relative to traditional channels. Therefore, in these models, there are several channels of monetary policy transmission linked with the distribution of income and wealth (see Violante, 2021, and references therein).[21] Our paper also speaks to the literature on the role differences in portfolio earnings in explaining wealth accumulation. De Nardi and Fella (2017) find that labor income differences alone are not able to match the thicker right tail of the wealth distribution observed in the data. Recent findings indicate that critical factors behind the wealth accumulation in the U.S. are heterogeneous portfolio returns (Bach et al., 2020; Fagereng et al., 2020; Hubmer et al., 2021; Xavier, 2021), skewed earning, and differential saving rates (Benhabib et al., 2019).

Lastly, in using the DFA, we relate our paper to the literature on the measurement of wealth inequality in the U.S. Only recently, giant leaps have been made in characterizing the distribution of U.S. household wealth (see Kopczuk, 2015; Bricker et al., 2016; Saez and Zucman, 2020, for a survey of various approaches). Some authors use estate tax returns for top wealth shares (Kopczuk and Saez, 2004) while others adopt income capitalization

[21]The channels amplifying or dampening the effects of monetary policy in HANK models are the redistribution, precautionary saving motive and fiscal policy channels. The redistribution channel arises from the heterogeneous sensitivity of earnings to aggregate fluctuations which are largest at the tails of the distribution. The precautionary saving channel entails a larger response of expenditure to negative aggregate shocks arising from the desire of building additional buffer stock of saving. According to the fiscal policy channels, interest rate cuts increase the fiscal capacity of the government by reducing the burden of debt with positive spillovers on government transfers.

techniques to characterize the distribution of wealth (Saez and Zucman, 2016; Kuhn et al., 2020). In 2019, the Federal Reserve released quarterly measures of the distribution of U.S. household wealth, the DFA (Batty et al., 2020). In this paper, we opt for these data as the their frequency, higher relative to others, suits well the study of the distributional consequences of monetary policy.[22]

Road map. The structure of the paper is organized as follows. Section 2.2 introduces and describes the DFA. Section 2.3 outlines the econometric strategy and the monetary policy shocks. Section 2.4 discusses the results. Section 2.5 presents evidence for the portfolio composition channel. Section 2.6 concludes.

2.2 The Distributional Financial Accounts of the United States

The analysis of the distributional effects of monetary policy is based on the Distributional Financial Accounts of the United States. The DFA combine household-level balance sheets from the Survey of Consumer Finances with the aggregate balance sheet of the household sector from the Financial Accounts to estimate how wealth is distributed since 1989 (Batty et al., 2020). We consider the distribution of household wealth by four wealth percentile: Bottom 50%, Next 40% (or 50^{th}-90^{th} percentile), Next 9% (or 90^{th}-99^{th} percentile) and Top 1%.[23]

2.2.1 Wealth inequality according to the Distributional Financial Accounts

Wealth is unevenly distributed across households in the U.S. On average, between 1989 and 2020, households in the Bottom 50%, Next 40%, Next 9% Top 1% held 2.37, 32.83, 36.65 and 28.15 percent of total wealth, respectively (see last row in Table 2.1). The unequal distribution of wealth is even more striking if one considers that, in terms of population, the Top 1% is only 1/55 of the population of the Bottom 50%, 1/44 of the population of the Next 40% and 1/10 of the population of the Next 9%.

Figure 2.1 plots the wealth shares according to the DFA since 1989. Wealth is computed as total assets net of liabilities. The wealth share of the Bottom 50% halved since 1989. This group began to lose ground already in the mid-1990s with the wealth share decreasing even during the pre-Global Financial Crisis economic expansion. After the crisis, it took more than a decade for the wealth share to reach the pre-2007 level. Similarly, the share

[22] Blanchet et al. (2022) recently published quarterly measures for the distribution of U.S. household wealth without information on wealth components.

[23] The DFA consider also income percentiles, race, education levels, age groups and generations.

of wealth owned by households in the Next 40% has decreased over time from more than 35% in the late 1980s to less than 30% in 2020. In contrast, households in the Next 9% and Top 1% of the wealth distribution have seen their wealth share increase over time. At the end of 2020, the Next 9% and Top 1% own together almost 70% of total household wealth. In particular, the wealth share of the Top 1% steadily increased from less than 25% in 1989 to more than 30% in 2020.

Table 2.1 shows the distribution of assets and liabilities across wealth groups. It reports holdings of assets and liabilities for each group as a share of aggregate holdings from the balance sheet of the household sector. The bulk of non-financial assets is owned by the Next 40%. Most of the financial assets are concentrated on the balance sheets of the

	Bottom 50%	Next 40%	Next 9%	Top 1%
Assets	6.96	34.41	33.90	24.73
Nonfinancial assets	15.28	44.41	27.28	13.04
Real estate	13.50	45.03	28.76	12.72
Consumer durable goods	22.86	42.01	20.95	14.20
Financial assets	2.93	29.59	37.13	30.36
Checkable deposits and currency	11.61	37.80	32.25	18.35
Time deposits and short-term investments	3.97	37.72	36.55	21.75
Money market fund shares	1.35	23.63	41.79	33.22
US government and municipal securities	1.12	14.15	30.94	53.79
Corporate and foreign bonds	0.74	16.08	31.49	51.68
Loans	0.76	10.15	33.67	55.41
Corporate equities and mutual fund holdings	1.09	15.53	36.08	47.31
Equity in noncorporate business	1.71	16.98	31.82	49.49
Life insurance reserves	9.73	42.50	28.80	18.98
Pension entitlements	3.43	45.33	43.13	8.12
Miscellaneous assets	20.00	47.56	23.47	8.96
Liabilities	33.27	43.67	18.18	4.88
Home mortgages	27.70	46.98	20.68	4.64
Consumer credit	53.06	37.13	8.05	1.74
Deposit institution loans n.e.c.	29.60	28.60	16.54	25.27
Other loans and advances	18.09	22.63	32.26	27.01
Deferred and unpaid life insurance premiums	10.23	42.79	29.24	17.74
Wealth	2.37	32.83	36.65	28.15

Notes: The table shows average shares of wealth, assets, liabilities and their components owned or held by each wealth group. The table report simple averages between 1989 and 2020.

Table 2.1 Distribution of assets, liabilities and wealth (1989-2020) top tail. The Bottom 50% holds very few financial assets, mostly concentrated in the form of deposits and currency. The Next 40% holds most of deposits, life insurance reserves, and pension entitlements. More than a third of money market fund shares, pension entitlements, deposits, and currency are held by households in the Next 9%. The very top of the distribution owns the lion's share of debt and equity instruments. Liabilities are also very unequally distributed. While owning only less than seven percent of total assets, the Bottom 50% owes a third of total liabilities. The Next 40% owes almost half of total liabilities. In contrast, the top tail owes 18% (Next 9%) and less than 5% (Top 1%) of total liabilities.

2.2.2 Comparison with alternative estimates of wealth inequality in the U.S.

A widely established source of data on the distribution of household wealth in the US is Saez and Zucman (2016). These series are now regularly published as part of of the Distributional National Accounts (DINA, hereafter). While the DINA wealth series are based on income tax data, the DFA rely on survey data by interpolating estimates of wealth between triennial waves of the Survey of Consumer Finances, supplemented with wealth estimates from Forbes 400. This allows to distribute the Financial Accounts data for the household sector to households in different wealth groups. Other differences between the DFA and the DINA wealth series concern *(i)* the treatment of consumer durables and unfunded pensions, and *(ii)* the unit of observation. Saez and Zucman (2016) exclude durables and unfunded pensions from the calculation of household wealth while the Federal Reserve includes them in the wealth concept underlying the DFA. As a result, wealth inequality in the DFA is lower than in the DINA (Figure 2.1). Moreover, since the DFA rely on the Survey of Consumer Finances, the units of observation are households instead of individuals.

In Figure 2.1, we compare the original wealth shares from the DFA with an alternative measure of wealth that excludes consumer durables and pension entitlements. The reason for excluding these components is to make the wealth concept used in the DFA as close as possible to the wealth concept in DINA. Moreover, Figure 2.1 plots the wealth shares from Blanchet et al. (2022) which are, to the best of our knowledge, the only available quarterly measures of wealth using the wealth concept used in DINA.[24] Excluding

[24] These series have been downloaded from Realtime Inequality which provides monthly and quarterly estimates of the distribution of income and wealth in the US (see Blanchet et al. (2022) for a companion paper). The original series, however, are expressed in real terms and the wealth series for the Next 9% of the distribution are not reported. To ensure comparability with the DFA series, we use households as the units of observations, obtain nominal wealth using the same deflator used in Blanchet et al. (2022), and calculate the wealth of the Next 9%.

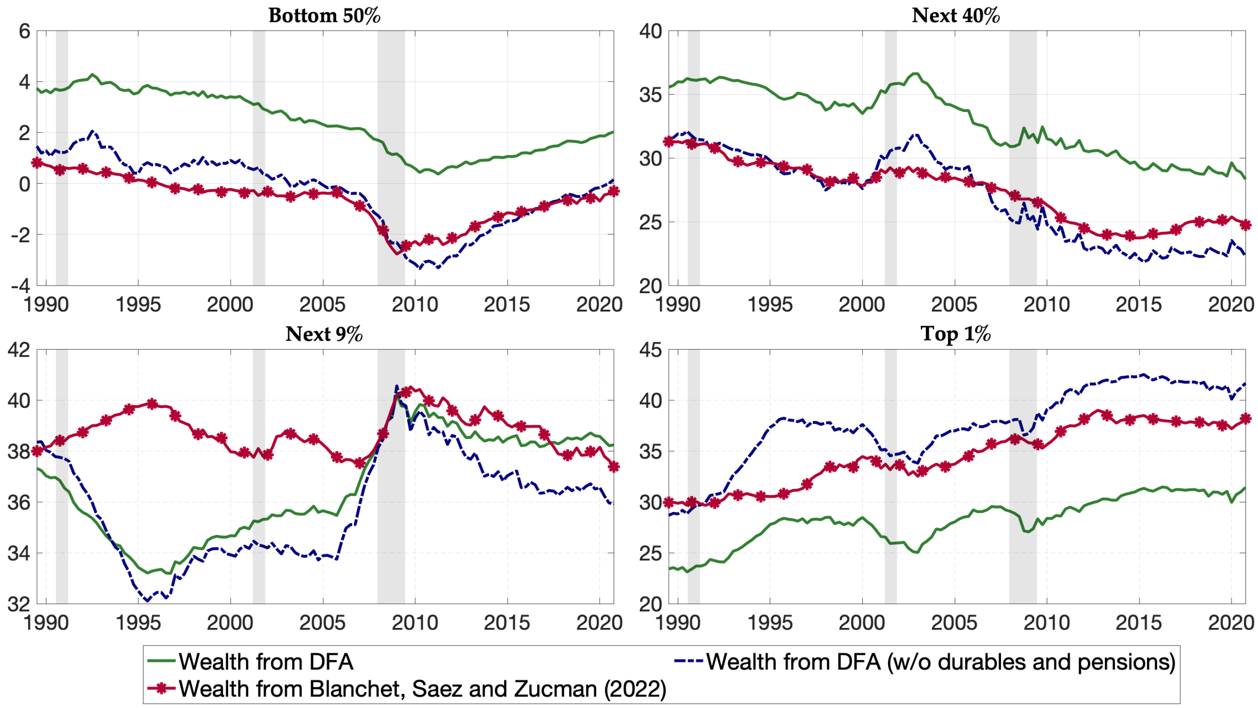


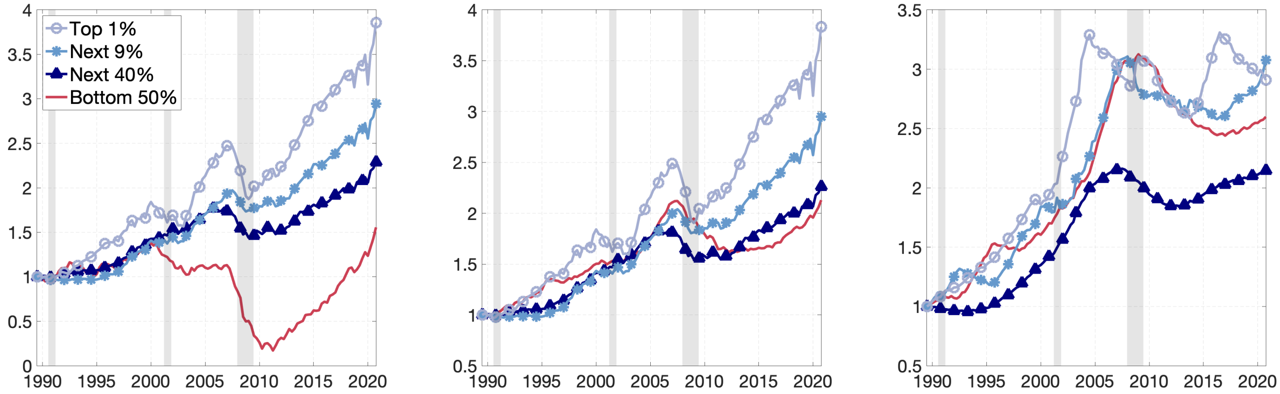
Fig. 2.1 Net worth shares

Notes: This figure compares the evolution of wealth shares for the Bottom 50%, the Next 40%, the Next 9%, and the Top 1% of the wealth distribution. The green solid lines represent wealth shares from the Distributional Financial Accounts. The dashed blue lines represent wealth shares net of consumer durables and pensions from the Distributional Financial Accounts. Lastly, the red lines with markers are taken from Blanchet et al. (2022). The wealth share of the Next 9% of Blanchet et al. (2022) is derived using data for the Top 10% and the Top 1%.

consumer durables and pension entitlements reduces the wealth share of the Bottom 50% by roughly 2.7 percentage points. Instead, the consequences for the Next 40% and the Top 1% are more dramatic. On average, the wealth share decreases by almost 5.8 percentage points for the former, while it increases by 9.4 percentage points for the latter. Overall, despite the methodological differences, excluding both consumer durables and pension entitlements makes the DFA wealth shares similar to the DINA series (see also Saez and Zucman, 2020). However, quantitative differences in the estimation of wealth inequality remain, especially for the Next 9%.

2.2.3 The unequal growth of wealth

In Figure 2.2, we compare wealth, total assets, and debt growth across wealth groups since 1989. Wealth, total assets, and debt are deflated using the consumer price index and set to 1 in 1990. Consistently with Kuhn et al. (2020), real wealth growth has been unequally distributed across groups. Relative to 1990, the Top 1% almost quadrupled its wealth, the Next 9% tripled it, the Next 40% doubled it, while the wealth of the Bottom



(a) Real wealth **(b)** Real asset **(c)** Real debt

Fig. 2.2 Wealth, assets and debt dynamics along the wealth distribution

Notes: This figure shows the evolution of net worth (panel A), total assets (panel B), and debt liabilities (panel C) for the four wealth groups of the Distributional Financial Accounts. All time series are indexed to 1 in 1989Q3 and deflated using the CPI.

50% increased only by fifty percent.

Excluding the Top 1%, wealth growth converged for all groups until the early 2000s. Subsequently, wealth growth for the Bottom 50% stagnated starting from early 2000s (panel A) as households in this group increased holdings of assets (panel B) largely through new borrowing (panel C). The Great Recession almost completely wiped out the wealth of households in the Bottom 50%. Notice that it took more than a decade of deleveraging to restore the lost wealth. Real wealth growth for the Next 40% and 9% decoupled only in mid-2000s. For other groups, the effect of the crisis on wealth growth was much less dramatic than for the Bottom 50% as households in the Next 40% and 9% groups accumulated less debt during the expansion and undertook a softer deleveraging process. The Top 1% of the wealth distribution stands out as the winner of the wealth share race. On average, wealth growth for the Top 1% has been higher than that of any other group. The pandemic only exacerbated these disparities.

2.2.4 Households' portfolios heterogeneity

Besides income and savings, other important determinants of wealth inequality are gains from asset price changes. As pointed out by Kuhn et al. (2020), asset prices influence the dynamics of wealth inequality through two channels. First, if households have heterogeneous portfolios across the wealth distribution, asset price movements induce heterogeneous capital gains. Second, when wealth-to-income ratios are high, the dynamics of the wealth distribution are affected more by asset prices than by saving flows. Asset price changes revalue the stock of existing wealth and induce shifts in the wealth distribution beyond changes in savings.

Households' portfolios need to exhibit persistent heterogeneity in composition for asset prices to influence the distribution of wealth beyond savings. Table 2.2 shows the average composition of assets and liabilities between 1989 and 2020. We also report the wealth-to-asset ratio, which indicates high leverage as it approaches zero and no leverage when it is equal to 100. Figure 2.3 portrays the composition of assets across wealth groups. As in Bauluz et al. (2022), we consider the following asset classes: real estates, consumer durables, fixed income assets, equities and mutual funds holdings, life insurance and pension funds, and miscellaneous assets.[25]

[25] In particular, the asset classes are real estates, consumer durables, fixed income assets (checkable deposits and currency, time deposits and short-term investment, money marker fund shares, US government and municipal securities, corporate and foreign bonds, loans), equities and mutual funds holdings (corporate equities, mutual fund holdings and equity in noncorporate business), life insurance and pension funds (life insurance reserves and pension entitlements) and miscellaneous assets.

