Unconventional Monetary Policy and Economic Inequality*

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July 4, 2022

Abstract

This paper evaluates the distributional effects of US unconventional monetary policy. The results show that balance sheet policies tend to be the key measures that shape its overall effects. Unconventional monetary policy reduces the unemployment rate, moderately increases prices, and stabilizes financial conditions. Yet, it raises capital income more than labor earnings. This impact leads to the relatively higher increase in income at the upper part of distribution, resulting in the growth of income inequality. Also, unconventional monetary policy increases stock prices more than house prices. This effect results in the relatively larger growth of wealth at the top of distribution, leading to the rise of wealth inequality. The impact of unconventional monetary policy on wealth inequality is particularly strong.

Keywords: unconventional monetary policy, identification, inequality.

JEL Codes: C32, D31, E52.

*I gratefully acknowledge helpful comments and suggestions from Stefania Albanesi, Jonas Arias, Christiane Baumeister, Luca Benati, Florin Bilbiie, Matthias Doepke, Josep Lluís Carrion-i-Silvestre, Enrique López-Bazo, Gernot Müller, Raul Ramos, Barbara Rossi, and Moritz Schularick. All errors are my own.

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1 Introduction

Unprecedented economic measures have been taken worldwide to alleviate the effects of the Great Lockdown. Among the economic measures, unconventional monetary policy has been implemented. Nevertheless, unconventional monetary policy was already conducted to respond to the global financial crisis. Though the current unconventional monetary policy measures are more extensive and targeted to the wider spectrum of economic agents, there are already some records of the implementation of unconventional policy measures. These records have been used to evaluate the macroeconomic and the financial effects of unconventional monetary policy while its distributional impact has not systematically been explored yet (Lenza and Slacalek 2018; Saiki and Frost 2020). As with any remedy, it is important to know all its effects. The objective of this paper is to provide the evidence on the distributional impact of unconventional monetary policy.

The distributional impact of unconventional monetary policy is evaluated in the case of the USA. In particular, this paper assesses the effect of unconventional monetary policy on income and wealth inequality. An unconventional monetary policy shock is identified with zero and sign restrictions (Arias, Caldara, and Rubio-Ramirez 2019), and alternatively with a high-frequency approach (Eberly, Stock, and Wright 2020). The estimated overall effects of unconventional monetary policy are generally driven by quantitative easing. This paper computes proxy inequality measures, which are the at the same frequency as other variables. To compliment the analysis with standard inequality measures, this paper applies a mixed frequency framework given that inequality data are generally available at the low frequency.

The results indicate that unconventional monetary policy fosters real economic activity, moderately increases prices, and eases financial conditions. At the same time, it leads to the relatively larger increase in capital income than in labor earnings. This impact of unconventional monetary policy results in the growth of income inequality because lower and middle earners mainly receive labor earnings while higher earners mostly gain capital income. The application of standard inequality measures shows that the monetary policy expansion leads to the relatively higher increase in income at the upper part of distribution. Moreover, it reduces the income shares of lower and middle earners while it raises the income share of higher earners.

This paper finds that unconventional monetary policy increases stock prices more than house prices. This impact leads to the growth of wealth inequality given that the groups in the lower and the middle parts of wealth distribution mostly own non-financial assets such as houses while the portfolio of the group at the top of wealth distribution is mainly composed of financial assets such as stocks. Using standard inequality measures, this paper finds that unconventional monetary policy lowers the bottom and the middle wealth shares whereas it raises the top wealth share. The impact of unconventional policy measures on wealth inequality is generally stronger. In particular, the variance decomposition analysis reveals that unconventional monetary policy accounts for the higher variation in wealth inequality than in income inequality.

The topic on the distributional impact of unconventional monetary policy has lately gained growing interest but the literature on this topic is still scarce, given that these policy measures have relatively recently been implemented. On the other hand, there is already some literature on the distributional effects of conventional monetary policy. Particularly, in this area of research, some of the first studies are the influential articles by Doepke and Schneider (2006), Albanesi (2007), and Coibion et al. (2017).

The evidence on the distributional effects of monetary policy is mixed. Coibion et al. (2017) provide evidence for the USA that contractionary conventional monetary policy increases economic inequality. Dolado, Motyovszki, and Pappa (2021) show that expansionary monetary policy raises earnings inequality between low and high skilled workers in the USA. Based on survey data for 2010, Adam and Tzamourani (2016) provide evidence that the increase in equity prices profits the richest households while the growth of house prices benefits the median household. Guerello (2018) show that expansionary conventional monetary policy reduces income inequality while unconventional monetary policy raises it in the euro area. Similarly, for the UK, Mumtaz and Theophilopoulou (2017) find that contractionary conventional monetary policy raises economic inequality whereas quantitative easing increases it. For the UK, Mumtaz and Theophilopoulou (2020) also provide evidence that monetary policy raises wealth inequality and accounts for its substantial variation.

The most closely related papers are the works by Lenza and Slacalek (2018), and Saiki and Frost (2020), who also focus their analyses on the distributional effects of unconventional monetary policy. Lenza and Slacalek (2018) provide evidence for the euro area that quantitative easing decreases income inequality and has a small effect on wealth inequality. They first estimate the aggregate effects of unconventional monetary policy and then distribute them on the survey data for 2014. This paper complements their work by estimating the dynamic responses of inequality measures to unconventional monetary policy.

Saiki and Frost (2020) show that unconventional monetary policy raises income inequality in the case of Japan. They focus on the features of Japanese economy and the relatively longer history of the implementation of unconventional monetary policy in Japan. This paper provides additional evidence and estimates the impact of unconventional monetary policy on wealth inequality too.

This paper is also related to the large literature on the economic effects of unconventional monetary policy. The recent comprehensive review of the identifications methods and the literature can be found in the article by Rossi (2021). This paper provides complementary evidence on the economic effects of unconventional monetary policy using two of the current identification approaches.

The rest of the paper is organized as follows. Section 2 discusses the distribution channels of monetary policy. Section 3 presents the empirical approach while Section 4 describes the data. Section 5 provides the results and Section 6 concludes.

2 Distribution Channels of Monetary Policy

In response to the global financial crisis, many central banks substantially lowered their policy rates. To improve deteriorated economic conditions, they also resorted to unconventional monetary policy measures when their policy rates hit the effective zero lower bound. They took these measures to ease financial conditions by providing external funding. In particular, as unconventional monetary policy measures, the large scale asset purchases implemented by the Federal Reserve. These operations tend to change the relative supply of bonds and other assets, consequently affecting their prices and the flow of funds in the economy. This could benefit high income households, who own these bonds and assets.

The main objective of unconventional monetary policy measures is to lower long term interest rates to support private borrowing of households and businesses, thereby fostering aggregate demand and real economic activity (Baumeister and Benati 2013). This in turn can be beneficial for households who mainly rely on labor income, which might be adversely affected during the crisis. Labor earnings are the primary source of income for the most of households, and these earnings are mostly exposed to recessions (Coibion et al. 2017). Besides, unconventional monetary policy measures help to recover prices for houses, which are the main class of assets in the portfolio of low income households.