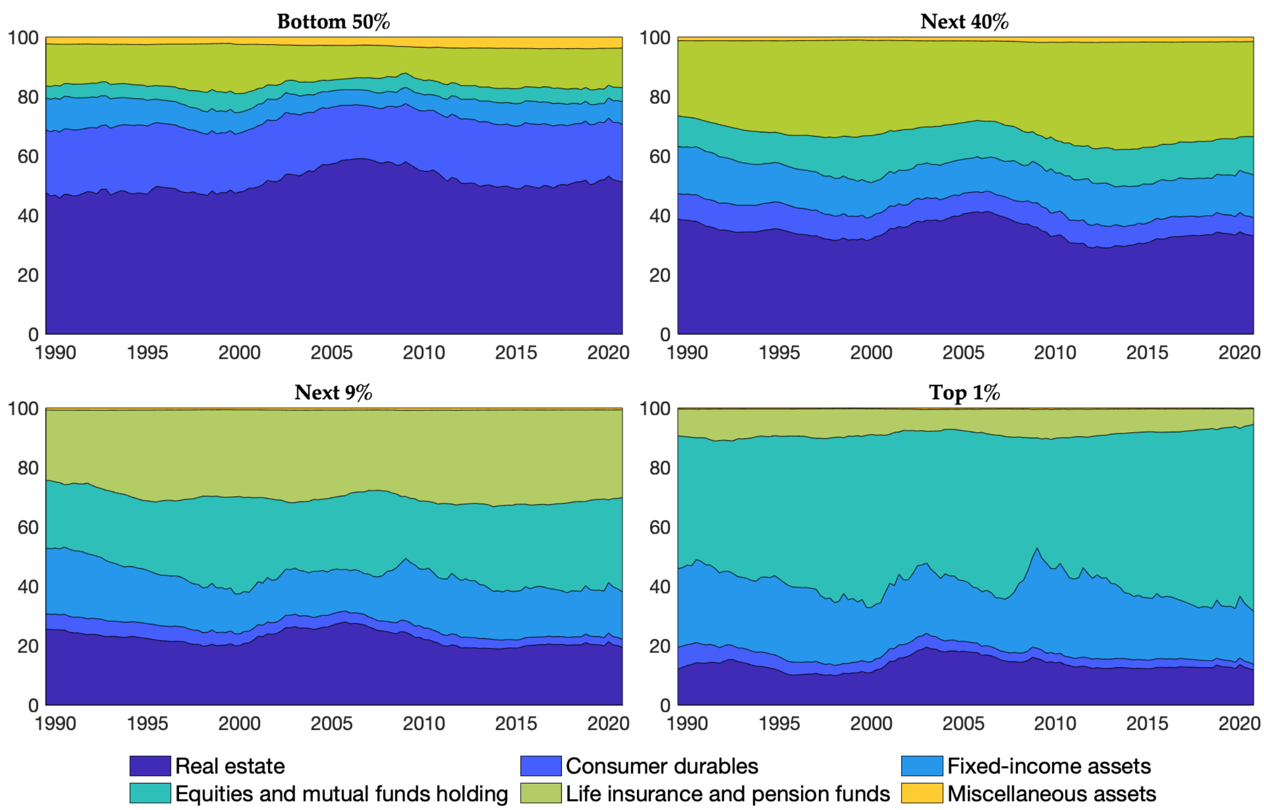
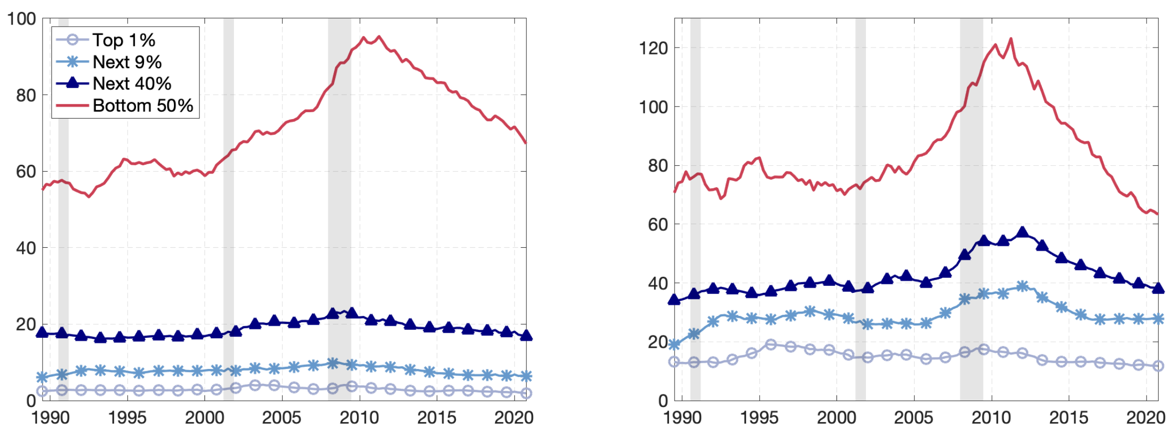


Fig. 2.3 Portfolio heterogeneity

Notes: This figure shows the heterogeneity in the asset-side of household portfolios by showing the dynamic composition of major asset classes, as share of total assets, for each wealth group in the Distributional Financial Accounts.

Real estates make up roughly half of total assets for households in the Bottom 50% (Figure 2.3). The share of real estates and consumer durables in total assets decreases as we move towards the top tail. Instead, the Top 1% holds 14% and 4% of these assets. An opposite trend can be observed when we look at other asset classes. The shares of fixed-income assets, equities, and mutual funds holdings dramatically increase as we move towards the top of the distribution. Life insurance and pension funds, instead, are an important asset class for the Next 40% and 9%.

For all wealth groups, home mortgages make up most of the debt holdings, followed by consumer credit, except for the Top 1% (Table 2.2). However, substantial differences persist in the leverage of households in different wealth groups. Figure 2.4 (panel A) reports debt-to-assets ratios and shows that the Bottom 50% is the most leveraged group, with gross debt reaching almost 100% of total assets after the Great Recession. All other groups, instead, have lower leverage. Panel B in Figure 2.4 reports the aggregate mortgage loan-to-value ratio for each group. This indicator provides an approximate measure of the funding for home mortgages. Debt at the Bottom 50% increased strikingly relative to assets before and during the Great Recession. Furthermore, in the aggregate, the collapse in house prices led these mortgages to be underwater as the value real estates fell short of the value of home mortgages.



(a) Debt-to-assets

(b) Mortage loan-to-value

Fig. 2.4 Leverage ratios

Notes: This figure shows the debt-to-assets ratio (panel A), and the mortgage loan-to-value ratio (panel B) for the four wealth groups in the Distributional Financial Accounts.

	Bottom 50%	Next 40%	Next 9%	Top 1%
Assets (% of total)				
Nonfinancial assets	71.76	42.12	26.30	17.29
Real estate	51.18	34.48	22.37	13.59
Consumer durable goods	20.58	7.64	3.93	3.70
Financial assets	28.24	57.88	73.70	82.71
Checkable deposits and currency	1.76	1.13	1.01	0.78
Time deposits and short-term investments	4.32	8.28	8.26	6.75
Money market fund shares	0.37	1.31	2.33	2.66
US government and municipal securities	0.57	1.46	3.28	7.91
Corporate and foreign bonds	0.15	0.63	1.23	2.69
Loans	0.09	0.28	0.95	2.16
Corporate equities and mutual fund holdings	2.37	7.02	16.79	30.31
Equity in noncorporate business	2.47	5.00	9.57	20.53
Life insurance reserves	2.25	1.99	1.37	1.20
Pension entitlements	10.88	29.35	28.20	7.35
Miscellaneous assets	3.02	1.43	0.71	0.37
Liabilities (% of total)				
Home mortgages	60.26	77.78	82.14	68.65
Consumer credit	36.88	19.51	10.21	8.21
Deposit institution loans n.e.c.	0.79	0.46	0.47	2.26
Other loans and advances	1.98	1.99	6.73	19.93
Deferred and unpaid life insurance premiums	0.09	0.28	0.45	0.95
Wealth-to-Asset ratio	28.28	81.26	92.08	97.06

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 report simple averages between 1989 and 2020.

Table 2.2 Portfolio heterogeneity

To sum up, households across the wealth distribution have very heterogeneous portfolios. Households in the Bottom 50% have very little wealth, hold illiquid assets, and are the most leveraged. Fixed-income and other liquid assets make up only a small share of their portfolio. The portfolio of the Next 40% is more diversified. Real estates and pension entitlements make up the largest share of their assets, and they hold significant shares of fixed-income assets. Moving towards the top tail, the share of financial assets increases significantly, with the Top 1% holding most of its portfolio in fixed-income assets, equities, and mutual funds. The large heterogeneity among these groups of households - in terms of both leverage and portfolio composition - is a crucial factor that motivates the study of the conventional and unconventional monetary policy consequences for the wealth distribution.

2.3 Econometric methodology

In this section, we first present the identification strategy for conventional and unconventional monetary policy shocks. Then, we introduce the Bayesian VAR model for estimating the distributional effects of monetary policy.

2.3.1 Conventional monetary policy

A common approach to the identification of monetary policy shocks consists of measuring high-frequency interest rate changes, such as differences in the three-month fed funds futures, around Federal Open Market Committee (FOMC) announcements. The implicit assumption backing this strategy is that, around these announcements, asset prices respond only to monetary policy shocks. This is a convenient strategy, as focusing on interest rate changes in a narrow window around FOMC announcements plausibly rules out reverse causality and other endogeneity problems. However, a potential drawback of the high-frequency approach is that shocks identified in this fashion generate puzzling effects. Specifically, these shocks produce estimates that go in the opposite direction or that are too small relative to what standard macroeconomic models would predict. Some studies explain the puzzle relying on the *Fed information effect* (Romer and Romer, 2000; Nakamura and Steinsson, 2018). Following this explanation, FOMC announcements convey information about both monetary policy itself and about the central bank's assessment of the economy, causing the private sector to revise its forecasts. According to this explanation, the central bank has superior information than private forecasters. More recently, Bauer and Swanson (2021, 2022) propose an alternative explanation for these puzzling effects, the *Fed response to news* channel. According to this view, new publicly available economic news cause the Fed to change monetary policy and the private sector to revise its forecasts.

Therefore, we find convenient to use the *pure monetary policy shock* of Jarociński and Karadi (2020). These authors decompose monetary policy surprises into *pure monetary shocks* and *information shocks*. They identify *pure monetary policy shocks* when changes in the three-month fed funds rate and in the S&P 500 stock price index co-move negatively around FOMC announcements.[26] Instead, a positive co-movement identifies an *informa-*

[26]The three-month future is convenient as it reflects the shift in the expected federal funds rate following the next policy meeting. Hence, this horizon has the advantage of constituting a broad measure of the overall monetary policy stance.

tion shock, potentially happening when the central bank responds more aggressively to publicly available news than markets expected.[27] In line with the new survey to forecasters conducted by Bauer and Swanson (2021), Jarociński and Karadi (2020) find few significant observations for the *information shock*.

Our identification strategy follows Gertler and Karadi (2015) and uses the series of *pure monetary policy shock* as an instrument for the structural monetary policy shock in a proxy-SVAR. We believe that this approach has several advantages over alternatives. First, using a proxy-SVAR, we can retrieve a sequence of monetary policy shocks for a longer period than the original instrument. This allows us to fully exploit the DFA which start in 1989. Second, we can identify the structural monetary policy shock from a monthly proxy-SVAR and then aggregate the sequence of monetary policy shocks at quarterly frequency (as in Cloyne et al., 2018).[28] More formally, the monthly proxy-SVAR reads as follows:

$$\underset{n\times 1}{\mathbf{y}_t} = \underset{n\times 1}{\mathbf{c}} + \sum_{j=1}^{p} \underset{n\times n}{\mathbf{B}_j}\, \mathbf{y}_{t-j} + \underset{n\times 1}{\mathbf{u}_t} \tag{6}$$

where $\mathbf{y}_t$ is a $(n \times 1)$ vector of endogenous variables, $\mathbf{c}$ is a $(n \times 1)$ vector of intercepts, $\mathbf{B}_j$ 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 $(n \times n)$ variance-covariance matrix $\mathbf{\Omega}$. The vector $\mathbf{y}_t$ includes, in the following order, the 1-year government bond rate as policy variable, the log of industrial production, the log of the consumer price index and the excess bond premium of Gilchrist and Zakrajšek (2012).[29] The model is estimated from July 1988 to March 2020 with $p = 12$ lags. Under the assumption that the VAR is invertible, we can map the reduced-form innovations u_t to the structural shocks $\boldsymbol{\varepsilon}_t$ as follows:

$$\mathbf{u}_t = \boldsymbol{S}\boldsymbol{\varepsilon}_t \tag{7}$$

where $\boldsymbol{\varepsilon}_t \sim \mathcal{N}(\mathbf{0}, \mathbf{\Sigma})$ is a vector of structural shocks with unit variance and $\boldsymbol{S}$ is a non-singular matrix with the standard covariance restrictions $\mathbf{\Omega} = \boldsymbol{S}\mathbf{\Sigma}\boldsymbol{S}' = \boldsymbol{S}\boldsymbol{S}'$. Then, we denote $\boldsymbol{s}$ to be the column in matrix $\boldsymbol{S}$ that corresponds to the impact of the structural

[27] The original explanation given by Jarociński and Karadi (2020) is that the Fed releases a positive assessment about the economy by tightening its policy to prevent the economy to overheat. From an econometric point of view, this explanation is coherent with the *Fed response to news* channel of Bauer and Swanson (2021, 2022). In fact, the macroeconomic effects of monetary policy shocks shown in Figure 2.1 are consistent with Bauer and Swanson (2022).

[28] The relevance condition of the instrument fails to hold when estimating the proxy-SVAR with quarterly data while it holds using monthly data.

[29] The use of a safe interest rate with a longer maturity than the funds rate provides a better characterization of monetary policy during the ZLB period, i.e., when the Fed's forward guidance became strategically more important (Swanson and Williams, 2014; Hanson and Stein, 2015).

monetary policy shock ε_t^p on each element of the vector of reduced form residuals $\boldsymbol{u}_t$.

Formally, let z_t be a generic instrument, ε_t^p be the monetary policy shock and $\boldsymbol{\varepsilon}_t^q$ be a $(n-1) \times 1$ vector with structural shocks other than the policy shock. In our application, z_t is the *pure monetary policy shock* series of Jarociński and Karadi (2020). To be a valid instrument, z_t must be correlated with the shock of interest ε_t^p but orthogonal to all other shocks $\boldsymbol{\varepsilon}_t^q$, that is:

$$\mathbb{E}[z_t \varepsilon_t^{p'}] \neq 0 \qquad \text{(relevance condition)} \tag{8}$$

$$\mathbb{E}[z_t \boldsymbol{\varepsilon}_t^{q'}] = \mathbf{0} \qquad \text{(exogeneity condition)} \tag{9}$$

Let u_t^p the reduced form residual from the equation for the policy indicator (1-year government bond) and let $\boldsymbol{u}_t^q$ be the vector collecting the reduced form residuals from the equations for variables $q \neq p$. Also, let $\boldsymbol{s}^q, s^p \in \boldsymbol{s}$ be, respectively, the response of $\boldsymbol{u}_t^q$ and u_t^p to a unit increase in ε_t^p. After estimating the residuals $\mathbf{u}_t$ of the reduced form VAR in equation (6) using OLS, and provided that conditions 8-9 hold, the estimation of the elements in the vector $\boldsymbol{s}$ proceeds in two steps. First, regress u_t^p on its structural counterpart ε_t^p, replaced by the external instrument z_t, to form the fitted value $\hat{u}_t^p$. Second, given that the variation in $\hat{u}_t^p$ is due only to ε_t^p, the second stage regression of $\boldsymbol{u}_t^q$ on the resulting fitted value of $\hat{\boldsymbol{u}}_t^p$ yields a consistent estimate of $\boldsymbol{s}^q/s^p$:

$$\boldsymbol{u}_t^q = \frac{\boldsymbol{s}^q}{s^p} \hat{u}_t^p + \zeta \tag{10}$$

where $\hat{u}_t^p$ is orthogonal to the error term ζ, given assumption of equation 9. An estimate of s^p can be derived by using the estimated variance-covariance matrix of the reduced form model $\boldsymbol{\Omega} = \mathbb{E}[\boldsymbol{u}_t \boldsymbol{u}_t^{'}] = \mathbb{E}[\boldsymbol{S}\boldsymbol{S}^{'}]$ and equation 10. Finally, we can derive the implied series of structural monetary policy shocks by inverting the structural VAR impact matrix. We aggregate the resulting structural monetary policy shocks over quarters with a simple time sum to obtain a series of shocks at quarterly frequency. Hereafter, we refer to the quarterly conventional monetary policy shock extracted from the proxy-SVAR as the conventional monetary shock, federal funds rate shock, or $\hat{s}_t^{FFR}$.

2.3.2 Unconventional monetary policy: large-scale asset purchases

To identify surprise changes in unconventional monetary policy, we rely upon the large-scale asset purchase (LSAP, hereafter) factor proposed by Swanson (2021). The author identifies the LSAP factor as one of the (three) principal components with the greatest explanatory power for asset price changes collected during the conventional 30-minute window around each FOMC announcement between July 1991 and June 2019.[30] The LSAP factor can be interpreted as *"the component of FOMC announcements that conveys information about asset purchases above and beyond changes in the federal funds rate itself"* (Swanson, 2021, p. 37). In line with the literature on the effects of quantitative easing in the U.S., changes in the LSAP factor have small effects on yields at short maturities while having large long-term rates, particularly on the 5 and 10-year Treasury Bond yields (Vissing-Jorgensen and Krishnamurthy, 2011). Notice that we do not find evidence for the relevance of the *"Fed response to news"* channel when focusing on LSAP shocks.[31] Specifically, we get virtually unchanged estimates when adjusting the LSAP factor using the Greenbook forecasts as suggested by Kim et al. (2020). Hereafter, we refer to the quarterly LSAP factor as the unconventional monetary shock, asset purchase shock, or $\hat{s}_t^{LSAP}$. Both shocks presented in this Section are plotted in Figure 2.1.

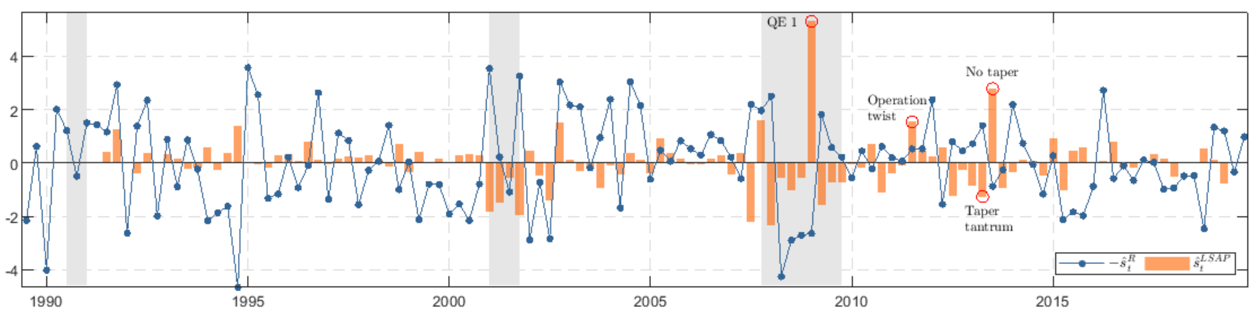


Fig. 2.1 Monetary policy shocks

Notes: This figure plots the monetary policy shocks presented in this section and used to estimate the macroeconomic and distributional effects of monetary policy.

2.3.3 Model

The baseline model to estimate the macroeconomic and distributional effects of conventional and unconventional monetary policy shocks is a standard VAR model:

$$\underset{n\times 1}{\mathbf{y}_t} = \underset{n\times 1}{\mathbf{c}} + \sum_{j=1}^{p} \underset{n\times n}{\mathbf{B}_j}\, \mathbf{y}_{t-j} + \underset{n\times 1}{\mathbf{u}_t} \quad \text{with} \quad \mathbf{u}_t \sim \mathcal{N}\left(\underset{n\times 1}{\mathbf{0}}, \underset{n\times n}{\mathbf{\Omega}}\right) \tag{11}$$

[30] Asset prices include federal funds futures, Eurodollar futures, several Treasury bond yields, S&P500, and exchange rates. By construction, the LSAP factor is orthogonal to the other two factors which capture changes in the federal funds rate and forward guidance.

[31] The results are not shown and are available upon request. In addition, the set of predictors proposed by Bauer and Swanson (2022) and published on April, 28 2022 will be used to orthogonalize the raw LSAP shock and control for the *Fed respond to news* channel.

where $\mathbf{y}_t$ is a $(n \times 1)$ vector of endogenous variables, $\mathbf{c}$ is a $(n \times 1)$ vector of intercepts, $\mathbf{B}_j$ 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 $\mathbf{\Omega}$. Time is indexed by $t = 1, \ldots, T$, each time period is a quarter, and the maximum lag length p is set to 4 as it is standard in VAR models using US macroeconomic time series.

This model may be subject to the "curse of dimensionality" due to the large number of parameters to be estimated relative to the sample length. Hence, we estimate the VAR with Bayesian techniques following the methodology outlined in Giannone et al. (2015). This setting treats the hyperparameters, which determine the prior distribution and describe their informativeness for the model coefficients, as random variables and conduct posterior inference also on them. The motivation for this strategy is twofold. First, the hierarchical approach greatly reduces the importance and numbers of subjective choices in the setting of the prior. Second, with respect to standard flat priors, the hierarchical approach increases the efficiency of impulse responses estimates at the cost of a relatively small bias.

2.3.3.1 Internal instrument approach

To estimate impulse response functions we use the two shocks as *internal instruments* following Plagborg-Møller and Wolf (2021). In addition to conditions 8 and 9, the *internal instrument* approach requires the instrument, say z_t, to be orthogonal to leads and lags of the structural shocks, say $\boldsymbol{\varepsilon}_t$, that is:

$$\mathbb{E}[z_t \boldsymbol{\varepsilon}_{t+k}] = \mathbf{0}, \quad \text{for } k \neq 0 \tag{12}$$

Under assumptions 8-9 and 12, we can estimate the dynamic causal effects of monetary policy by augmenting the VAR with the instruments presented in previous sections. If the instrument is contaminated with measurement errors or the VAR is non-invertible, the internal instrument (recursive) approach delivers valid estimation of relative impulse responses (see Li et al., 2021 and Plagborg-Møller and Wolf, 2021 for a formal treatment, and Känzig, 2021a for a recent application). Under the internal instrument approach, the vector of endogenous variables can be partitioned as:

$$\mathbf{y}_t = \left[\hat{s}^i_t, \tilde{\mathbf{y}}_t\right]' \tag{13}$$

where $\hat{s}^i_t$ is, alternatively, the conventional ($\hat{s}^{FFR}_t$) and unconventional ($\hat{s}^{LSAP}_t$) monetary policy shock, and $\tilde{\mathbf{y}}_t$ is a vector containing macroeconomic, financial and distributional variables. Intuitively, this allows the variables in the vector $\tilde{\mathbf{y}}_t$ to respond to the instrument $\hat{s}_t^i$ on impact.

2.4 Results

As a first step, we explore the macroeconomic effects of conventional and unconventional monetary policy shocks identified in the previous section. We use a version of the VAR model in equation (11) in which the vector of endogenous variables $\mathbf{y}_t$ includes, in the following order: the monetary policy instrument, real GDP, the consumer price index, the Gilchrist and Zakrajšek (2012) excess bond premium and the policy variable. In the model for conventional (unconventional) monetary policy, the instrument is $\hat{s}_t^{FFR}$ ($\hat{s}_t^{LSAP}$) while the policy variable is the 1-year Treasury yield (term spread). The term spread is the difference between the 10-year Treasury and the 3-month Treasury yield.[32]

Table 2.1 summarizes variables, units, and sources pertaining to the baseline model. We estimate the distributional effects of conventional and unconventional monetary policy shocks by augmenting the baseline model with data on the distribution of household wealth from the DFA. All models with conventional monetary policy shocks are estimated using quarterly time series from 1989Q3 to 2019Q4 while the estimation sample for the models with unconventional monetary policy shocks goes from 1991Q3 to 2019Q2.[33] All variables but the monetary policy shocks, interest rates and spreads enter in level of their natural logarithm. Interest rates and spreads enter in percent. Real variables are deflated using the consumer price index. Moreover, to compare the results across models, in the following sections we report impulse responses normalized to generate a 1% response of real GDP four quarters after the monetary policy shock.

[32] With quarterly data, we prefer the term spread over the most commonly used 10-year Treasury yield for estimating the effects of unconventional monetary policy shocks. In a different exercise, we replaced the term spread with the 10-year Treasury yield and estimated the model on the full sample. This model yields a not significant response of the 10-year Treasury yield to asset purchase shocks. Although the sequences of asset purchase shocks might not be relevant for long-term rates in the full sample, they turn out to be quite relevant once we restrict the estimation sample to exclude the pre-crisis period in a monthly model. In this case, the monthly VAR model includes industrial production, the consumer price index, the excess bond premium and the 10-year Treasury yield. These results are not shown but are available upon request.

[33] The difference in estimation sample is due to the length of the shock series. The results for the conventional monetary policy shock are not sensitive when setting the same sample to 1991Q3–2019Q2.

Series	Unit	Source
Baseline models		
Conventional ($\hat{s}_t^R$)/unconventional ($\hat{s}_t^{LSAP}$) shock		Sections 2.3.1 and 2.3.2
Real GDP	BoC 2012$	Bureau of Economic Analysis
Consumer price index	2015 = 100	Bureau of Economic Analysis
Excess bond premium	Percent	Gilchrist and Zakrajšek (2012)
Interest rate or spread:		
1-year Treasury Constant Maturity Rate	Percent	McCracken and Ng (2021)
Term spread	Percent	McCracken and Ng (2021)
Models with aggregate balance sheet		
Baseline model		
Real assets/liabilities/wealth	Bil of 2015$	Distributional Financial Accounts
Models with Distributional Financial Accounts data		
Baseline model		
Real assets/liabilities/wealth of Bottom 50%	Bil of 2015$	Distributional Financial Accounts
Real assets/liabilities/wealth of Next 40%	Bil of 2015$	Distributional Financial Accounts
Real assets/liabilities/wealth of Next 9%	Bil of 2015$	Distributional Financial Accounts
Real assets/liabilities/wealth of Top 1%	Bil of 2015$	Distributional Financial Accounts

Table 2.1 MODELS

2.4.1 Macroeconomic effects of monetary policy

Figure 2.1 reports the dynamic effects of conventional (solid blue line) and unconventional (orange line with markers) expansionary monetary policy shocks from the baseline models. Both shocks lower the 1-year Treasury yield and the term spread on impact.[34] Both conventional and unconventional monetary policy shocks raise real GDP and the price level, in line with several studies on the macroeconomic effects of monetary policy (see Ramey, 2016, for an extensive survey). However, a conventional monetary policy shock has more lasting effects on activity and prices relative to its unconventional counterpart. Specifically, the hump-shaped output and price responses to an unconventional monetary policy shock are coherent with the findings in Inoue and Rossi (2021). In line with the literature on the transmission of monetary policy through the financial sector, the excess bond premium falls in response to both shocks, suggesting that monetary policy works by easing financial conditions and decreasing the degree of risk aversion in the

[34] In an alternative specification, we include the level of securities held by the Federal Reserve System in place of the term spread. We find that the asset purchase shock leads to a persistent increase in securities held by the Federal Reserve System. This, in turn, reinforces our view that the large asset purchase shock effectively captures an unconventional monetary policy shock. These results are available upon request.

economy (Gertler and Karadi, 2015).

Fig. 2.1 Macroeconomic effects of monetary policy shocks

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from a Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to induce a 1 percentage point increase in real GDP. Shaded areas are 68% and 90% posterior coverage bands.

Figure 2.2 shows the response of wealth, assets, liabilities, and their components for the aggregate household sector to both shocks.[35] The components of the aggregate household balance sheet to the baseline models are added one by one to estimate the aggregate response of the household sector to the shocks. Both monetary policy shocks lead to an increase in total household wealth. This increase occurs earlier and it is more persistent when generated by a conventional monetary policy shock than by its unconventional counterpart.

[35]We obtain the aggregate balance sheet of the household sector by summing up each item in the DFA across wealth groups. The aggregate wealth, assets, and liabilities are deflated using the consumer price index and enter the model in log level.

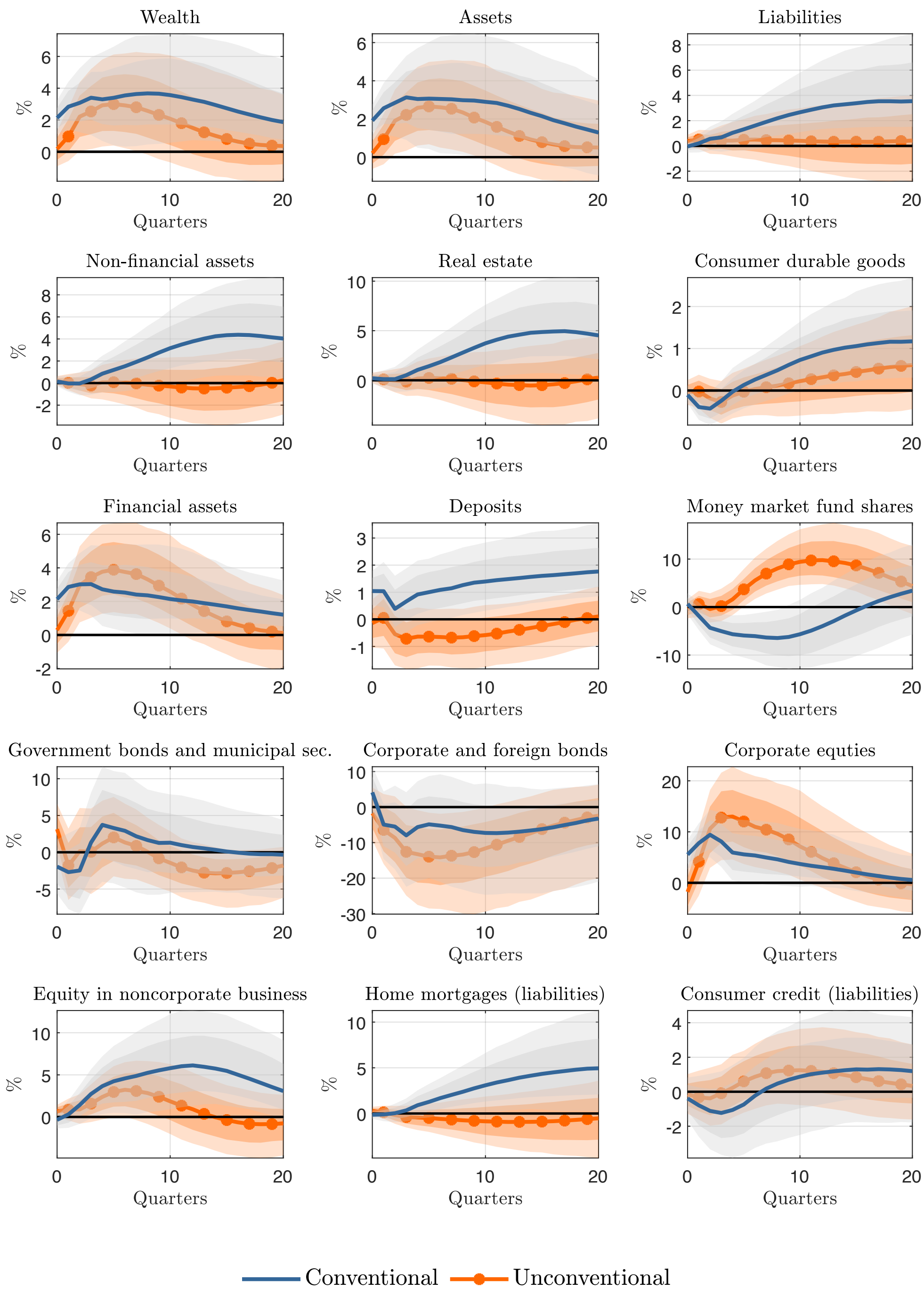


Fig. 2.2 Effects of monetary policy shocks on aggregate household balance sheet components

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from a Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to induce a 1 percentage point increase in real GDP. Shaded areas are 68% and 90% posterior coverage bands.

Moving on to asset components, a federal funds rate shock generates an increase in the level of non-financial assets, particularly in real estates, which materializes at the end of the first year after the shock. In contrast, non-financial assets are largely unresponsive to an asset purchase shock. Unsurprisingly, an unconventional monetary policy shock has larger effects, though less persistent, on financial assets than its conventional counterpart. Liquid assets exhibit very different responses according to the type of monetary policy. A conventional monetary policy shock leads to a persistent increase in the level of deposits – checkable and time deposits, currency, and short-term investments – and a temporary, though much larger, decrease in money market fund shares. In contrast, an asset purchase shock marginally reduces deposits and leads to large increases in the real value of money market fund shares for the aggregate household sector. The increase in money market fund shares in response to an unconventional monetary policy shock is notably large, reaching 10% two years following the shock. In contrast to government bonds and municipal securities, the real value of bonds issued by corporations and foreigners decreases after both shocks, in particular after an asset purchase shock. Corporate and noncorporate equities increase in response to both shocks. For corporate equities, which also include holdings of mutual funds, an asset purchase shock has larger effects than a federal funds rate shock, with the more than 10% peak response occurring roughly after one year following the shock. Noncorporate equities, in contrast, increase more in response to a conventional than to an unconventional monetary policy shock.

Turning to the responses of liabilities, the only notable effect is the persistent increase in home mortgages in response to a federal funds rate shock, which drives the reaction of total liabilities. Notice that this response is similar in size and sign to the reaction of real estates on the asset side.

2.4.2 Distributional effects of monetary policy

The impulse responses shown in Figure 2.2 mask the heterogeneous responses of households across the wealth distribution. To illustrate this heterogeneity, we augment the baseline models with the components of the balance sheet for each wealth group in the DFA. All components of the balance sheet are deflated using the consumer price index and enter in level of their natural logarithm.[36]

WEALTH. The impulse responses of wealth to a federal funds rate and an asset purchase shock in Figure 2.3 suggest that a monetary policy expansion has heterogeneous

[36]In other words, for each component of the balance sheet, say wealth, we augment the baseline model with the levels of wealth of the Bottom 50%, Next 40%, Next 9% and Top 1%, respectively. This implies that vector of endogenous variable $\mathbf{y}_t$ contains nine variables (see Table 2.1).

effects on household wealth across the distribution. Both shocks raise the wealth of all groups, with the tails of the distribution experiencing the largest increase. A federal funds rate shock raises Bottom 50% and Top 1% wealth up to a maximum of 10% and 4%, respectively. However, the response of the Bottom 50% is significant only at the 68% credibility interval. A conventional monetary policy shock has small though persistent effects on the wealth of both the Next 40% and Next 9%. Similarly, an asset purchase shock raises wealth across all groups, albeit less persistently in relation to its conventional counterpart.