Thus, the implementation of unconventional monetary policy could facilitate to overcome the financial crisis. At the same time, it might also affect income and wealth distribution. On the one hand, unconventional monetary policy might increase the capital income and the wealth of high income households. On the other hand, it could restore the labor earnings and the wealth of low income households. As a result, monetary policy might affect income and wealth inequality but its impact is ambiguous because of the opposite effects.

The overall distributional effect of monetary policy depends on different channels through which monetary policy can have an impact on income and wealth inequality. Based on the distributions channels specified by Coibion et al. (2017) and Monnin (2017), this paper categorizes the following income and wealth distribution channels of monetary policy:

Income Distribution Channels:

- *Income composition*: It is related to the heterogeneity in the primary sources of income (labor earnings and capital income) across households. Low income households mostly get labor income while high income households tend to receive the higher proportion of capital income. Income distribution changes when monetary policy affects one component of income more than the other. If expansionary monetary policy boosts capital returns more than labor earnings, income inequality increases.
- *Labor income (earnings) heterogeneity*: It represents the tendency that the labor income of the poorest population is primarily exposed to business cycle fluctuations. In Table 1, this paper provides the data on the composition of income in the USA in 2007 (just before the global financial crisis). It can be observed that labor earnings are the primary source of income for the poor while capital income is gained mostly by the rich. Low income households usually gain from the increase in labor market activity, mostly through the reduction in unemployment. Therefore, expansionary monetary policy is likely to benefit low income households more and reduce income inequality.
- *Capital income heterogeneity*: The returns of various assets are differently affected by monetary policy, and the portfolio composition of households differs along distribution. So, the impact of expansionary monetary policy on inequality depends on the combination of heterogeneous asset returns and portfolios.

Wealth Distribution Channels:

- *Portfolio channel*: The asset composition of households is different across the distribution. The wealth of households generally consists of capital assets and housing, and the net wealth are determined by deducting debts from that amount. The portfolio of low income and middle class households mainly consists of nonfinancial assets such as houses while wealthy households tend to have capital assets such as stocks. So, monetary policy affects household wealth through its impact on the prices of these different assets. Given the heterogeneous structure of portfolios, monetary policy have different effects on household wealth. Thus, the impact of monetary policy on wealth inequality depends on its effects on asset prices and the balance sheet structure of households.

- *Savings redistribution channel*: Households keep their savings differently. Low income households tend to hold relatively more currency while high income households mostly have deposits and given loans. Consequently, both cash holders and lenders are exposed to inflation, which reduces the real value of currency, and deposits and debt that are fixed in nominal terms. The impact of expansionary monetary policy on wealth inequality hinges on its proportional effects on household savings along the distribution.

Table 1: Income Composition

Income	Quantiles					Top 1%
	1st	2nd	3rd	4th	5th	
Labor	35.6	60.8	72.6	77.8	60.5	39.0
Capital	-1.9	1.8	1.9	2.9	15.5	30.4
Business	0.7	4.6	5.5	7.6	19.0	28.3
Transfers	59.9	30.3	18.4	10.5	4.3	2.1
Other	5.7	2.5	1.6	1.2	0.7	0.2

Source: 2007 Survey of Consumer Finances (Diaz-Gimenez, Glover, and Rios-Rull 2011).

Monetary policy could have different distributional effects through the channels. They can operate with different intensity with conventional and unconventional monetary policies. That is, conventional and unconventional monetary policies could have disproportionate effects on the channels. Moreover, the magnitude of their impact through the channels might be different too, and, consequently, they can have different overall distributional effects. This paper aims to evaluate the distributional effects of unconventional monetary policy via the income composition, the earnings heterogeneity, and the portfolio channels. In particular, to examine the earnings heterogeneity and the income composition channels, this paper includes the unemployment rate, and the ratio of capital income to labor earnings in the model considered for the analysis. To explore the portfolio channel, this paper incorporates the ratio of stock prices to house prices in the model.

3 Empirical Approach

This paper considers a structural vector autoregression (VAR) model for the analysis of the distributional impact of unconventional monetary policy. These types of models are commonly used for the evaluation of the effects of monetary policy in the literature (among others, Arias, Caldara, and Rubio-Ramirez 2019; Baumeister and Benati 2013; Gertler and Karadi 2015). The current section describes the estimation of the VAR model, including a mixed frequency approach, and the identification of an unconventional monetary policy shock.

3.1 Estimation

In line with Arias, Caldara, and Rubio-Ramirez (2019), the structural VAR model of order p, is formulated as follows:

$$Y_t'\mathsf{A} = A_0 + Y_{t-1}'A_1 + \cdots + Y_{t-p}'A_p + \varepsilon_t' \tag{1}$$

where Y_t is a (6×1) vector of endogenous variables, A_0 is a (1×6) vector of intercepts, A and A_{js} (for $j = 1, ..., p$) are (6×6) matrices of parameters, and ε_t is a (6×1) vector of structural shocks. It is assumed that conditional on $Y_0, ..., Y_{1-p}$, the vector $\varepsilon_t \sim N(0,\ I_6)$. The variables are included in levels in the empirical analysis. The implementation of the analysis in levels allows for implicit cointegration relations among them[1] (Sims, Stock, and Watson 1990).

The reduced form representation of the VAR model is the following:

$$Y_t' = B_0 + Y_{t-1}'B_1 + \cdots + Y_{t-p}'B_p + v_t' \tag{2}$$

where $B_j = A_j\mathsf{A}^{-1}$ (for $j = 0, ..., p$), $v_t' = \varepsilon_t'\mathsf{A}^{-1}$ and the reduced form error covariance matrix is $\mathbb{E}(v_t v_t') = \Sigma_v = \mathsf{A}^{-1'}\mathsf{A}^{-1}$.

The vector of endogenous variables Y_t consists of an indicator of real economic activity, prices, the excess bond premium, an economic inequality measure[2], and conventional and unconventional monetary policy indicators: $Y_t = (u_t,\ p_t,\ m_t,\ z_t,\ i_t,\ s_t)'$. In particular, the baseline specification includes the unemployment rate, the PCE deflator, the excess bond premium, the income inequality ratio, the federal funds rate, and the term spread

[1] In the case of conventional monetary policy, an explicit cointegration analysis of the variables can be found in the paper by Davtyan (2017).

[2] As an economic inequality measure, either income or wealth inequality measure is considered.

that is defined as a spread between the 10-year and the 3-month treasury constant maturity rates.

The data for the macroeconomic variables are available at the monthly frequency. However, the data for the inequality measure are mainly available only at the annual frequency. Whereas the inequality measures that are computed in this paper are at the monthly frequency, the standard measures of income and wealth inequality are only at the annual frequency. Therefore, in order not to aggregate the monthly macroeconomic variables or interpolate the annual inequality measures, this paper adopts a mixed frequency approach.

In the case when the data for inequality measures are only available at the annual frequency, this paper applies the mixed frequency approach for the structural VAR model following Foroni and Marcellino (2016). This mixed frequency approach can straightforwardly be combined with the available methods for the identification of a monetary policy shock. The application of the mixed frequency approach allows incorporating annual inequality data with monthly macroeconomic variables within the same VAR model. This paper treats the lower frequency variable, an inequality measure, as a high frequency variable with missing observations, which are subsequently estimated with the Kalman filter. In line with Foroni and Marcellino (2016), and Mariano and Murasawa (2010), this procedure is implemented by presenting the VAR model in a state space form and estimating it with the maximum likelihood method.