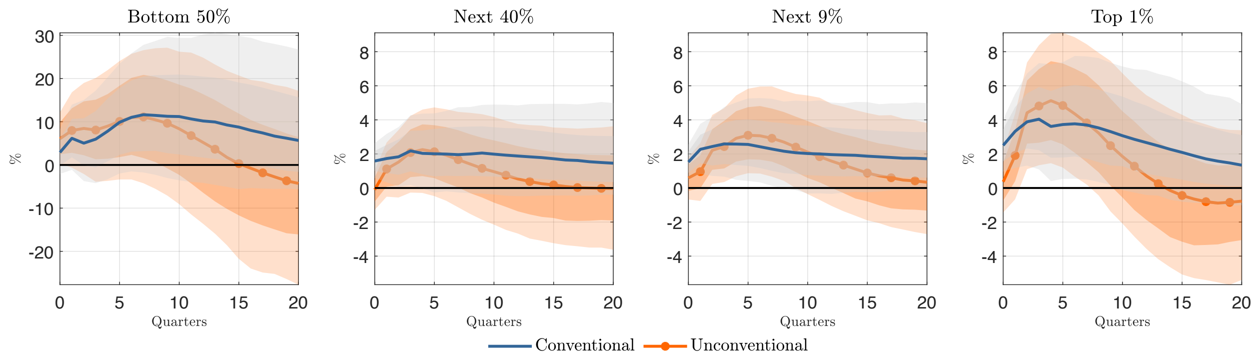


Fig. 2.3 Wealth

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from a Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to induce a 1 percentage point increase in real GDP. Shaded areas are 68% and 90% posterior coverage bands.

WEALTH SHARES. Figure 2.4 plots the impulse responses of wealth shares. Both shocks cause the wealth share of the Top 1% to increase in the first two years, especially for the asset purchase shock. At their peak values, the effect of an unconventional shock is twice that of its conventional counterpart. For all other groups, the evidence is mixed. The wealth share of the Bottom 50% slightly increases following a conventional shock, while its response is more subdued after an unconventional shock. The wealth share of the Next 40% decreases following both shocks, particularly after an asset purchase shock. Lastly, the Next 9% experiences a fall in the wealth share after both shocks, which is temporary after an asset purchase shock. Taken together, these results suggest that expansionary monetary policy shocks have distributional effects as they induce shifts in the wealth shares. Specifically, both shocks induce a temporary redistribution from the Next 40% towards the top tail. This is especially true for the asset purchase shock.

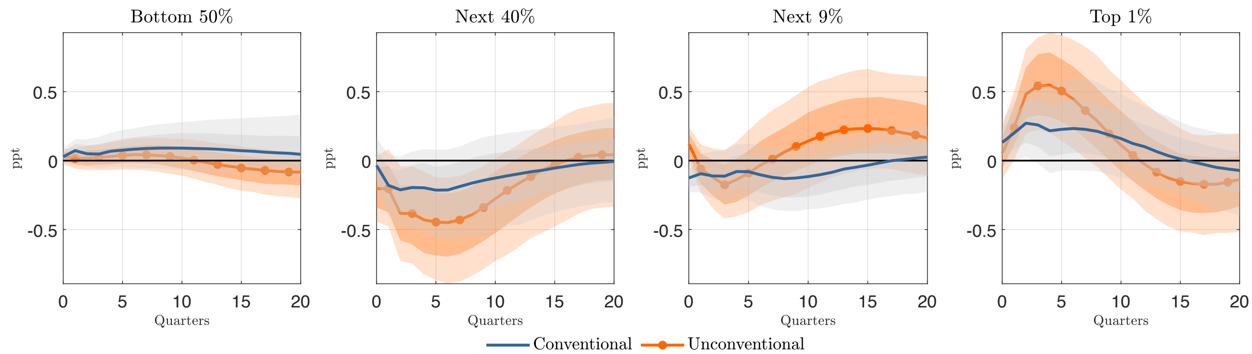


Fig. 2.4 Wealth shares

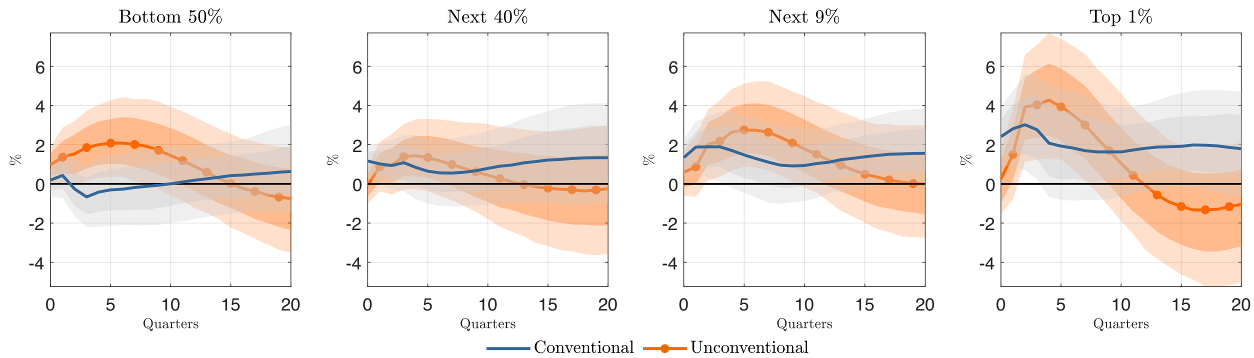
Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point $\times 100$) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

2.4.3 Heterogeneous effects of monetary policy on balance sheet components

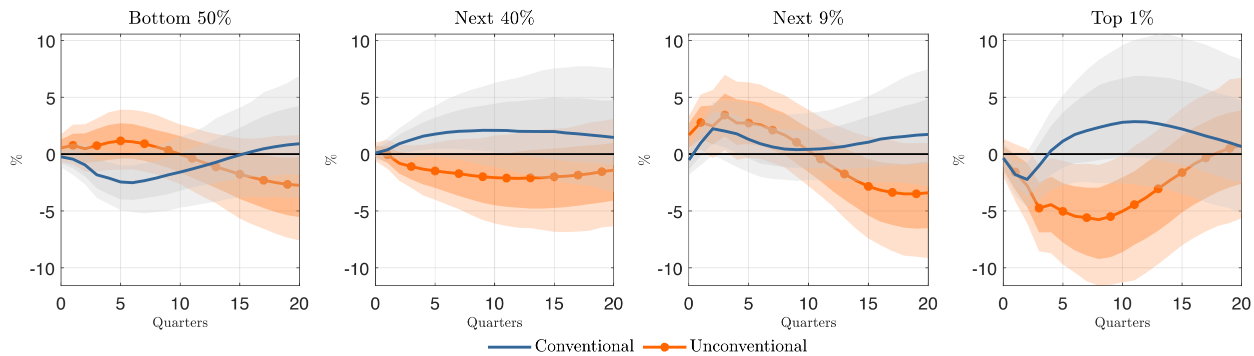
In this section we explore in details the responses of assets, liabilities, and their components.

TOTAL ASSETS AND LIABILITIES.

Panel A in Figure 2.5 shows that the benefits of a federal funds rate shock on the level of total assets are increasing in the wealth distribution, with the Top 1% recording the largest increase. An asset purchase shock leads to similar effects, with the only difference that the Next 40% experiences a smaller increase in the level of assets relative to the lower tail of the distribution. Moreover, panel B in Figure 2.5 indicates that an unconventional monetary policy shock temporarily raises the liabilities of the Bottom 50% and the Next 9% while decreasing them for all other wealth groups, especially for the Top 1%. A federal funds rate shock, instead, reduces the liabilities of the Bottom 50% while increasing them for all other wealth groups. For the Top 1%, however, the rise in liabilities materializes only after an initial decline.



(a) Assets

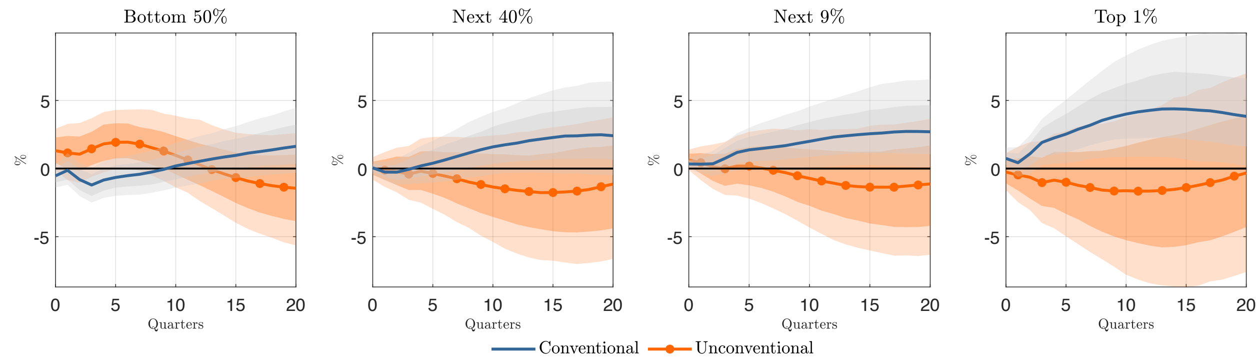


(b) Liabilities

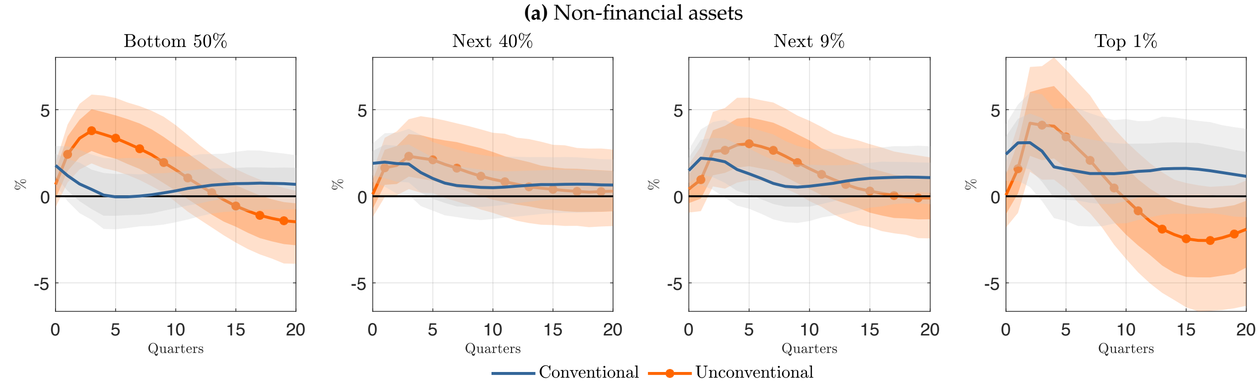
Fig. 2.5 Total assets and Liabilities

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point $\times 100$) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

FINANCIAL AND NON-FINANCIAL ASSETS. We now disaggregate the components of total assets. As shown in panels A and B of Figure 2.6, the benefits of a conventional monetary policy shock on financial and non-financial assets are increasing in the wealth distribution. An asset purchase shock increases the level of non-financial assets only for the Bottom 50% (panel A) and raises the level of financial assets for all wealth groups (panel B). Furthermore, the increase in financial assets is larger at the tails of the distribution.



(a) Non-financial assets

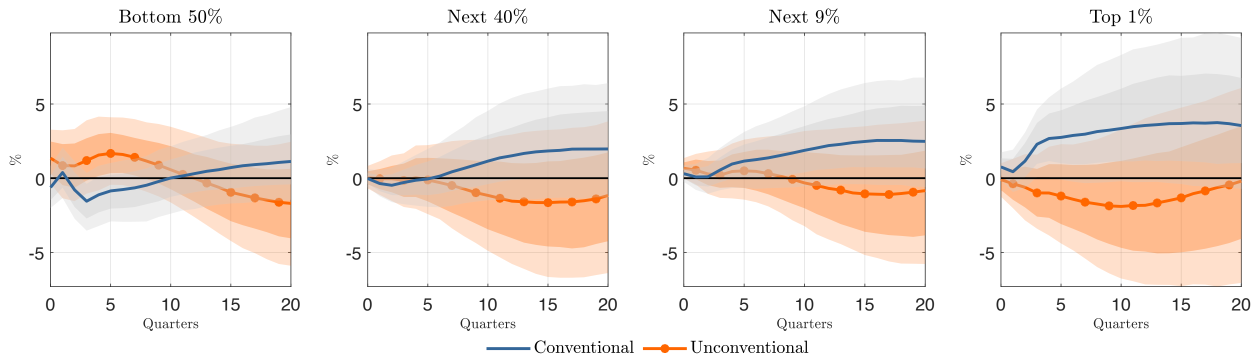


(b) Financial assets

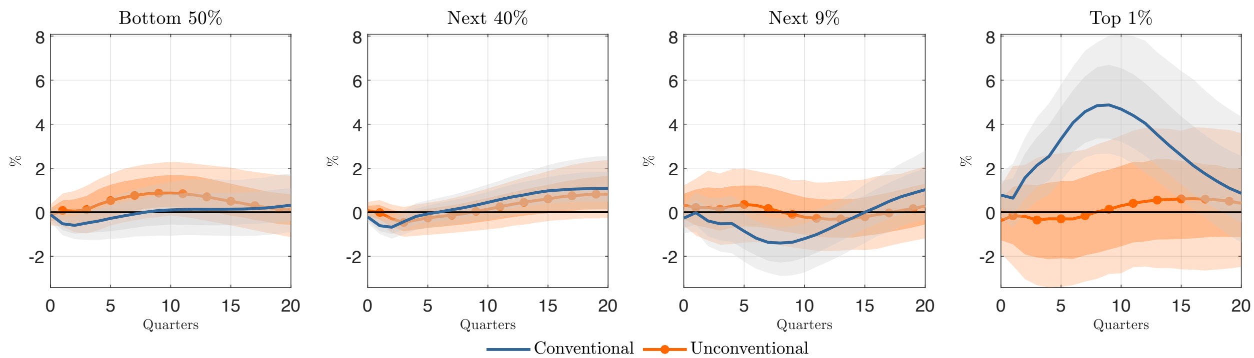
Fig. 2.6 Financial and non-financial assets

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point $\times 100$) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

NON-FINANCIAL ASSETS. Both shocks lead to very different effects on real estates and consumer durables depending on the wealth group. Panel A in Figure 2.7 suggests that the increase in the level of real estates for the household sector shown in Figure 2.2 is largely driven by the top tail. Indeed, the Bottom 50% experiences a temporary reduction in the level of real estates. Panel B, instead, shows that a federal funds rate shock lowers (raises) the level of consumer durables for the Next 9% (Top 1%). In contrast, a conventional shock has no effects for the Bottom 50% and the Next 40%. Lastly, an asset purchase shock has no significant impact on consumer durables except for households in the Bottom 50% that experience a small temporary increase.



(a) Real estates

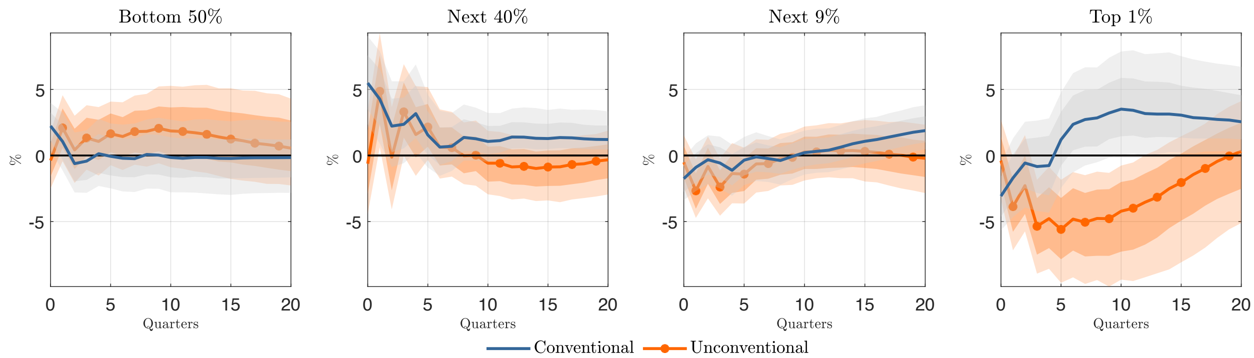


(b) Consumer durables

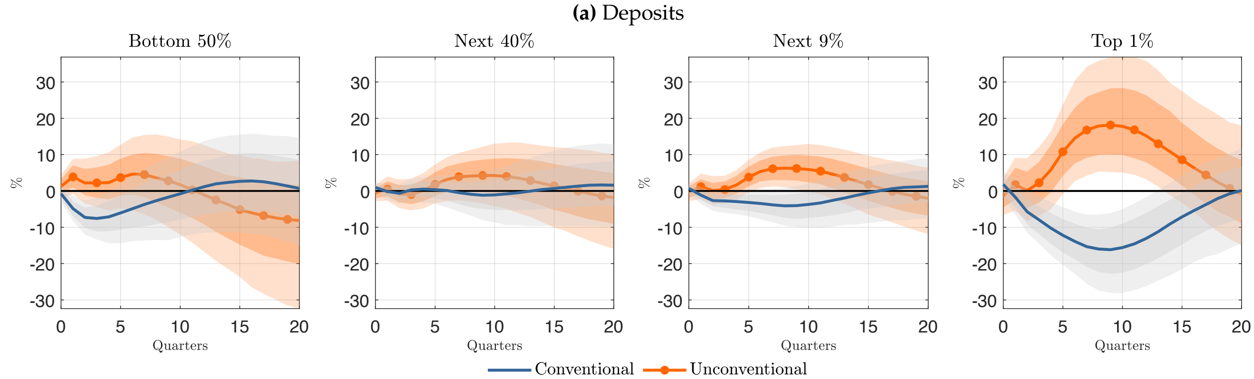
Fig. 2.7 Non-financial assets: real estate and consumer durables

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point $\times 100$) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