The high frequency variables $u_t,\ p_t,\ m_t,\ i_t$, and s_t are observable every period. Since the highest frequency of the variables is monthly, the low frequency series z_t is observable only once in every twelfth period. The unobservable high frequency series is denoted by z_t^*. It is an underlying series for z_t so that, for each t, $z_t = \omega(L)\ z_t^*$ where $\omega(L)$ is a lag polynomial of order l: $\omega(L) = \omega_0 + \omega_1 L + \cdots + \omega_l L^l$. In the current case of the mixed frequency combination of monthly and annual data, l is thirteen. Thus, the lag polynomial $\omega(L)$, which can be considered as a one-sided filter, provides an aggregation scheme from the high frequency to the low frequency. Then, the aggregated series $\omega(L)\ z_t^*$ is skip-sampled so that the variable is observed only every n period (twelfth month). Following Foroni and Marcellino (2016), for simplicity, the case is considered when the observed value of the low frequency variable corresponds to the z_t^* value for every n period (twelfth month).

For further derivations, the following (6×1) vectors are specified: $\mathrm{Y}_t = (z_t,\ u_t,\ p_t,\ m_t,\ i_t,\ s_t)'$ and $\mathrm{Y}_t^* = (z_t^*,\ u_t,\ p_t,\ m_t,\ i_t,\ s_t)'$, where the low frequency variable z_t and the underlying unobservable high frequency variable z_t^* is univariate while the subvector of the high frequency variables $(u_t,\ p_t,\ m_t,\ i_t,\ s_t)'$ is five-variate. Given these notations, the following VAR model is formulated:

$$\Phi(L)\ \mathsf{Y}_t^* = \eta_t \tag{3}$$

where $\eta_t \sim N(0,\ \Sigma_\eta)$ while $\Phi(L)$ is a lag polynomial of order p, which is specified to be one. At the same time, the following relation between Y_t and Y_t^* must hold:

$$\mathsf{Y}_t = H(L)\ \mathsf{Y}_t^* \tag{4}$$

where

$$\underset{(6\times 6)}{H(L)} = \begin{bmatrix} \underset{(1\times 1)}{\omega(L)\, I} & \underset{(1\times 5)}{0} \\ \underset{(5\times 1)}{0} & \underset{(5\times 5)}{I} \end{bmatrix}$$

This model in equations (3) and (4) is cast in a state space form. Given $p \leq l+1$, the state space representation is the following:

$$\mathsf{X}_t = C\mathsf{X}_{t-1} + D\xi_t \tag{5}$$

$$\mathsf{Y}_t = E\mathsf{X}_t \tag{6}$$

where $\xi_t \sim N(0,\ I_6)$, the state vector is specified as

$$\underset{(6(l+1)\times 1)}{\mathsf{X}_t} = (\mathsf{Y}_t^*,\ \cdots,\ \mathsf{Y}_{t-l}^*)'$$

and the coefficient matrices of the state space form are defined as follows:

$$\underset{6(l+1)\times 6(l+1)}{C} = \begin{bmatrix} \Phi_1 \ \cdots \ \Phi_p & 0_{6\times 6(l+1-p)} \\ I_{6l} & 0_{6l\times 6} \end{bmatrix}$$

$$\underset{6(l+1)\times 6}{D} = \begin{bmatrix} \Sigma_\eta^{1/2} \\ 0_{6l\times 6} \end{bmatrix}$$

$$\underset{6\times 6(l+1)}{E} = \begin{bmatrix} H_0 \ \cdots \ H_l \end{bmatrix}$$

Since Y_t is observable only every twelfth month, the state space model is estimated by replacing the missing observations with zeros and using the Kalman filter, in line with Foroni and Marcellino (2016), and Mariano and Murasawa (2010). Therefore, the first stage of this mixed frequency approach involves the estimation of monthly inequality series with the Kalman filter. In the next stage, the estimated inequality series is included in the monthly VAR model, which is used to identify a monetary policy shock and assess its effects. The subsequent consideration of the monthly VAR model provides a general basis for comparison with the results obtained using the inequality measures that are observed at the monthly frequency.

The estimation of the monthly VAR model is implemented by the Bayesian approach, following Arias, Caldara, and Rubio-Ramirez (2019). In particular, a uniform-normal-inverse-Wishart distribution is considered for the priors over the orthogonal reduced-form parameterization. The prior density parametrization is also in line with the approach by Arias, Caldara, and Rubio-Ramirez (2019). It leads to the prior densities that are equivalent to the ones considered by Uhlig (2005).

Given that the estimation sample is relatively short, the objective is to have a parsimonious VAR model. Based on information criteria, the lag order of two is selected for the VAR model. At the same time, robustness checks with higher lag orders is also implemented. These robustness checks are provided in Online Appendix.

3.2 Identification

The identification of monetary policy shock is implemented in line with the approach by Arias, Caldara, and Rubio-Ramirez (2019). This paper combines zero and sign restrictions on the parameters[3] of the structural monetary policy rule (the last column of A) and on impulse response functions (the last row of A^{-1}) on impact. Sign restrictions are imposed on impact because there is no independent identification information at longer horizons as shown by Baumeister and Hamilton (2015).

Since unconventional monetary policy is generally regarded as an expansionary policy, this paper identifies an expansionary monetary policy shock. Consequently, this paper considers the normalization that the yield spread has a negative sign when, as a monetary policy instrument, it is on the left side of the policy equation. Analogously, this paper normalizes the response of the yield spread to be negative on impact in response to an expansionary monetary policy shock. Therefore, all sign restrictions are imposed in accordance with this normalization to consider an expansionary monetary policy shock.

For the monetary policy rule, the following contemporaneous restrictions are imposed. It is assumed that the contemporaneous reaction of the monetary policy indicator to the unemployment rate is positive while it is negative for prices. If a wealth inequality

[3] The parameters are normalized with respect to the monetary policy indicator.

measure is considered as an economic inequality measure in the specification of the VAR model, a zero restriction is imposed on the response of the policy indicator to wealth inequality. The responses of the policy indicator to the other variables are left unrestricted.

For the impulse response functions (IRFs), this paper imposes zero restrictions on the contemporaneous responses of the unemployment rate, prices, income inequality, and the federal funds rate. If wealth inequality is included instead of income inequality, its contemporaneous responses to a monetary policy shock is not restricted given that it can change within a month. The zero restriction on the response of the federal funds rate is a key restriction to disentangle an unconventional monetary policy shock from a conventional policy shock (Baumeister and Benati 2013). All the restrictions are summarized in Table 2.

Table 2: Zero and Sign Restrictions for the Identification of an Expansionary Monetary Policy Shock

Restrictions on the Monetary Policy Rule					
u_t	p_t	m_t	z_t	i_t	s_t
+	–	?	?/0	?	1
Restrictions on the IRFs on Impact					
0	0	–	0/?	0	–

Note: + and − indicate that the parameters are restricted to be positive and negative, respectively, while ? means that the parameter is left unconstrained. / distinguishes restrictions on either income or wealth inequality z_t , respectively. 1 implies the normalization with respect to the monetary policy indicator.