LIQUID ASSETS. Panel A in Figure 2.8 shows that monetary policy shocks have heterogeneous effects on holdings of liquid assets – deposits (currency, time and saving deposits, short-term investments) and money market fund shares – across the wealth distribution. In response to a federal funds rate shock, holdings of deposits rise on impact for the Next 40% and the Bottom 50%, albeit more persistently for the former. Instead, the Top 1% experiences a delayed increase. In response to a federal funds rate shock, holdings of deposits rise for the Top 1%, the Next 40%, and the Bottom 50%. However, this increase is limited to the first quarter for the bottom tail and from the second year onward for the top tail. Instead, this shock has no significant effect on the level of deposits for the Next 9%. Following an asset purchase shock, the level of deposits falls at the top of the distribution, especially for the Top 1%. For the Bottom 50% and the Next 40%, instead, the level of deposits increases. The deposit response of households in the Bottom 50% and Next 40% to the federal funds rate shock traces the taxonomy of households in HANK



(a) Deposits



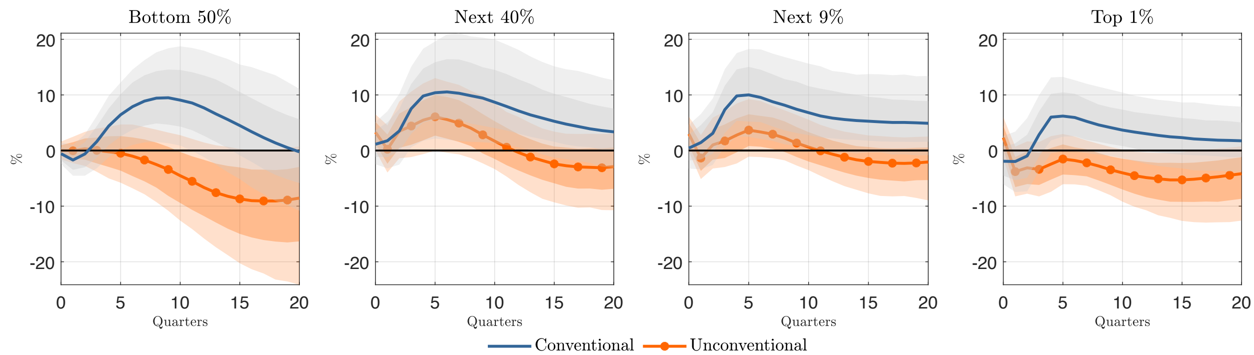
(b) Money market funds shares

Fig. 2.8 Liquid assets

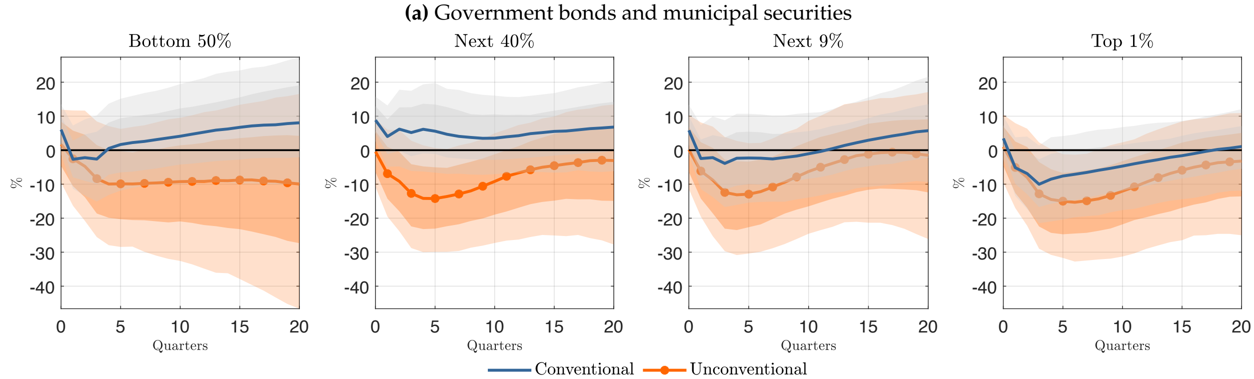
Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point $\times 100$) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

models. Households in the Next 40% hold large illiquid wealth and small liquid wealth, while households in the Bottom 50% have generally little wealth (Table 2.2). Hence, these groups can be thought of as representing the wealthy and poor hand-to-mouth households, respectively (Kaplan et al., 2014). Indeed, in response to an expansionary shock, the Bottom 50% can only increase deposits by a little margin. Instead, consistently with a precautionary saving motive, the rise in deposits for the Next 40% is much larger.

Money market fund shares represent another form of very liquid assets that can be used as a saving vehicle and a low-risk financial investment. They are very unequally distributed among households, with the Top 10% of the wealth distribution owning more than two thirds of money market fund shares of the whole household sector. In contrast, households in the Bottom 50% own less than 2% of money market fund shares. Although money market fund shares are another form of very liquid asset, their response to a conventional monetary policy shock is very different relative to deposits for all groups (Figure 2.8, panel B). The level of money market fund shares decreases for all groups, except for the Next 40%. More specifically, the fall in money market fund shares is the largest for the Top 1%. In contrast, an asset purchase shock raises the level of money market fund shares mainly for the top tail. Again, the Top 1% benefits the most from an unconventional monetary policy shock as the real value of money market funds shares increases by 20% at the peak.



(a) Government bonds and municipal securities



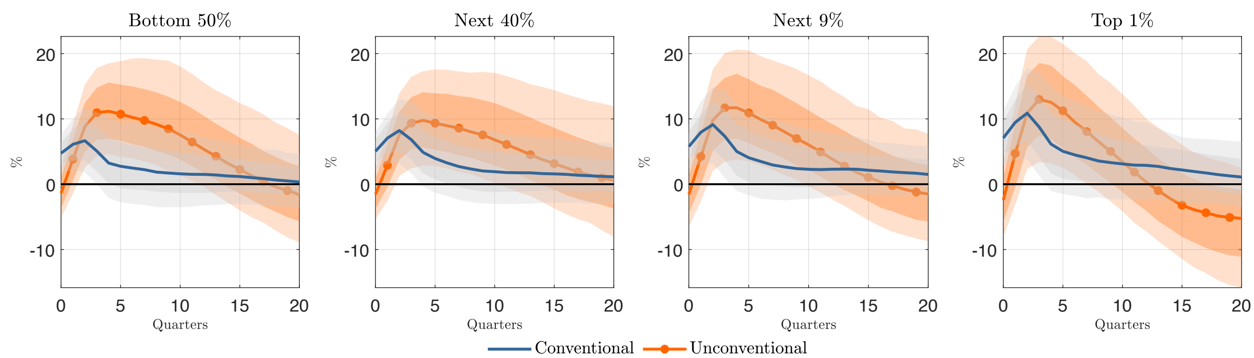
(b) Corporate and foreign bonds

Fig. 2.9 Bonds

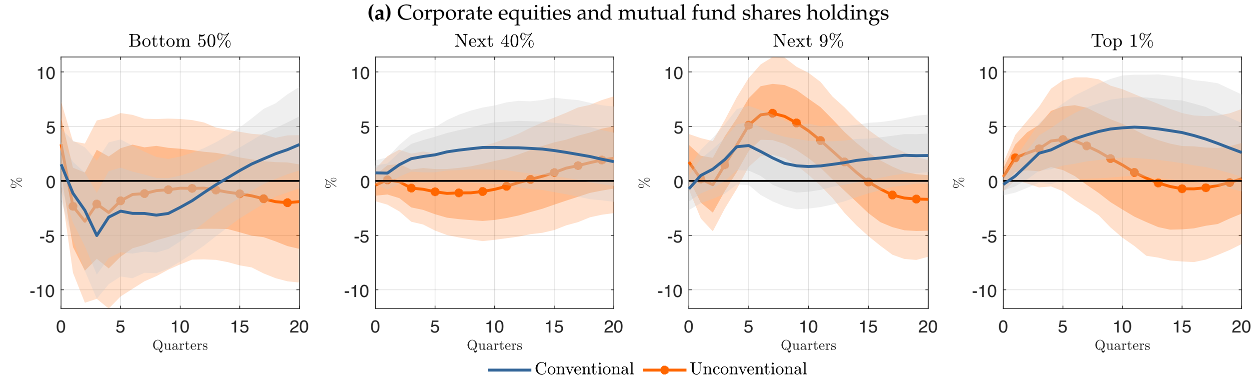
Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point $\times 100$) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

BONDS. Bonds are very unequally distributed among households. Although the degree of liquidity varies substantially between US government bonds and corporate and foreign bonds, these instruments represent a further buffer of liquid assets that households can use to shield their consumption from income fluctuations. Moreover, and perhaps most importantly, bonds provide a source of financial income and allow households to diversify their earnings. Figure 2.9 shows that a federal funds rate shock increases the level of US government bond and municipal securities for all groups. In contrast, an asset purchase shock reduces the level of government bonds and municipal securities only at the tails of the distribution. Panel B shows that a conventional monetary policy shock has a statistically negligible effect on holdings of corporate and foreign bonds. Instead, an asset purchase shock reduces corporate and foreign bonds for all wealth groups.

EQUITIES. Figure 2.10 plots the impulse responses for corporate equities and mutual fund shares (panel A) and for equity in noncorporate business (panel B). Both shocks increase the level of corporate equities and mutual fund shares for all wealth groups, especially for households at the top, which own almost half of corporate equities in the economy. Panel B indicates that a federal funds rate shock raises the level of equity in noncorporate business for all groups but the Bottom 50%. In contrast, an asset purchase shock increases equity in noncorporate business of households in the top tail of the wealth distribution.



(a) Corporate equities and mutual fund shares holdings

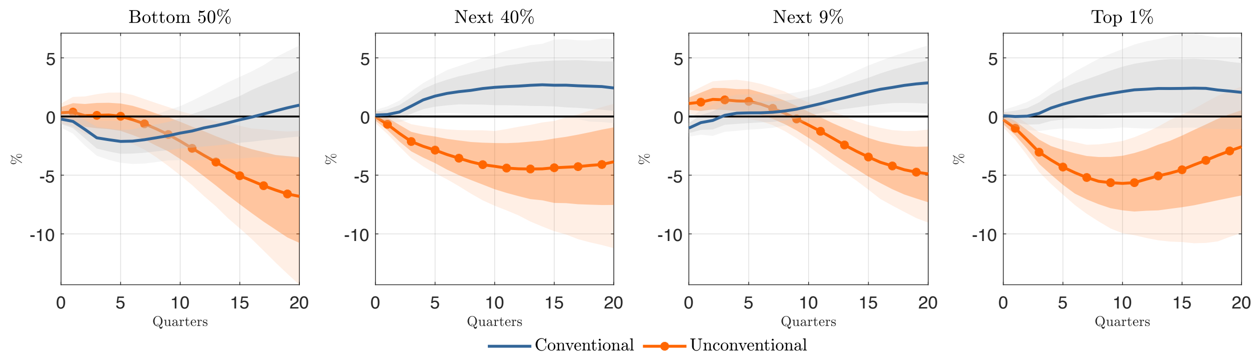


(b) Equity in noncorporate business

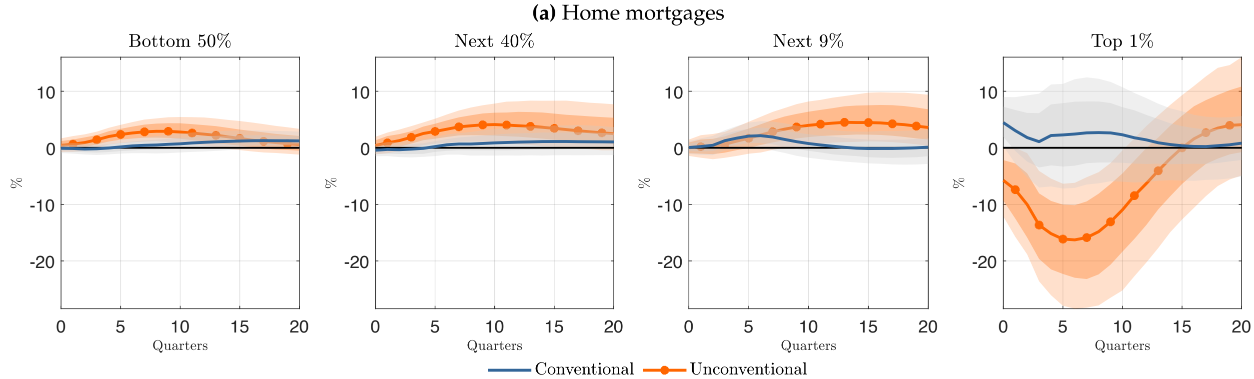
Fig. 2.10 Equities

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point $\times 100$) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

LIABILITIES. Figure 2.11 plots the responses for home mortgages (panel A) and consumer credit (panel B). A conventional monetary policy shock reduces the level of outstanding home mortgages only for the Bottom 50%. Instead, an asset purchase shock persistently reduces home mortgages for all wealth groups. Panel B shows that a federal funds rate shock has negligible effects on outstanding consumer credit for all wealth groups but the Top 1%. Similarly, an asset purchase shock, increases consumer credit for all groups but the Top 1% which records a large reduction.



(a) Home mortgages



(b) Consumer credit

Fig. 2.11 Liabilities

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (or 1 log point ×100) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

2.5 The portfolio composition channel

Although expansionary monetary policy shocks raise the wealth of all households across the distribution, they induce changes in wealth shares favoring the very top tail. What are the channels through which such a redistribution of wealth occurs? Is there a role for monetary policy? Answering these questions is not straightforward as the factors driving the dynamics of wealth accumulation, namely asset prices and saving, can be influenced by monetary policy only to some extent. In this section, we explore how changes in asset prices induced by monetary policy shocks influence the wealth distribution (portfolio composition channel) and explain differences in wealth growth across groups since 2008.

Wealth levels change across time as a result of changes in the saving rate and capital gains. Shifts in the saving rate affect wealth levels through quantity effects, that is, by changing the volume of wealth. Capital gains, instead, are driven by (relative) asset price changes and they influence wealth levels through valuation effects. Kuhn et al. (2020) show how changes in asset prices influence both wealth levels and shares when portfolios are heterogeneous. To show how asset price changes and differences in portfolios generate heterogeneous capital gains, let $\left\{A^i_{j,t}\right\}_{j=1}^{J}$ be a portfolio of assets $j = 1, \ldots, J$ owned by households in wealth group i at time t and let W^i_t be the wealth (assets net of liabilities) of each group. Then, the growth rate of group i's wealth from capital gains reads as:

$$q^i_t = \sum_{j=1}^{J} \left(\frac{p_{j,t+1}}{p_{j,t}} - 1 \right) \frac{A^i_{j,t}}{W^i_t} \tag{14}$$

where $A^i_{j,t}/W^i_t$ is the portfolio share of asset j for group i in period t and $p_{j,t}$ is a (real) price index for asset j in period t.[37] Equation 14 shows that portfolio differences captured by the term $A^i_{j,t}/W^i_t$ lead to different capital gains q^i_t for a given asset price change. The distribution of assets in Table 2.1 together with equation 14 suggest that portfolio heterogeneity along the wealth distribution is crucial for explaining differential growth rates of wealth from capital gains.

Portfolio heterogeneity across the wealth distribution gives rise to the so-called portfolio composition channel of monetary policy. Monetary policy shocks lead to changes in asset prices (Figure 2.1) which drive differential capital gains if portfolios are heterogeneous. In turn, differential capital gains driven by (monetary policy-induced) changes in asset prices may contribute to the unequal growth of wealth across groups.

2.5.1 Asset price changes drive differentials in wealth growth

Following Kuhn et al. (2020), we compute asset prices-induced wealth growth for each group i (Bottom 50%, Next 40%, Next 9% and Top 1%) of the wealth distribution, for asset j, between the base period 0 and quarter t:

$$\frac{A^i_{j,0}\left(\frac{p_{j,t+1}}{p_{j,0}-1}\right)}{W^i_0} \tag{15}$$

[37] As in Kuhn et al. (2020) and Lenza and Slacalek (2021), we assume that different wealth groups face the same asset price index.

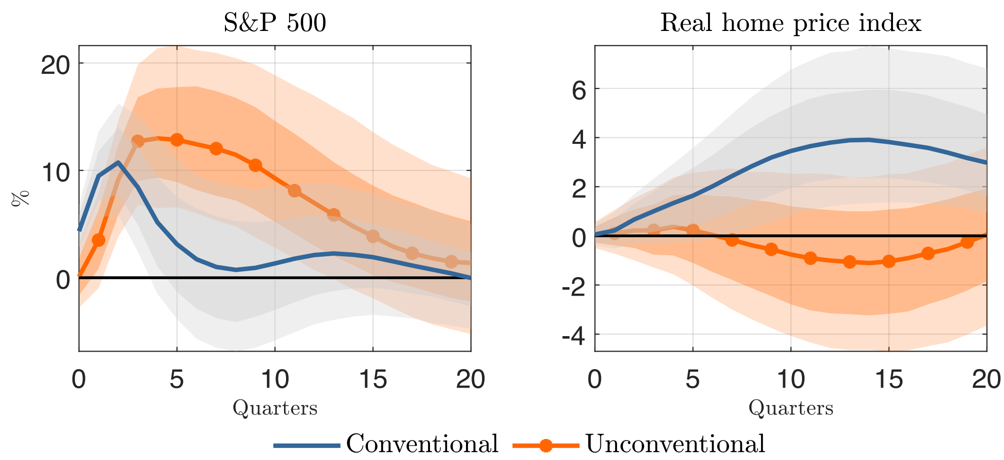


Fig. 2.1 Response of asset prices to monetary policy shocks

Notes: Impulse responses to conventional (blue line) and unconventional (orange line) monetary policy shocks from Bayesian VAR. Solid lines are median impulse responses from the posterior distribution. Impulse responses are scaled to imply a 1 percentage point (1 log point) response of real GDP. Shaded areas are 68% and 90% posterior coverage bands.

where $A^i_{j,0}$ and W^i_0 designate holding of asset j by group i and wealth of group i in the base period, respectively. Both wealth and assets are deflated using the consumer price index. For simplicity, we consider only two assets: real estates and corporate equity and mutual funds holdings. For the asset price index $p_{j,t}$, we use the real S&P/Case-Shiller National Home Price Index to price real estates and the S&P 500 (real) stock price index to price holdings of corporate equity and mutual funds.[38] The base period is the first quarter of 2008.