Overall, one zero restriction is imposed on economic inequality. If income inequality is considered, a zero restriction is imposed on its response to a monetary policy shock given it should not change within a month. If wealth inequality is included in the model, a zero restriction is imposed on the response of monetary policy to wealth inequality. In addition to economic reasoning, this framework of zero restrictions is not too restrictive and allows obtaining admissible set of draws, which satisfies the restrictions.

Alternatively, this paper identifies an unconventional monetary policy shock using the structural VAR–instrumental variables (SVAR–IV) approach. This paper applies this identification following the approach developed by Gertler and Karadi (2015). When this identification approach is applied, the VAR model is estimated with the method of ordinary least squares.

This paper uses an analogous specification of the VAR model to the one provided in the work by Eberly, Stock, and Wright (2020), who also use the SVAR–IV methodology to estimate the effects of conventional and unconventional monetary policies. In particular, following Eberly, Stock, and Wright (2020), the general effects of unconventional monetary policy are identified through its combined impact on the slope of the term structure, which, as previously specified, is the yield spread between the 10-year and the 3-month interest rates. For the slope shock, an external instrument is considered from Eberly, Stock, and Wright (2020). It is the series of changes in the 10-year Treasury yield measured within two-hour windows following monetary policy announcements. The estimation results show that the instrument is strong[4] for the slope shock. In particular, the values obtained for the F-statistic are above 22.

The IRFs are normalized to be the responses of the variables to a one unit expansionary monetary policy shock. In the case of the identification with zero and sign restrictions, this paper provides posterior median IRFs together with the 68% credible interval of the posterior distribution based on 10,000 draws. In the case of the SVAR–IV method, this paper reports 68% confidence intervals using 10,000 bootstrap replications. The IRFs are presented for 20 periods.

4 Data

The empirical analysis is implemented in the case of the USA. The monthly estimation sample is from 2008:M1 to 2019:M12. The sample is chosen to coincide with the period of the implementation of unconventional monetary policy measures by the Fed before the Great Lockdown. The focus on this period also provides the stability of the parameter estimates. Besides, the end of the estimation period is also related to the availability of standard inequality measures, which are released later than typical economic data get available for the same period.

Some estimation sub-samples are considered because of data availability related to the identification of an unconventional monetary policy shock. The estimation sample for the SVAR-IV method is 2008:M1–2019:M3 given that the series of the instrument is available until 2019:M3. The series is from Eberly, Stock, and Wright (2020). The estimation period for the identification of an LSAP shock is 2008:M1–2015:M12 because LSAPs were generally conducted within this period. As a monetary policy indicator of

[4] Following Stock, Wright, and Yogo (2002), the instrument is considered strong given that the F-statistic from the first-stage regression of the reduced form residuals of the policy indicator on the instrument is above the threshold value of 10.

LSAPs, the series of their announcements is considered and it is from Hesse, Hofmann, and Weber (2018).

The data on the economic variables are taken from different sources. The data source for the unemployment rate is the U.S. Bureau of Labor Statistics. The data on personal consumption expenditures (PCE) excluding food and energy chain-type price index (deflator) are from the U.S. Bureau of Economic Analysis. As an alternative measure for real economic activity, this paper uses the monthly estimates of the real gross domestic product (GDP) from IHS Markit. As an alternative indicator for prices, the consumer price index (CPI) is considered from the Organization for Economic Co-operation and Development (OECD). The variables are seasonally adjusted. The real GDP and the price indices are scaled with respect to the base year of 2009 and used in logs in the empirical analysis.

This paper considers various financial series, which are from the Board of Governors of the Federal Reserve System. The excess bond premium (Gilchrist and Zakrajšek 2012) is used to control for financial conditions. As an alternative indicator of financial conditions, this paper uses the Chicago Board Options Exchange (CBOE) Volatility Index (VIX), which measures expected future volatility. The effective federal funds rate is considered as a conventional monetary policy tool. As a general indicator of unconventional monetary policy measures, this paper uses the yield spread that is specified as a spread between the 10-year and the 3-month treasury constant maturity rates. Alternatively, this paper also considers the yield spread that is computed as the difference between the 10-year government bond rate and the federal funds rate.

Proxy inequality measures are computed for the empirical analysis. As an income inequality measure, this paper computes the ratio between the personal income receipts on assets and the compensation of employees. The data on these variables are from the U.S. Bureau of Economic Analysis. The series are seasonally adjusted. As a wealth inequality measure, this paper computes the ratio between the S&P 500 Index and the S&P/Case-Shiller U.S. National Home Price Index. The series are from S&P Dow Jones Indices LLC. The house price index is seasonally adjusted. The indices of the stock and the house prices are scaled with respect to the base year of 2009. The proxy inequality measures are used in logs in the empirical analysis.

Standard income inequality measures are considered from the report by Shrider et al. (2021) on the Current Population Survey (CPS) of the U.S. Census Bureau. The inequality measures are based on money income, i.e., the income that is not taxed and does not include government transfers. As a general inequality measure, this paper considers the Gini index, which is in percent. Based on the percentiles provided in the report by Shrider et al. (2021), the 50-10 and the 90-50 percentile ratios are computed to measure the relation among different parts of income distribution. The percentile ratios are in logs. This paper also uses the income shares of the lowest, the middle, and the highest quitiles, which are in percent.

Standard wealth inequality measures are also considered though they are more limited compared to income inequality measures. This paper uses the bottom 50%, the middle 40%, and the top 10% shares of net personal wealth from the World Inequality Database (WID). Net personal wealth is defined as personal financial and non-financial assets less personal debt. The middle 40% share is specified as the share of net personal wealth held by the group between percentiles 50 and 90. The wealth shares are expressed in percent.

The economic and the financial series as well as the proxy inequality measures are at the monthly frequency while the standard inequality measures are at the annual frequency. Therefore, when the standard inequality measures are included in the empirical analysis, this paper applies the mix frequency approach. The descriptive statistics of the inequality measures are provided in Appendix A.1.

5 Empirical Analysis

First, the empirical analysis is implemented in the cases when income inequality measures are computed at the monthly frequency. In particular, this paper considers proxy inequality measures between capital and labor income, and between stock and house prices. This paper conducts the various robustness checks of the results, including the alternative identification of an unconventional monetary policy shock with the SVAR-IV method.

To focus on the measures of unconventional monetary policy, the impact of LSAPs is considered given that they were key policy tools. An LSAP shock is identified considering that LSAPs were previously announced before their actual implementation. That is, the announcements came as surprises while actual purchases were already anticipated. Consequently, the series of the announcements (Hesse, Hofmann, and Weber 2018) is considered as a monetary policy indicator of LSAPs. An asset purchase announcement shock is identified using the zero and the sign restrictions described in Subsection 3.2. In the current case, the IRFs are just normalized to be the responses to a 0.5 trillion USD asset purchase announcement shock. This normalization provides the quantitative responses that align well with the magnitudes of the IRFs based on the baseline normalization.

This paper evaluates the impact of unconventional monetary policy using standard income inequality measures too. Since such measures are generally available at the annual frequency, this paper uses the mixed frequency approach described in Subsection 3.1. The approach is helpful to combine monthly economic data and annual inequality measures, and to identify a monetary policy shock within a monthly framework. At the same time, the mixed frequency estimates have higher uncertainty than the results of the empirical analysis with solely monthly data.

As an inequality measure, various standard inequality indicators are included in the VAR model one by one. That is, each VAR model that is estimated contains one inequality measure only. This empirical analysis allows the reflection of the distributional impact of unconventional monetary policy through the standard inequality measures. Besides, the consideration of inequality measures is useful for the estimation of the impact of unconventional monetary policy on different parts of the income and the wealth distribution. Within this analysis, the focus is on the responses of inequality measures only to outline their pattern.

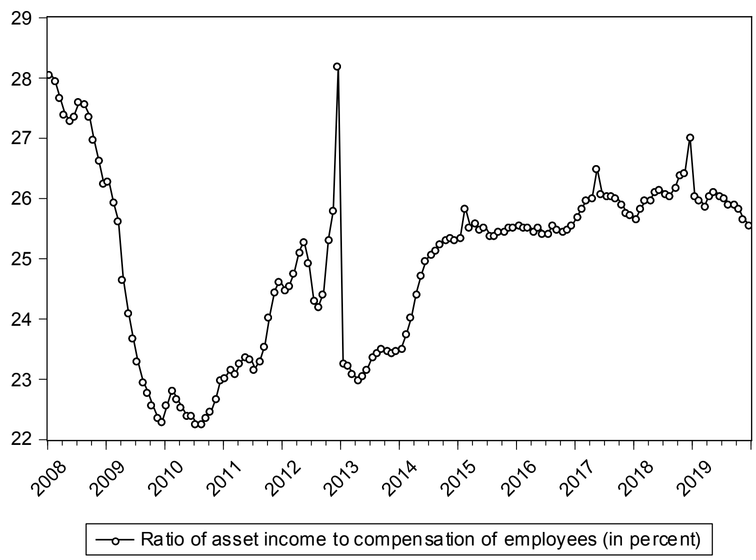
Finally, to assess the relative importance of an unconventional monetary policy shock, a variance decomposition analysis is implemented. It is informative to observe the contribution of an unconventional monetary policy shock to the variation in the inequality measures. The analysis is implemented in the cases of the income and the wealth inequality ratios, which are computed at the monthly frequency.

5.1 Ratio between Capital and Labor Income

The ratio between capital and labor income is considered as a baseline income inequality measure. This paper uses personal income receipts on assets and the compensation of employees, as proxies for capital income and earnings, respectively. The dynamics of asset income and earnings are presented in Figure A.1. As can be seen, both variables generally have similar dynamics. After the decline during 2008 and 2009, they had growing trends over the period from 2010 to 2019.

To explore the relation between capital and labor income, this paper computes the ratio of personal income receipts on assets to the compensation of employees. It is assumed that the increase in asset income mostly benefits high income households while the rise in earnings mainly relates to the income of low income households. Figure 1 provides the graph of the ratio. As can be observed, after the initial decline in 2008 and 2009, the ratio generally had an increasing trend from 2010 onward, indicating that capital income grew at a faster rate than earnings. The spike of the graph for December of 2012 captures the additional stimulus within the third round of quantitative easing (QE3), which lasted from September 2012 to October 2014. Thus, for the relation between capital and labor income, this ratio is considered as an income inequality proxy variable, which is at the monthly frequency as the other macroeconomic variables.

Figure 1: Income Inequality Ratio



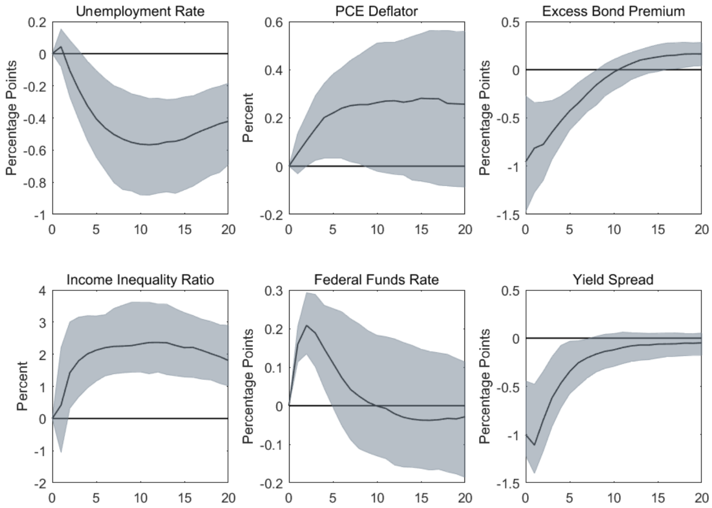
Note: The figure includes the graph of the ratio of the personal income receipts on assets to the compensation of employees (in percent). The data source for the asset income and the compensation of employees is the U.S. Bureau of Economic Analysis.

The estimation results of the IRFs for the VAR model with the income inequality ratio are provided in Figure 2. Given the normalization, an expansionary monetary policy shock leads to the decrease of the yield spread by 1 percentage point. The shock reduces the unemployment rate up to 0.6 percentage points. The response is in line with the corresponding result obtained by Eberly, Stock, and Wright (2020). The shock leads to an increase in the PCE deflator by approximately 0.2 percent. The result is similar to the response of prices to an asset purchase announcement shock[5] provided by Hesse, Hofmann, and Weber (2018). It reduces the excess bond premium on impact by around 0.9 percentage points. The response is analogous to the respective result found by Gertler and Karadi (2015). Following the expansion, the federal funds rate initially rises up to 0.2 percentage points and then it decreases. Also, the expansionary monetary policy shock significantly increases the income inequality ratio by approximately 2 percent. That is, unconventional monetary policy raises capital income more than labor earnings, leading to the increase in income inequality[6]. Figure A.3 shows that both capital income and labor earnings increase following the monetary policy expansion.

[5] Hesse, Hofmann, and Weber (2018) identify the asset purchase announcement shock through zero and sign restrictions on IRFs.

[6] Standard inequality measures are considered later in the text.

Figure 2: IRFs to a Slope Monetary Policy Shock (The Model with the Income Inequality Ratio)



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Various robustness checks of the results are implemented. First, the alternative identification of an unconventional monetary policy shock (SVAR–IV) is implemented. Figure A.5 contains the resulting IRFs. Although quantitative responses of the variables are a bit smaller, their dynamics are analogous to the results obtained with the baseline identification. In particular, unconventional monetary policy fosters real economic activity, moderately increases prices, and loosens financial conditions. In response to this expansion, the federal funds rate increases. Yet, unconventional monetary policy leads to the relatively larger growth in capital income than in earnings, resulting in the increase in income inequality. At the same time, the contemporaneous response of the income inequality rate is not significant in line with the corresponding zero restriction imposed in the case of the baseline identification.