Although monetary policy shocks can potentially affect the market value of most assets in the balance sheet of the household sector, we focus only on wealth growth driven by changes in house and stock prices. A first reason is that real estates and corporate equities are among the most unequally distributed assets in the DFA (see Table 2.1) which, according to equation 14, is a necessary condition for generating differential capital gains and wealth growth across groups. Moreover, current debates on the distributional effects of low interest rates and asset purchase programs center on the presumably inflationary effects these policies have on house and equity prices. A further reason for focusing only on wealth growth driven by price changes in housing and stock markets is that finding the correct price index to price asset holdings in the DFA is not straightforward. Feilich (2021), for example, builds a composite price index that reflects the heterogeneity in port-

[38]Notice that we cannot separate neither between corporate equities and mutual funds holdings nor between equities issued by domestic and foreign corporate equities in the Distributional Financial Accounts. Therefore, the S&P 500 stock price index can be considered as an approximation of the price index for corporate equities and mutual funds holdings.

folio compositions across wealth groups in the DFA by assuming that many prices are equal to 1 or that both corporate and noncorporate equities can be priced using the same price index.

For each wealth group, the yellow solid line in Figure 2.2 plots the share of wealth growth since 2008 driven by house price (panel A) and stock price (panel B) changes. Differences in the shares of wealth growth across groups and between asset classes are telling of the the race between the housing market and the stock market (Kuhn et al., 2020); the lower-middle class gains relatively more than the top when the housing market is booming while households in the top gain relatively more than the lower-middle class when the stock market is thriving. Since 2008, all wealth groups have experienced a reduction in wealth because of changes in house prices (panel A). However, the consequences of falling house prices have not been equally borne in the society because wealth groups differ in the relative exposure to house price changes. Between 2008 and 2012, about 18% of the fall in wealth of the Bottom 50% was driven by the contraction in house prices. Moving toward the top of the distribution, the share in wealth growth between 2008 and 2012 explained by house prices diminishes as real estates become relatively less important than other asset classes. The other side of the coin of the race between the housing and stock market is that rising stock prices did not benefit equally all wealth groups (panel B). Between 2008 and 2020, Top 1% increased wealth by up to 4% because of rising stock market valuations.[39]

2.5.2 Monetary policy, asset price changes and heterogeneous wealth growth

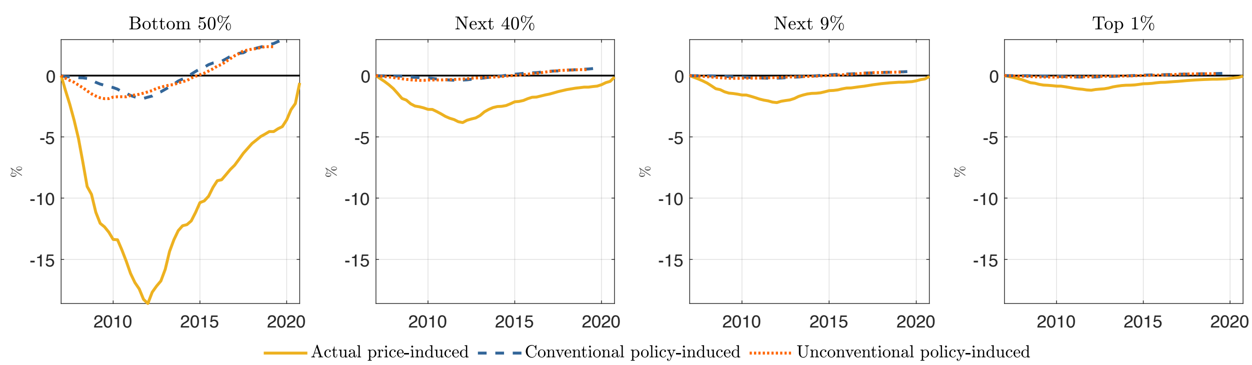
Heterogeneous portfolios make the wealth distribution highly sensitive to changes in asset prices, regardless of the influence of heterogeneous saving dynamics on the accumulation of wealth. As monetary policy shocks have sizable effects on stock and house prices, we ask if monetary policy-induced asset price changes induce differentials in wealth growth.

We address this question by constructing a series of house and stock prices *as if* they were driven only by current and past conventional and unconventional monetary policy shocks. We refer to these counterfactual series as the conventional and unconventional monetary policy-induced house and stock prices (see Appendix for a detailed explanation). Then, we use the counterfactual series to obtain the share of wealth growth

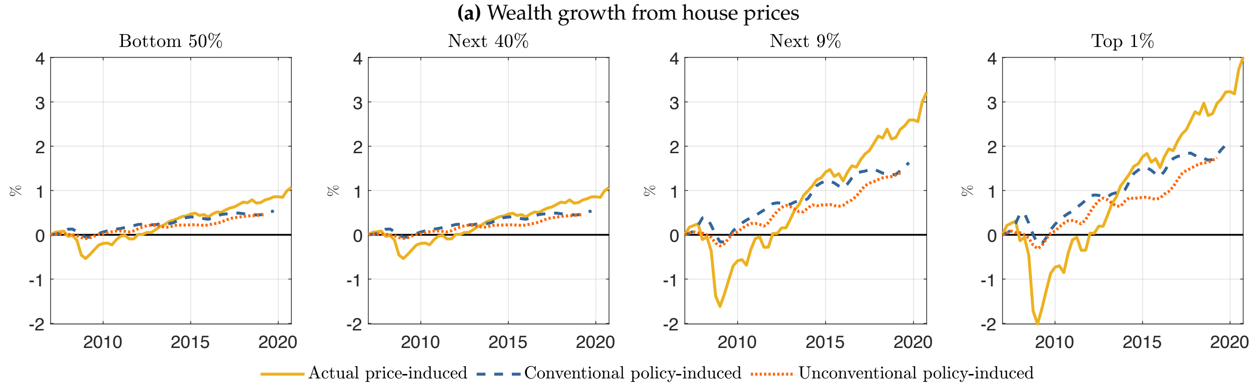
[39] Kuhn et al. (2020) provide similar estimates for the effects of asset prices on wealth growth using annual data from the Survey of Consumer Finances. They show that up to 15% of the fall in Bottom 50% wealth between 2007 and 2016 is due to lower house prices while up to 5% of Top 10% wealth growth during the same period is due to rising stock prices.

since 2008, driven by monetary policy-induced house and stock prices. In practice, we replace the observed price indexes in equation (15) with the counterfactual prices. In Figure 2.2, dashed blue lines plot the share of wealth growth since 2008 driven by conventional monetary policy-induced house (panel A) and stock prices (panel B). Similarly, dotted orange lines plot the share of wealth growth since 2008 driven by unconventional monetary policy-induced price changes in housing (panel A) and stocks (panel B).

The counterfactual exercise points to two key results. First, we provide evidence for the importance of the portfolio composition channel. Monetary policy shocks induce differences in wealth growth through its effects on asset prices. Heterogeneous portfolios and the uneven exposure of wealth to different asset prices explain the differential growth in wealth across groups. The relevance of the portfolio composition channel of monetary policy is particularly important for the Bottom 50% through house prices and for the Top 1% through stock prices.



(a) Wealth growth from house prices



(b) Wealth growth from stock prices

Fig. 2.2 Wealth growth from house and stock price changes, 2008-2020

Notes: The yellow lines show wealth growth from changes in house (panel A) and stock (panel B) prices. The dashed blue lines show wealth growth from changes in conventional monetary policy-induced house (panel A) and stock (panel B) prices. The dotted orange lines show wealth growth from changes in unconventional monetary policy-induced house (panel A) and stock (panel B) prices.

Second, Figure 2.2 sheds light on the quantitative importance of monetary policy in driving wealth inequality. We observe that wealth growth from house price changes (yellow solid line) since 2008 has been very different across groups due to heterogeneous portfolios. If monetary policy shocks were the only factor driving house prices (orange dotted and blue dashed lines), wealth growth from house prices would have been more homogeneous across groups. Panel B of Figure 2.2 reveals that the unequal distribution of equity holdings implies substantial heterogeneity in wealth growth from stock prices (yellow solid line). Such heterogeneity would persist even if prices were driven only by monetary policy shocks (orange dotted and blue dashed lines). Therefore, the main takeaway from this counterfactual exercise is that monetary policy appears to affect wealth inequality to a greater extent via the stock market than through the housing market.

2.6 Conclusions

In times of high income and wealth inequality, the expansionary stance of the Federal Reserve since the Global Financial Crisis has raised concerns about the distributional consequences of expansionary conventional and unconventional monetary policy.

Using the Distributional Financial Accounts of the United States, we have shown that monetary policy has heterogeneous effects on household balance sheets across the wealth distribution. Although all households benefit from expansionary federal funds rate and asset purchase policies, households in the top tail of the distribution gain the most in terms of wealth shares. In comparison, unconventional monetary policy shocks have larger distributive consequences relative to their conventional counterpart. For each asset class, we find substantial heterogeneity in the effects of monetary policy shocks across wealth groups. Among the most unequally distributed asset classes, money market fund shares and corporate equities represent two illustrative examples. The right-skewed distribution of these assets and their high sensitivity to monetary policy shocks imply substantial differences in gains and losses across the distribution. This is especially true for an asset purchase shock.

Lastly, we provide evidence for the relevance of the portfolio composition channel of monetary policy. Since portfolios are heterogeneous across the wealth distribution, households can largely differ in their sensitivity to changes in asset prices. As a result, monetary policy shocks would induce differences in wealth growth across the distribution through asset price changes. Our findings indicate that expansionary monetary policy affects wealth inequality to a larger extent via the stock market than through the housing market.

Appendix to Chapter 2

2.A Monetary policy, asset price changes and heterogeneous wealth growth: Methodology

To obtain counterfactual series of monetary policy-induced house and stock prices, we proceed as follows:

1. For conventional (unconventional) monetary policy, we estimate a VAR model with, in order, the federal funds rate shock (asset purchases shock), real GDP, the consumer price index, the excess bond premium, the 1-year Treasury yield (term spread), a real stock price index and a real house price index. We use the S&P 500 as proxy of stock prices and the S&P/Case-Shiller National Home Price Index as a proxy of house prices.

2. We compute the historical decomposition of both stock and house prices. The historical decomposition breaks down an actual time series into the contribution of the structural shock over time, together with a deterministic component. Since we interpret the first structural shock as the monetary policy shock, we can compute the historical contribution of conventional and unconventional monetary policy shocks to the dynamics of house and stock prices.

3. For each policy shock and price series, we compute monetary policy-induced asset prices by summing the historical contribution of the policy shock to the deterministic component of the series. The resulting price series can be seen as counterfactual asset prices, that is what asset prices would have been if they were only driven by monetary policy shocks while setting all other shocks in the model to zero.

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Chapter 3

Fiscal Consolidation, Labor Markets, and Income Inequality

3.1 Introduction

In the past four decades, the steady increase in the government debt-to-GDP ratio has rehabilitated the role of austerity policies as the cure for debt sustainability and excessive budget deficits. Nevertheless, the economic cost of these policies has been generally underestimated (Blanchard and Leigh, 2013, 2014). In recent years, many governments have embarked on substantial fiscal adjustments through a combination of tax hikes, spending and transfer cuts, and these events have added new empirical evidence to the fiscal literature aimed at quantifying the effects of fiscal adjustments (Hernández De Cos and Moral-Benito, 2013; Cimadomo et al., 2014; Guajardo et al., 2014; Yang et al., 2015; Jordà and Taylor, 2016; Alesina et al., 2015b,a, 2017, 2018a,b, 2019; House et al., 2020). While most of the empirical literature focuses on the effects of fiscal adjustments on economic growth and components of aggregate demand, this investigation sheds light on a comparatively underdeveloped area.

This paper contributes to the literature by exploring the effects of fiscal consolidation plans on the labor market and income inequality. Specifically, it builds on Alesina et al. (2017) who provide evidence that, on average, fiscal adjustments based upon spending or transfer cuts have smaller output costs than tax hikes and sheds light on the dynamics underlying the final output effect.

In this regard, the analysis exploits the view that fiscal consolidation might have caused significant distortions for the labor market and income inequality. This view is based on two observations. The first is that austerity measures aimed at deregulating labor markets in order to foster flexibility have caused negative effects on labor market outcomes, especially for the youth. These measures reduce social safety nets in labor market policies that, together with growing misalignment with the demand for the skills of a rapidly changing and very competitive global economy, translate into substantial difficulties for the youth. Consequently, periods of fiscal adjustments are associated with higher and persistent youth unemployment, and this leads to severe economic consequences, such as higher fiscal costs in terms of lower tax revenues for the future, hence foregone output, and, sooner or later, an increase in public spending to support these people. Hence, it is reasonable to view fiscal adjustments as key policies for labor markets, especially for vulnerable segments of the population, such as the youth. The evidence presented in this paper shows that the youth pay a higher price for fiscal consolidation, in terms of unemployment and labor market participation.

The second observation is that, since the 1980s, important factors behind the rise in income inequality in advanced economies might have been the reforms aimed at lessening the generosity of social benefits and the progressivity of income tax systems. While the IMF stresses that fiscal adjustments that are perceived as being fundamentally unfair will be difficult to maintain, the OECD highlights that austerity programs, which excessively worsen income inequality conditions, can undermine long-term growth. It is therefore important for governments to adopt strategies that minimize these adverse side-effects. Previous findings suggest that fiscal consolidation increases income inequality (Furceri et al., 2016) via several channels, among which we find the labor market (Rawdanowicz et al., 2013). Overall, the substantial consensus in the literature is that spending cuts have larger distributional effects than tax hikes (Ball et al., 2013; Woo et al., 2017; Heimberger, 2020). In this paper I show that is crucial to distinguish between spending and transfer cuts as the latter, by their nature, impact almost entirely households in lower parts of the income distribution. As a consequence, lower social spending (transfers), from which financially vulnerable people benefit the most, should increase income inequality. However, I find that transfer cuts do not affect the income distribution, and the reason should be attributed to the budget constraint of agents that receive public subsidies. These households may follow rules of thumb that depend more strongly on current income (see Romer and Romer, 2016). Hence, following a reduction in transfers, i.e., a negative income shock, they would compensate for the lost transfer income with additional labor income. In other words, cuts in transfers determine an increase in hours worked due to a wealth effect on labor supply. As a result, they offset the expected negative impact on the Gini coefficient for income inequality.

Overall, this paper paves the way for understanding the implications of fiscal adjustments for the labor market and income inequality, while promoting the necessary condition of disaggregating this set of policies among the budget's three main components, i.e., taxes, spending, and transfers. The main implications can be summarized as follows. The youth should be a priority for policymakers when they design fiscal adjustments, as they exhibit a higher vulnerability in terms of labor force participation and unemployment rate. Austerity measures that reduce transfers should be avoided as they specifically target low-income individuals, leaving the most financially vulnerable pay for the fiscal consolidation. Tax hikes, distributing the adjustment cost to both households and firms, cause higher unemployment and lower employment rates. Finally, spending cuts, targeting public sector wages and employment, negatively affect all labor market indicators analyzed.

Road map. The rest of the paper is organized in four sections. Section 3.2 introduces the narrative measure for fiscal consolidation plans and the data for income inequality. Section 3.3 illustrates the empirical model. Section 3.4 presents the results, and Section 3.5 concludes.

3.2 Data

The empirical analysis covers the following 16 OECD countries between 1978 and 2014: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Portugal, Spain, Sweden, United Kingdom, and United States. The identification of exogenous fiscal consolidation plans is performed using the narrative measure developed by Devries et al. (2011) and extended by Alesina et al. (2017). The peculiarity of their measure is that it allows me to take into consideration the multiyear nature of fiscal adjustments for tax, spending, and transfers together, rather than as isolated shocks. For the measure of income inequality, I obtained the data on the net measure of the Gini coefficient (disposable income) from Version 8.2 of the Standardized World Income Inequality Database (SWIID) developed by Solt et al. (2020).

3.2.1 Fiscal Consolidation Plans

Alesina et al. (2017) first show that the effects of fiscal adjustments depend on their design and, in particular, on two characteristics: their composition (taxes, spending, or transfers)[40] and their persistence (whether changes are permanent or transitory). In particular, this analysis studies the effects of fiscal "plans," defined as announcements and implementation of shifts in fiscal variables over a horizon of several years. In fact, real-world fiscal adjustments adopted by parliament at time t consist of three components:

1. Unexpected measures (announced upon implementation at time t), e_t^u;
2. Measures implemented at time t, but which were announced j years before, $e_{t-j,t}^a$;

[40]See Appendix 3.B for the classification of tax, spending and transfers defined by (Alesina et al., 2017).

3. Measures announced at time t, and to be implemented in j future years, $e^a_{t,t+j}$.

Implementing fiscal policy through plans means that fiscal corrections in each year can be written as follow:

$$e_t = e^u_t + e^a_{t-j,t} + \sum_{j=1}^{hor} e^a_{t,t+j} \quad \text{where } e_t = \tau_t + g_t + tr_t$$

For the sake of illustration, Table 3.1 summarizes the fiscal adjustment measures introduced in Denmark in 1983-1985. For simplicity, and without loss of generality, fiscal plans are aggregated among the three budget components.