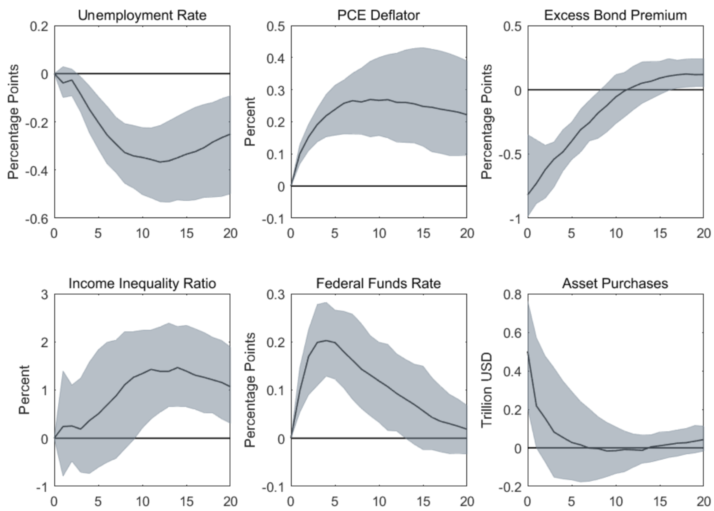
Other robustness checks are provided in Online Appendix[7]. The variables of the model are replaced with their corresponding alternative measures one by one. As an alternative measure for real economic activity, this paper uses the real GDP (monthly estimates from IHS Markit) instead of the unemployment rate. The PCE deflator is substituted with the CPI. Instead of the excess bond premium, VIX is considered. The yield spread is alternatively specified as the difference between the 10-year government bond rate and the federal funds rate. The baseline specification of the model is estimated both with the lag orders of three and four instead of the selected lag order of two. In all the cases, the results are generally similar to the IRFs obtained with the baseline specification of the model.

[7] Online Appendix is provided at the end of this paper.

The aforementioned results are obtained for the overall effect of unconventional monetary policy. Yet, they might be related to different elements of unconventional policy measures such as forward guidance and large scale asset purchases (LSAPs). Especially, LSAPs were important policy measures, which helped to overcome the global financial crisis, and affected the relative supply of financial assets and their prices in the economy. Therefore, this paper tries to disentangle the impact of LSAPs to check whether they drive the results obtained for the overall effect of unconventional monetary policy.

Figure 3 contains the IRFs to an asset purchase announcement shock. Their dynamics and magnitudes are similar to the initial IRFs provided in Figure 2. An asset purchase announcement shock reduces the unemployment rate by around 0.4 percentage points. It raises prices up to 0.25 percent. Following the expansion, the excess bond premium decreases on impact by approximately 0.8 percentage points and the federal funds rate rises by about 0.2 percentage points. The shock increases the income inequality ratio up to 1.2 percent. Thus, all these results are analogous to the IRFs obtained initially.

Figure 3: IRFs to an Asset Purchase Announcement Shock (The Model with the Income Inequality Ratio)



Note: The figure reports posterior median impulse responses to a 0.5 trillion USD asset purchase announcement shock and 68% credible intervals of the posterior distribution.

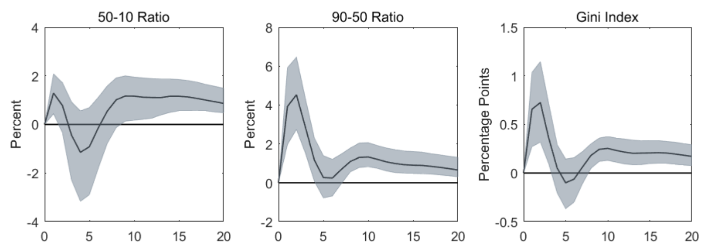
It can be claimed that the overall impact of unconventional monetary policy is mainly driven by LSAPs although there are some caveats to this inference. LSAPs were generally implemented until 2015 and consequently the sample is shorter for the estimation of their effects. Nevertheless, principal payments and maturing securities were reinvested, and the balance sheet of the Fed remained largely expanded until the final point of the baseline estimation period 2019:M12. So, the overall effect of unconventional monetary policy that this paper evaluates can capture these effects in addition to accounting for the impact of LSAPs implemented until 2015. Thus, balance sheet policies appear to be the key measures that shape the overall impact of unconventional monetary policy.

5.2 Standard Income Inequality Measures

This paper uses standard income inequality measures for the further analysis of the distributional effects of unconventionality monetary policy. This analysis allows to uncover the heterogeneous effects of unconventional policy measures. Figure 4 displays the IRFs of income inequality measures to a slope monetary policy shock. In particular, the figure includes the response of the Gini index, which is a general measure of inequality. An expansionary monetary policy shock raises the Gini index up to 0.7 percentage points. The response is equivalent to the increase of the Gini index by around of 1.4 percent, which is in line with the result obtained in the case of the income inequality ratio. The magnitude of the response of the Gini index is economically significant given that the Gini index increased by 1.8 percentage points from 2008 (the value of 46.60) to 2019 (the value of 48.40).

The response of the Gini index is of opposite sign from the respective result found by Coibion et al. (2017) in the case of conventional monetary policy. Some of the reasons for the opposite results should be related to the differences in methodologies and estimation samples. Yet, the main reason for the opposite results is probably related to unconventional monetary policy measures. As discussed above, unconventional policy measures are effective in fostering real economic activity and easing financial conditions but they tend to increase capital income more than earnings.

Figure 4: IRFs of Income Inequality Measures to a Slope Monetary Policy Shock



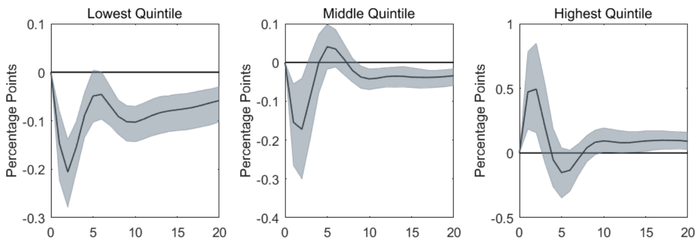
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution. The income inequality measures are included in the VAR model one by one.

This paper evaluates the impact of unconventional monetary policy on the different parts of income distribution. The lower and the upper parts of income distribution are proxied by the 50-10 and the 90-50 percentile ratios, respectively. The VAR model is modified by incorporating each of the percentile ratios as an inequality measure one at a time.

As can be observed from Figure 4, an expansionary monetary policy shock increases the 50-10 and the 90-50 ratios by approximately 1 and 4 percent, respectively. That is, following the monetary policy expansion, the income of middle earners grows up with respect to the income of lower earners. Nevertheless, the monetary policy expansion leads to the much larger increase in the income of higher earners relative to the income of middle earners. Furthermore, the responses of 90-50 ratio and the Gini index are analogous. That is, the response of the Gini index is mainly driven by the response in the upper part of income distribution.

The consideration of income shares compliments the analysis on the impact of unconventional monetary policy on the different parts of income distribution. The results are presented in Figure 5. A slope monetary policy shock reduces the income shares of the lowest and the middle quintiles by around 0.2 and 0.17 percentage points, respectively. At the same time, the shock raises the income share of of the highest quintile up to 0.5 percentage points. The dynamics of the responses of the lowest and the middle quintiles are analogous but the response of the lowest quintile is more pronounced. Yet, their responses are actually asymmetric to the response of the highest quintile.