Year	e^u_t	$e^a_{t-1,t}$	$e^a_{t,t+1}$	$e^a_{t,t+2}$	$e^a_{t,t+3}$
1983	2,90	0,11	1,20	0	0
1984	0,54	1,20	1,81	0	0
1985	0	1,81	0	0	0

Table 3.1 Denmark - Fiscal adjustments in 1983-1985

In 1983 Denmark announced a new plan worth 4.21% of its GDP $(e^u_t + e^a_{t-1,t} + e^a_{t+1,t})$. This measure included an "unexpected" part (e^u_t) that went into effect immediately for a total of 2.90% of GDP, an "expected" part that was announced the preceding year $(e^a_{t-1,t})$ amounting to 0.11% of GDP, and measures announced in 1983 but with implementation for the following year $(e^a_{t,t+1})$, with no announcements made for measures of implementation beyond the first year – $e^a_{t,t+2}$ and $e^a_{t,t+3}$ are equal to zero. In 1984 the Danish government revised the previous fiscal adjustment plan introducing additional unexpected measures amounting to 0.54% of GDP and announced for the next year fiscal adjustments for 1.81% of GDP. Notice that the $e^a_{t,t+1}$ component in 1983 now is labelled as an expected measure implemented in 1984. Finally, in 1985 no additional measures, both unexpected and announced, were introduced and the plan only consisted of previously announced measures.

3.2.1.1 The intra-temporal dimension

A fiscal consolidation includes an increase in taxes (T), a reduction in government consumption and investment (CI) and in transfers (TR). These measures are intra-temporally correlated, and their correlation poses a challenge to the estimation of a consolidation plan's effect. To allow for heterogeneous effects of plans according to their nature, and due to limitations in sample sizes, I follow Alesina et al. (2017), reducing the dimension of the model by separating the sample into tax-based (TB), consumption-based (CB) and transfer-based (TRB) plans depending on the largest among the three components (measured as a percent of GDP) over the horizon of the plan, formally:

$$\textit{Case 1:} \quad \left(\tau_t^u + \tau_{t-1,t}^a + \sum_{j=1}^{hor} \tau_{t,t+j}^a\right) > \left(g_t^u + g_{t-1,t}^a + \sum_{j=1}^{hor} g_{t,t+j}^a\right) \quad \text{and} \quad > \left(tr_t^u + tr_{t-1,t}^a + \sum_{j=1}^{hor} tr_{t,t+j}^a\right)$$

$$\textit{Case 2:} \quad \left(g_t^u + g_{t-1,t}^a + \sum_{j=1}^{hor} g_{t,t+j}^a\right) > \left(\tau_t^u + \tau_{t-1,t}^a + \sum_{j=1}^{hor} \tau_{t,t+j}^a\right) \quad \text{and} \quad > \left(tr_t^u + tr_{t-1,t}^a + \sum_{j=1}^{hor} tr_{t,t+j}^a\right)$$

$$\textit{Case 3:} \quad \left(tr_t^u + tr_{t-1,t}^a + \sum_{j=1}^{hor} tr_{t,t+j}^a\right) > \left(g_t^u + g_{t-1,t}^a + \sum_{j=1}^{hor} g_{t,t+j}^a\right) \quad \text{and} \quad > \left(\tau_t^u + \tau_{t-1,t}^a + \sum_{j=1}^{hor} \tau_{t,t+j}^a\right)$$

$$Then \quad \begin{cases} Case\ 1: & TB_t = 1,\ \ CB_t = 0,\ \ TRB_t = 0; \\ Case\ 2: & TB_t = 0,\ \ CB_t = 1,\ \ TRB_t = 0; \\ Case\ 3: & TB_t = 0,\ \ CB_t = 0,\ \ TRB_t = 1,\ \forall t. \end{cases}$$

As shown above, these plans are (by assumption) mutually exclusive, hence it is possible to simulate each of them independently. Table 3.2 shows the number of plans in each category. There are 46 CB plans and 61 TRB plans, while TB plans are more frequent, amounting to 74 plans out of a total of 181.[41] I do not apply any further disaggregation for taxes into direct and indirect taxes as I would have only 21 episodes for indirect tax-based consolidations. Thus, the effect of tax-based plans should be largely attributed to direct taxes.

[41]Following the definition in Alesina et al. (2017), I count as a plan every year when a new measure is introduced. Not every year in which a fiscal shock occurs is labelled as a plan: this is the case in all years when no new measures are announced, and the government implements measures voted upon in previous years.

Notice that this classification strategy for multiyear fiscal plans does not lead to marginal cases in which a label is attributed on the basis of a negligible difference between the largest components. In only 30 out of 181 new plans the difference in share between the two biggest components is lower than 10 percent of the total fiscal correction. In only 16 cases the main components are less than 5 percent bigger than the second largest component (see Alesina et al., 2017, for a detailed discussion of this point).

Country	TB	CB	TRB	Total
AUS	3	1	3	7
AUT	2	0	6	8
BEL	6	0	9	15
CAN	8	7	4	19
DEU	6	0	8	14
DNK	3	1	4	8
ESP	8	7	0	15
FIN	2	1	6	9
FRA	4	4	2	10
GBR	5	2	4	11
IRL	7	6	1	14
ITA	5	6	7	18
JPN	4	5	1	10
PRT	6	5	0	11
SWE	0	0	5	5
USA	5	1	1	7
Tot.	74	46	61	**181**

Notes: *Plans are classified according to the category that is most affected. The Table reports new plans only. Note that if a plan is changed while being implemented, it is considered as a new plan.*

Table 3.2 Plans Classifications

3.2.1.2 The inter-temporal dimension

As shown in Table 3.1, the inter-temporal feature of fiscal policy generates "fiscal foresight" because agents learn in advance about future announced measures, and that poses a challenge to the identification of exogenous shifts in fiscal variables from VAR residuals. This is the reason for using a direct measurement of the shifts in fiscal variables, which is what the narrative approach does.

The auxiliary equations in (16) describe the correlation between the immediately implemented and the announced parts of a plan:

$$e^a_{i,t,t+j} = \varphi_j^{TB} e^u_{i,t} * TB_{i,t} + \varphi_j^{CB} e^u_{i,t} * CB_{i,t} + \varphi_j^{TRB} e^u_{i,t} * TRB_{i,t} + \nu_t \quad j = 1,2 \tag{16}$$

Overlooking announcements would mean assuming that they are uncorrelated with unanticipated policy shifts, incurring the risk of omitted variable bias. Hence, the intertemporal dimension of the plan should also be preserved when simulating the impulse response functions that compute fiscal multipliers.

Table 3.3 shows the length of the three types of plans (CB, TB and TRB). Most of the plans ($\approx 75\%$) have more than a one-year horizon, implying that the vast majority of fiscal consolidations include announcements of future measures. Overall, more than 60% of the announcements happen in the first two years. Hence, in line with Alesina et al. (2017), I restrict the length of announcements for the empirical exercise to a two-year horizon.

	Horizon of Plans in Years						
Type of Plan	1	2	3	4	5	6	Average
CB	16	17	3	4	1	5	2.39
TB	19	25	9	12	5	4	2.61
TRB	12	23	4	6	9	7	2.97
All Plans	47	65	16	22	15	16	

Table 3.3 Time Horizon of Fiscal Plans

3.2.2 The Standardized World Income Inequality Database

Solt et al. (2020) has provided an international database on various Gini coefficients by maximising the comparability of income inequality data maintaining the widest possible coverage across countries and over time. Income inequality estimates in the SWIID are based on thousands of reported Gini indices from hundreds of published sources, including the OECD Income Distribution Database, Eurostat, the World Bank and national statistical offices around the world, among many others. The database currently incorporates comparable Gini measures for disposable income inequality for 196 countries for as many years as possible from 1960 to the present.

To sum up, the advantages of using the SWIID dataset are threefold. First, the data include a large group of countries and allow me to obtain the longest series on the Gini coefficient of disposable income for all the 16 OECD advanced economies in my sample. Second, the data ensure perfect comparability across countries, given the harmonised way of calculating the coefficients. Third, comparability across countries is enhanced by a transparent procedure of how the data were collected.

The primary focus of this study is on disposable income inequality given that this is what ultimately matters for the household's actual spending, i.e., disposable income, and it has the following welfare definition: the amount of money coming into the household plus government transfer payments minus direct taxes, hence it is the 'post-tax, post-transfer' income. It is important to note that the Gini coefficient of disposable income still does not take into account indirect taxes such as sales or value-added taxes or public services, and indirect government transfers such as price subsidies. The reason being the very limited information about the distribution of such 'final income', which is why Solt et al. (2020) excludes indirect taxes from the SWIID source data.

3.3 Econometric Model

I study the effect of three types of fiscal consolidation plans (CB, TB, TRB) estimating a panel with country and time fixed effect for 16 OECD countries over the annual sample 1978-2014.

Besides equation (17), the model also includes a set of auxiliary equations in (16) to keep track of the correlation between the announced and the unanticipated components of plans. These equations are crucial for the simulation of plans because, in the data, unexpected shifts in fiscal variables do not happen in isolation but are typically accompanied by announcements of future shifts. These auxiliary regressions allow to simulate the average plan estimated in the data in the sense that when the effect of an unanticipated shift in some fiscal variable is simulated, announcements move consistently with what has been observed in the sample. Formally, I estimate the following model:

$$Y_{i,t} = \alpha_i + \lambda_t + \left[\sum_{j=0}^{3} \left(\overbrace{\beta_j e^u_{i,t-j}}^{\text{Unexpected}} + \overbrace{\gamma_j \underbrace{e^a_{i,t-j-1,t-j}}_{\text{Past}} + \delta \underbrace{(e^a_{i,t,t+1} + e^a_{i,t,t+2})}_{\text{Future}}}^{\text{Announced}} \right) \right] \begin{bmatrix} TB_{i,t} \\ CB_{i,t} \\ TRB_{i,t} \end{bmatrix} + u_{i,t} \tag{17}$$

where the index i refers to the countries in the panel. $Y_{i,t}$ is the variable of interest, in turn a labor market variable or the income inequality index. Fiscal consolidation plans, $e^u_{i,t-j}$, $e^a_{i,t-j-1,t-j}$ and $e^a_{i,t,t+k}$ $(k = 1,2)$, are the unexpected, past and future components of the total magnitude of the plan, respectively. $\beta_j = \left[\beta_j^{TB}\, \beta_j^{CB}\, \beta_j^{TRB}\right]$ is a 3-element coefficient vector corresponding to the unanticipated component of the three plans. Likewise, γ_j corresponds to the measures implemented in period t that were previously announced and δ to the announced measures $e^a_{i,t,t+j}$ for the future period t+j. $TB_{i,t}$, $CB_{i,t}$ and $TRB_{i,t}$ are dummies that take the value 1 depending on the component with largest size over the total plan, and α_i and λ_t are country and time fixed effect, respectively. The model is estimated using a joint generalised least squares method (SUR) to take into account the simultaneous cross-correlations of residuals.

There are two things to note in (17). First, I have restricted the coefficients δ to be equal for all announced measures $e^a_{i,t,t+k}$ (k = 1, 2). I have done so to increase power and because the dynamic effect is already captured by the coefficients of the plan's past component. Second, (17) is a truncated moving average, hence the efficient estimation of the relevant parameters requires that the left-hand side variables are time-series with a low degree of persistence, as it is the case for all the dependent variables employed.[42] I compute impulse responses to the announcement of a fiscal plan as the difference between two model-based forecasts for the first four years: those obtained conditionally upon a fiscal adjustment plan and an alternative scenario when there is no plan. More formally:

$$IR(t,s) = E(\mathbf{Z}_{i,t+s} \mid plans_t; I_t) - E(\mathbf{Z}_{i,t+s} \mid no\ plans_t; I_t) \qquad \text{with } \{s = 0, 1, \ldots, 4\}$$

Specifically, I simulate a baseline scenario (control) for all variables by setting to zero all the fiscal consolidation plans of the model, and an alternative model (treatment) for all variables conditional on having the plans. Then, I compute impulse responses as the difference between the control and the treatment model. Confidence intervals are calculated by block bootstrapping to take into account the possibility of autocorrelation in the residuals of the estimated system.

3.4 Results

This section presents the effects of heterogeneous fiscal consolidation plans on labor market variables and on the Gini coefficient of disposable income. Notice that the heterogeneity in the φ's implies that an initial unanticipated correction of 1% of GDP will generate plans of different size depending on the inter-temporal structure of the plan. To make the results comparable across them, multiyear plans are normalized by computing the impulse responses to a plan, rather than to e^u_t, of the size of 1% of GDP. Transfer-based plans are marked in green (triangle), plans based on reductions in current and investment spending in blue (square), and plans based on tax hikes in red (circle). Responses are cumulated over time so that the points along the impulse responses measure the deviation of the outcome from its level absent the change in fiscal policy.

[42] Given the high degree of persistence for the gini coefficient of income inequality, I simulate the response of its growth rate.

3.4.1 The Effect on the Labor Market

The results for the labor market are presented in Figures 3.1 and 3.2. The first group of variables are the employment rate, the log of real wages, and the log of hours worked per employee.[43] The second group are the unemployment rate and, to keep track of its denominator, the labor force participation rate. In addition, following the hypothesis that the youth may be more vulnerable to fiscal adjustments, I include the unemployment rate and the labor force participation rate for this segment of the population (age range: 15-24).

Figure 3.1 reports the impulse responses for the employment rate (3.1a), the log of hours worked per employee (3.1b) and the log of real wages (3.1c). The responses of the employment rate (Figure 3.1a) show different degree of reactions across types of interventions, with cuts in spending being the costliest, estimated to reduce the ratio by 2.34 percent in the fourth year.[44] This is in line with the composition of spending cuts, mainly focused on reduction in public wages and employment. By contrast, after a reduction in transfers, we observe a comparatively lower response, with the employment rate that falls up to 0.72 percent. The rationale is straightforward. A reduction in transfers impacts primarily financially vulnerable households, leaving the productive sector mostly unaffected. Hence, in principle, there should not be direct incentives in the labor markets, both for supply and demand forces, to generate a larger reduction in the employment rate. Tax hikes, on the contrary, which can potentially impact both firms (net profits) and households (disposable incomes), trigger an estimated reduction of around 1.5 percent in the employment rate. This reaction might be attributable to a declining labor demand, as firms will try to compensate for lower net profits by reviewing their costs, i.e., employment but also investments. This is in line with Alesina et al. (2017), which find a larger drop in private investment following tax hikes in comparison with fiscal adjustments made through other budget components.

Figure 3.1b reveals highly heterogeneous impulse responses across the three types of plans. First, hours worked increased following cuts in transfers. This policy, representing a (unexpected) negative income shock, may induce some consumers, i.e., liquidity constrained, to compensate for their lost transfer income by working more hours. In other words, transfer beneficiaries may follow rules of thumb that depend more strongly on current income or may feel more liquidity constrained, on average, than other households. Hence, the positive response of hours worked may be explained in connection to a wealth effect on labor supply, and, as a result, aggregate consumption would be less

[43] Appendix 3.C shows the results using an alternative indicator for hours worked.

[44] Impulse responses for total employment are in line with Figure 3.1a, and are available upon request.

negatively affected than with other plans. Indeed, Alesina et al. (2017) show that this is the case, with consumption contracting less with TRB plans. Note that the productive sector may accommodate an increase in hours worked rather than new employment, as being more costly (e.g. due to informational frictions), to increase inventories and smooth production.[45]

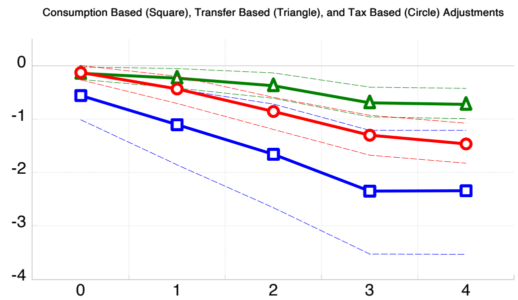
Then, a different scenario is outlined by TB and CB plans. Hours worked decreased after tax hikes and spending cuts. Unlike transfer cuts, tax hikes do not only target individuals that are financially vulnerable, i.e., Social Security recipients, but rather all taxpayers. In this regard, the wealth effect on labor supply should also apply in this circumstance. However, unlike cuts in transfers, where the productive sector is not particularly affected, with TB plans firms observe a reduction in their net profits (due to higher taxes). As highlighted for the employment rate, firms want to compensate for lower net profits by reducing their costs and, consequently, they do not accommodate upward pressures from labor supply. The larger drop in hours worked following cuts in government spending can be the result of direct reductions in public sector wages, eventually followed by the private sector, in a simple cost-cutting strategy that ultimately drives down hours worked.

Figure 3.1c shows the sluggish response of real wages after the introduction of a fiscal adjustment plan. This is in line with real wage rigidities of New Keynesian models (Blanchard and Galí, 2007). While the real wage is marginally affected by tax hikes and transfers cuts, it is potentially more responsive to reductions in government expenditure. The large reduction in the real wage after the third year a CB plan is introduced might suggest a certain degree of positive spillovers on private sector wages. Workers that lost their public employment increase the labor supply for the private sector driving down wages over time. Overall, the evidence supporting the more harmful role of CB plans on labor market conditions may be connected with fiscal interventions that cut public sector pay and employment.