Figure 5: IRFs of Income Shares to a Slope Monetary Policy Shock



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution. The income shares are included in the VAR model one by one.

Consistently with the analysis of the percentile ratios, unconventional monetary policy reduces the income shares of lower and middle earners while it raises the income share of higher earners. Moreover, the income share of lower earners decreases more than that of middle earners because, in general, the latter has higher skills, which are more complimentary to capital (Dolado, Motyovszki, and Pappa 2021). Thus, all these results corroborate the finding that unconventional monetary policy increases capital income more than labor income given that lower and middle earners mainly receive labor income whereas higher earners mostly gain capital income.

5.3 Ratio between Stock and House Prices

Unconventional monetary policy measures, especially LSAPs, tend to change the relative supply of assets and consequently to affect their prices. For instance, as can be observed from Figure A.2, stock prices initially dropped and they generally rose after 2009 throughout the rest of the considered period from 2008 to 2019. On the other hand, house prices decreased from 2008 to 2012 and grew up afterwards for the rest of the period. All these changes in the asset prices should be reflected in the dynamics of wealth inequality. Therefore, this paper estimates the impact of unconventional monetary policy on wealth inequality over the study period.

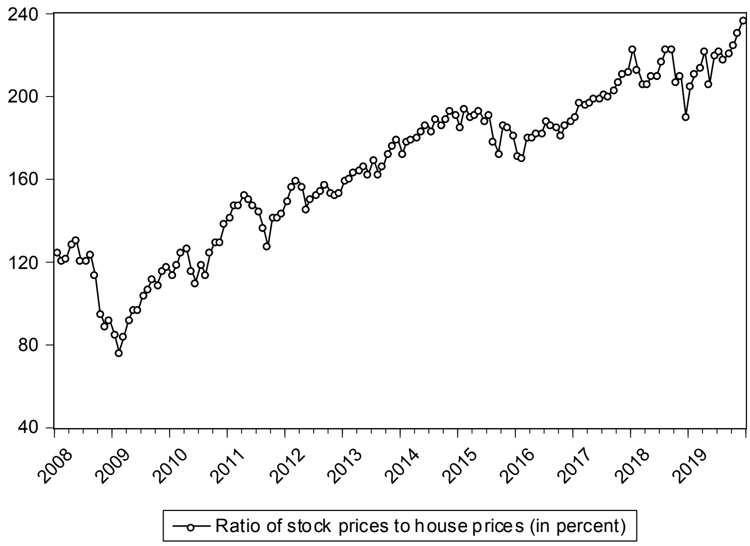
The dynamics of wealth inequality depend on the changes in the portfolio composition and the savings flows of households. If portfolios differ along distribution, asset prices lead to different capital gains and so to the changes in wealth inequality. Kuhn, Schularick, and Steins (2020) show that the effect of asset prices on wealth inequality is more prominent than savings flows when aggregate wealth to income ratio is high. Piketty and Zucman (2014) provide evidence of the considerable rise of this ratio in the USA over recent decades. That is, the dynamics of asset prices have been a decisive factor for the recent dynamics of US wealth inequality.

The portfolio of low income and middle class households mainly consists of nonfinancial assets such as houses while wealthy households mostly tend to have capital assets such as stocks. Because of these differences in the portfolio composition of households, the changes in the stock and the housing prices shape the dynamics of wealth inequality. For instance, Adam and Tzamourani (2016) provide evidence in the case of the Euro Area that the increase in equity prices benefits wealthy households while the rise in house prices is beneficial for middle class households.

Since the dynamics of wealth inequality are primarily affected by the changes in the stock and the house prices, their relative dynamics are examined for the study period. The ratio of stock prices to house prices is computed as a proxy indicator of wealth inequality. The dynamics of the ratio provided in Figure 6 show that it generally had an increasing trend after 2009. That is, stock prices grew at faster rate than house prices during the considered period.

Figure 7 provides the IRFs of the VAR model that includes the wealth inequality ratio as an inequality measure. As previously, an expansionary monetary policy shock leads to the reduction in the unemployment rate and the excess bond premium, and to the increase in prices. Besides, the shock significantly raises the wealth inequality ratio up to 18 percent, which is the largest response among the considered inequality indicators. Thus, this response indicates that unconventional monetary policy increases wealth

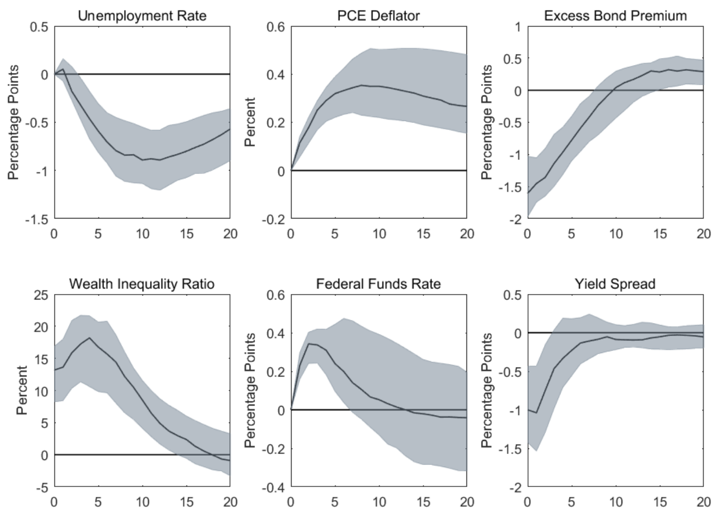
Figure 6: Wealth Inequality Ratio



Note: The figure includes the graph of the ratio of the S&P 500 Index to the S&P/Case-Shiller U.S. National Home Price Index (in percent). The data source for the stock and the house indices is S&P Dow Jones Indices LLC. The indices are scaled to 2009=100 before computing the ratio.

inequality by raising stock prices more than house prices. Following the unconventional monetary policy shock, the positive responses of the stock and the house prices are presented in Figure A.3.

Figure 7: IRFs to a Slope Monetary Policy Shock (The Model with the Wealth Inequality Ratio)



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

As in the case of the income inequality ratio, this paper curries out different robustness checks of the results. First, an unconventional monetary policy shock is alternatively identified with the SVAR-IV method. The results presented in Figure A.6. As in the case of the previous results, unconventional monetary policy spurs real economic activity, raises prices, and eases financial conditions. The federal funds rate increases in response to this expansion. Unconventional monetary policy also raises stock prices relatively more than house prices, leading to the increase in wealth inequality. In particular, the strongest response of the wealth inequality ratio is on impact to the monetary policy expansion. This contemporaneous response of the wealth inequality ratio might be explained by the fact that the stock and the house prices can immediately react to a monetary policy shock. It is also in line with the respective result in case of the baseline identification.