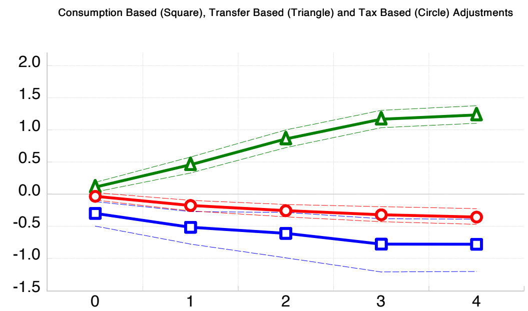
Figure 3.2 reports the responses for the unemployment rate (3.2a) and, to keep track of its denominator, the labor force participation rate (3.2c). Then, to shed light on additional heterogeneities in the effects of fiscal adjustments, I include the youth unemployment rate (3.2b) and the youth labor force participation rate (3.2d).

Figure 3.2a shows a positive response across types of plans, albeit with different magnitudes. The unemployment response to cuts in transfers has a milder effect with respect to cuts in spending and tax hikes. TRB plans leave the productive sector mostly untouched; hence, companies are likely to layoff fewer workers compared to CB and TB plans. Spending cuts continue to be the most recessionary throughout the horizon of the

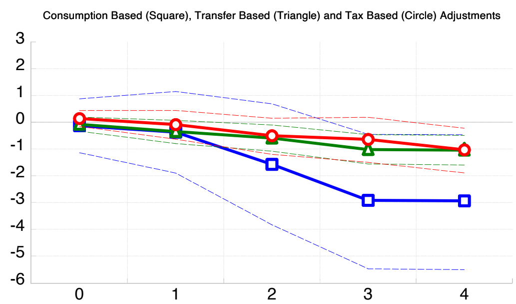
[45] Other reasons might be stock-out avoidance or inventories as a factor of production.



(a) Employment rate



(b) Hours worked per employee



(c) Real wage

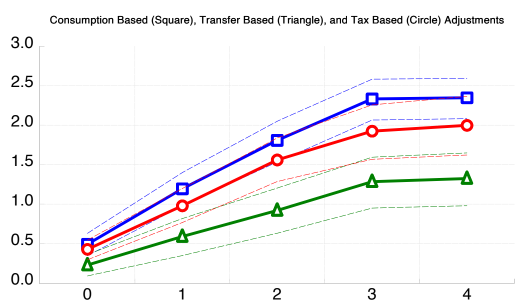
Fig. 3.1 Impulse Response Functions

Notes: Cumulative multipliers from the introduction of multi-year plans whose total size is normalized to be one percent of GDP. The dashed lines represent two standard errors bands.

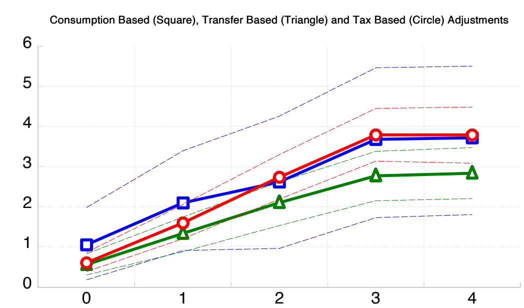
simulation. Figure 3.2b indicates that the impact of all types of plans on the youth unemployment rate is considerably more adverse, with the highest multiplier of the unemployment rate being roughly the lower bound for multipliers of the youth unemployment rate. In sum, Figures 3.2a and 3.2b show that fiscal consolidation plans can have heterogeneous effects on the unemployment rate among types of interventions and among the population, with TB and CB plans being the costliest and the youth being more vulnerable.

Figures 3.2c and 3.2d show heterogeneous responses for the labor participation rate, other than for types of plans. Figure 3.2c indicates that the reaction to CB plans displays larger multipliers for the participation rate, in absolute value, than in the case of TB and TRB plans. Moving to transfers cuts and tax hikes, the labor force participation rate reacts positively at impact, albeit with a small magnitude. After the first year, in the TB plan scenario, the rate goes back to zero, whereas in the TRB plan scenario the rate stays positive but below 0.5 percent. As for the response of hours worked, cuts in transfers and tax hikes may motivate the inactive population to join the labor force in response to a wealth effect on labor supply. However, while firms would accommodate job openings with TRB plans, as they are not affected by this policy, they would not with TB plans. As a result, following TB plans, the positive effect for the participation rate vanishes as people recognize that firms are not inclined to open new vacancies.[46]

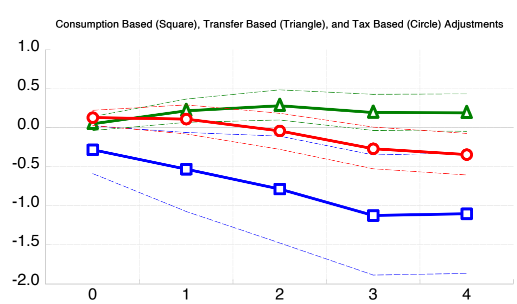
Again, Figure 3.2d indicates that the youth are more vulnerable to fiscal adjustments, with all plans implying a larger drop in the participation rate. Unlike in Figure 3.2c, the youth labor force participation rate goes down following transfers cuts. An explanation may be that social benefits do not have the youth as their main target. For instance, young and middle-age individuals typically transfer more than they receive in the form of care-giving to the elderly, while in old age, especially advanced old age, the flow of transfers generally reverses.



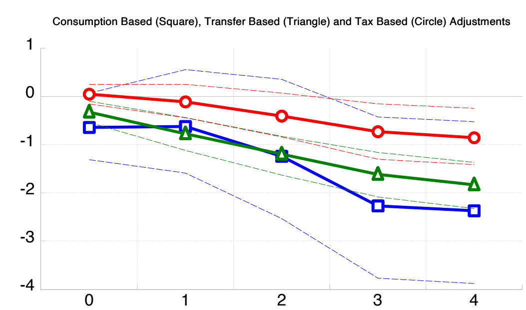
(a) Unemployment rate



(b) Youth Unemployment rate



(c) Labor force participation rate



(d) Youth labor force participation rate

Fig. 3.2 Impulse Response Functions

Notes: Cumulative multipliers from the introduction of multi-year plans whose total size is normalized to be one percent of GDP. The dashed lines represent two standard errors bands.

This section has painted an exhaustive picture on the role of austerity measures for labor market outcomes. There are two lessons that we learn from the simulation exercise.

[46]The cost-cutting strategy to compensate for tax hikes is also confirmed by the responses of private investment and business confidence in Alesina et al. (2017).

First, in terms of unemployment and participation rate, the youth are more vulnerable to fiscal consolidation measures. The gravity of conditions for young people is not only linked to the level and duration of unemployment but also, increasingly, to the declining quality of jobs available to them. The youth that do not acquire significant skills are left with a lower quantity and quality of jobs, which reduces their prospects for the future. Overall, the adverse economic consequences associated with higher (and potentially persistent) youth unemployment are larger fiscal costs in terms of foregone output, lower tax revenues for the future, and, sooner or later, the higher cost of social safety nets. On those grounds, the issue acquires a critical new dimension and deserves further investigation.

Second, households and firms determine their consumption and investment decisions by looking at, respectively, their disposable incomes and net profits. Fiscal consolidation constitutes a negative shock to their resources that may force some of them to adjust. When the government cuts transfers, the new preferences, higher labor supply to offset lower disposable incomes (inevitable for liquidity constrained households) and an accommodating productive sector, operate to attenuate the drop in private consumption, hence in economic growth. This is in line with Alesina et al. (2017), who find a negative reaction of consumer confidence in the TRB plans scenario: consumers are the ones that pay the price of fiscal adjustments. This is a crucial takeaway given that a consolidation that is perceived as being fundamentally unfair is difficult to maintain (Woo et al., 2017). When TB plans are implemented, households face a reduction in their disposable income, and rule-of-thumb workers will be forced to work additional hours. At the same time, firms are likely to reduce their costs to compensate for lower net profits, not allowing an increase in hours worked. This creates frictions in the labor market, with negative repercussions for private consumption, investments, and, more generally, economic growth. Lastly, CB plans turned out to be the most damaging for the labor market, as these measures directly hit public sector wages and employment. Overall, these responses are able to uncover the mechanisms underlying the final output effect of TB, CB, and TRB plans (see Alesina et al., 2017).

3.4.2 The Effect on Income Inequality

The assessment of the effects of austerity measures on income inequality relies on the empirical literature of the determinants of income inequality, which finds that GDP per capita, trade-openness, years of schooling, and technological change are the main determinants of cross-country variations in income inequality.[47]

[47] I include these controls in the econometric model. Notice that I had to exclude the variable ”change in the average years of schooling” due to too many missing values, making the series unsuitable for the

Figure 3.3 shows the responses for the percentage change in the Gini index of disposable income. The findings indicate that CB and TB plans raise income inequality, with the response to cuts in spending peaking in the first year, and the latter, continuing with an upward trajectory, peaking in the third year. Fiscal interventions that reduce spending have a stronger short-run impact, whereas tax hikes raise income inequality more gradually but persistently, peaking in the third year before starting to decline, matching the CB multiplier in the fourth year.

Following the introduction of TRB plans, the Gini coefficient of disposable income does not react, suggesting that these policies do not worsen the income distribution. From the analysis of the labor market, we know that consumers working more hours after cuts in transfers compensate for the lost transfer income with additional labor income. This compensation, in turn, implies that income inequality does not dramatically change. Overall, TRB plans, despite not showing distributional consequences, imply that the poorest pay the cost, in terms of leisure, of restoring fiscal sustainability.

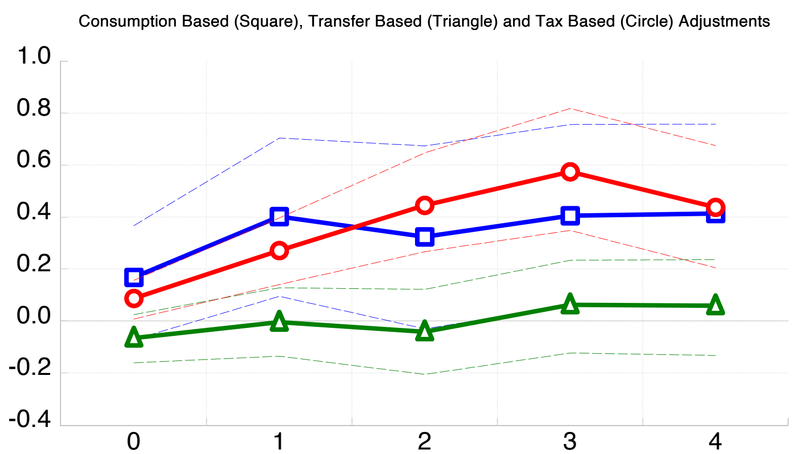


Fig. 3.3 Impulse Response Functions - Gini index

Notes: Cumulative multipliers for the percentage change in the Gini index of disposable income from the introduction of multi-year plans whose total size is normalized to be one percent of GDP. The dashed lines represent two standard errors bands.

3.5 Conclusion

Previous findings show that transfers and spending cuts are much less recessionary than tax hikes. However, not much can be said about the forces behind macroeconomic fluc-

simulation exercise used.

tuations. This study contributes to the existing literature by filling this gap, providing important implications for the way we think about such policies. In particular, this paper explores the impact of fiscal consolidation plans on labor market outcomes and income inequality.

The main findings can be summarized as follows. First, given that the youth are more exposed to the negative effects of austerity measures in terms of unemployment and participation rate, it is crucial to pay special attention to the young population when designing these interventions. This might avoid severe economic consequences, such as higher fiscal costs in terms of foregone output, lower tax revenues for the future, and, sooner or later, higher public spending to support young people. Second, while previous evidence finds that cuts in transfers are ideal for economic growth, the findings of this paper suggest that these policies leave the cost of fiscal adjustments on financially vulnerable individuals. Third, cuts in spending, mainly focused on reducing public wages and employment, can have adverse effects on labor markets. Finally, tax hikes, which negatively impact household incomes and firm profits, can potentially create frictions between labor demand and supply, generating a contraction in consumption and investment.

These results stem from a preliminary investigation into the role of fiscal consolidation for labor market outcomes and income inequality, and should await further substantiation. A future line of work could rely on a theoretical framework with heterogeneous agents to look at the joint effects of fiscal austerity on the labor market, income inequality, and GDP dynamics.

Appendix to Chapter 3

3.A Data Appendix

Unemployment rate: OECD Economic Outlook No 106 - November 2019;
Youth Unemployment rate: World Development Indicators - (% of total labor force ages 15-24);
Employment rate: OECD Economic Outlook No 106 - November 2019;
Nominal total wages: OECD Economic Outlook No 106 - November 2019;
Real total wages: Own calculation (Nominal total wages divided by the GDP deflator).
Hours worked per employee: OECD Economic Outlook No 106 - November 2019;
Average hours worked per person employed: Our World in Data - The OECD Productivity Database (the OECD Annual National Accounts, the OECD Employment Outlook and national sources). Link: https://ourworldindata.org;
labor Force Participation Rate: OECD Economic Outlook No 106 - November 2019;
Youth labor Force Participation Rate: World Development Indicators;
Total Factor Productivity: AMECO - total economy (ZVGDF) (Index);
Real GDP (gdpv): Gross Domestic Product, volume, market prices. OECD Economic Outlook n. 97 for all countries except Ireland (IMF WEO April 2015);
Nominal GDP (gdp): Gross Domestic Product, value, market prices. OECD Economic Outlook n. 97 for all countries except Ireland (IMF WEO April 2015);
Final Domestic Expenditures, volume (fddv): OECD Economic Outlook n.97;
Net Exports: Own calculation (gdpv - fddv);
Population, thousands persons (pop): OECD Historical population data and projections (1950-2050);
Real per capita GDP growth and Real total wages: own calculation, constructed as follows:

- **GDP deflator**

$$pgdp_{i,t} = \frac{gdp_{i,t}}{gdpv_{i,t}}$$

- **Real per capita GDP growth**

$$\Delta y_{i,t} = 100 * \left[log\left(\frac{gdpv_{i,t}}{gdpv_{i,t-1}}\right) - log\left(\frac{pop_{i,t}}{pop_{i,t-1}}\right)\right]$$

3.B The classification of tax, spending and transfers

The final version of the fiscal consolidation plans dataset includes the following aggregation: government spending and investments, transfers and taxes.

Government Spending and Investments: Government consumption includes current expenditures for goods and services, public sector salaries and other employee compensation, the corresponding social insurance contributions, the managing cost of State-provided services such as education (public schools and universities, but also training for unemployed workers) and healthcare. Public investment includes all expenditures made by the government with the expectation of a positive return. The category includes government gross fixed capital formation expenditures (e.g. land improvement, plants, purchases of machinery and equipment, construction of roads and railways.) In other words, we classify as government consumption and investment everything that is not a direct resource transfer to citizens or corporations. Ideally, one would want to separate government consumption from government investment and check if the two multipliers differ. Their organisation into plans prevents this since there are very few plans that consist mostly of shifts in government investment.

Transfers: Transfers are every payment made by the government to private entities. The main economic feature of a transfers is that it does not affect the marginal rate of substitution between consumption and leisure. We include among transfers subsidies, grants, and other social benefits. For instance, transfers include all non-repayable payments on current accounts to private and public enterprises, social security, social assistance benefits, and social benefits distributed in cash and in kind.

Direct and Indirect Taxes: We define direct every tax imposed on a person or a property that does not involve a transaction. We include in this component income, profits, capital gains and property taxes. We classify as direct all taxes levied on the actual or presumptive net income of individuals, on the profits of corporations and enterprises, on capital gains, whether realised or not, on land, securities, and other assets plus all taxes on individual and corporate properties. We also include in the category income tax credits and tax deductions. Indirect taxes are those imposed on certain transactions involving the purchase of goods or services. Examples include VAT, sales tax, selective excise duties on goods, stamp duty, service tax, registration duty, transaction tax, turnover selective taxes on services, taxes on the use of goods or property, taxes on the extraction and production of minerals and profits of fiscal monopolies. This category also accounts for VAT exemptions.

3.C Alternative variable for hours worked

Figure 3.C.1 shows the impulse responses for average hours worked per person employed. Following the introduction of a CB or a TB plan, we observe the same impulse responses, whereas the dynamics change when considering TRB plans. The alternative data-set used for hours worked is taken from the following alternative source: https://ourworldindata.org. Figure 3.C.1 shows that this additional evidence confirms the same dynamics for all the types of plans analyzed, highlighting the role that TRB plans have in raising hours worked per employee after a plan is introduced, suggesting that the multiplier may be somehow higher. However, the decision to use the OECD Economic Outlook data-set is made to maintain a certain consistency over all the variables employed. In this way, by using Figure 3.1b, I adopt a more prudent approach, given that it offers the same interpretation as Figure 3.C.1 but with a smaller increase in hours worked.

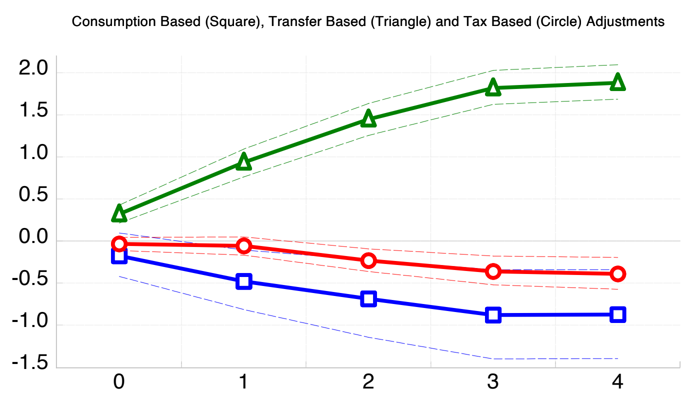


Fig. 3.C.1 Impulse Response Functions - Average hours worked per person

Notes: Cumulative multipliers from the introduction of multi-year plans whose total size is normalized to be one percent of GDP. The dashed lines represent two standard errors bands.

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