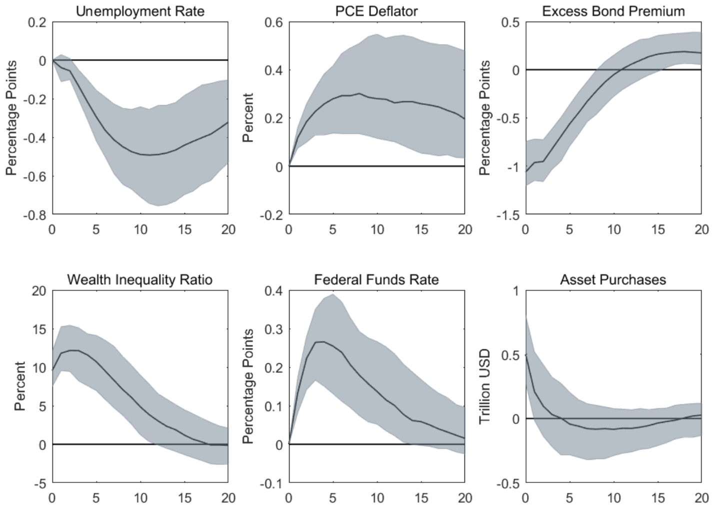
The set of other robustness checks is analogous to the case when the income inequality ratio is considered. The variables of the model are substituted by their respective alternative measures one by one. Instead of the selected lag order of two, the baseline specification of the model is estimated both with the lag orders of three and four. These robustness checks are reported in Online Appendix. In general, the results are robust to these different modifications.

As previously, this paper studies the impact of LSAPs disentangling it from the combined effect of unconventional monetary policy. The impact of LSAPs is evaluated as in the case of the consideration of the income inequality ratio. Figure 8 displays the resulting IRFs, which are analogous to the results presented in Figure 7. An asset purchase announcement shock reduces the unemployment rate and the excess bond premium, and increases prices. Following the expansion, the federal funds rate rises. At the same time, LSAPs increase the wealth inequality ratio up to 12 percent. This response of the wealth inequality ratio is just slightly lower than its response of around 18 percent in the baseline case. As in the cases of the responses of the other variables, the dynamics of the responses of the wealth inequality ratio are similar in both case. Thus, the combined impact of unconventional monetary policy is mainly driven by the balance sheet policies.

5.4 Standard Wealth Inequality Measures

This paper evaluates the effect of unconventional monetary policy on wealth inequality using standard inequality measures too. Yet, the availability of wealth inequality measures are much more limited than the availability of income inequality measures. In any case, the consideration of available standard wealth inequality measures is useful for complimenting the empirical analysis. In particular, the bottom 50%, the middle 40%, and the top 10% shares of net personal wealth are considered.

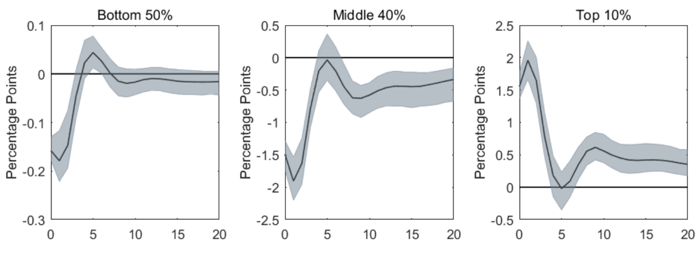
Figure 8: IRFs to an Asset Purchase Announcement Shock (The Model with the Wealth Inequality Ratio)



Note: The figure reports posterior median impulse responses to a 0.5 trillion USD asset purchase announcement shock and 68% credible intervals of the posterior distribution.

Figure 9 displays the estimation results of the impact of unconventional monetary policy on the different parts of wealth distribution. A slope monetary policy shock reduces the bottom 50% and the middle 40% wealth shares on impact by around 0.17 and 1.5 percentage points, respectively. Following the shock, the top 10% wealth share increases on impact by approximately 1.6 percentage points. The dynamics of the responses of the bottom 50% and the middle 40% wealth shares are similar but the response of the middle 40% wealth share is stronger. Besides, the response of the middle 40% wealth share is almost fully asymmetric to the response of the top 10% wealth share.

Figure 9: IRFs of Wealth Shares to a Slope Monetary Policy Shock



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution. The wealth shares are included in the VAR model one by one. The middle 40% is the share between percentiles 50 and 90.

The responses of different parts of wealth distribution are in line with the response of the wealth inequality ratio. The group at the bottom of wealth distribution generally posses less non-financial assets than the group in the middle of wealth distribution.

Consequently, the response of the wealth share of the former group is weaker, in line with the results by Adam and Tzamourani (2016). At the same time, the group in the middle of wealth distribution mainly owns non-financial assets such as houses while the group at the upper part of wealth distribution mostly possesses financial assets such as stocks. Therefore, the increase of stock prices with respect to house prices generally leads to the redistribution of wealth to the top.

5.5 Variance Decomposition

This paper implements a variance decomposition analysis to evaluate the contribution of an unconventional monetary policy shock to the variation in the income and the wealth inequality ratios. Table 3 provides the results of the variation in the inequality measures due to a slope monetary policy shock over the initial 20 months. The results indicate that the shock accounts for the higher variation in the wealth inequality ratio than in the income inequality measure over all considered periods. For instance, in the fourth period, the shock explains 25.03 percent of the variation in the wealth inequality ratio while the shock accounts for only 2.16 percent of the variation in the income inequality indicator. Similarly, in the twentieth period, the contribution of the shock to the variation in the wealth inequality ratio is 37.45 percent whereas the shock explains 16.15 percent of the variation in the income inequality measure.

Table 3: Variation in Inequality Measures due to a Slope Monetary Policy Shock

Periods (in Months)	Income Inequality Ratio	Wealth Inequality Ratio
4	2.16	25.03
8	6.70	37.73
12	10.97	39.28
16	14.49	39.02
20	16.15	37.45

Note: The table reports the posterior median variation in inequality measures due to a slope monetary policy shock. The variation is expressed in percent.

Thus, analogous to the results of Mumtaz and Theophilopoulou (2020) for the UK, this paper finds that unconventional monetary policy substantially affects the variation in wealth inequality. This impact is stronger than in the case of income inequality. In the fourth period, the considerable difference in the results might be related to the fact that the income inequality ratio does not contemporaneously react to the monetary policy shock in contrast to the contemporaneous response of the wealth inequality indicator. In any case, over all the considered periods, the monetary policy shock accounts for the substantially higher variation in the wealth inequality ratio than in the income inequality measure.

6 Conclusion

This paper evaluates the distributional impact of US unconventional monetary policy conducted in response to the the global financial crisis. The results indicate that the monetary policy expansion fosters real economic activity and moderately increases prices as well as eases financial conditions. At the same time, unconventional monetary policy measures increase income and wealth inequality, having a stronger effect on the latter. The estimated overall effects of unconventional monetary policy are mainly driven by LSAPs. An unconventional monetary policy shock is identified both with zero and sign restrictions, and with the SVAR-IV method. The results are also robust to the application of the standard and the mixed frequency approaches, and the different modifications of the model specification.

The results show that unconventional monetary policy increases capital income more than labor earnings. This impact of unconventional policy results in the growth of income inequality measured with standard indicators. In particular, unconventional monetary policy raises the 50-10 and the 90-50 percentile ratios, and the Gini index. The results are mostly driven by the relatively higher increase in income at the upper part of distribution. Besides, unconventional policy measures reduce the income shares of the lowest and the middle quintiles while they increase the income share of the highest quintile. Given that lower and middle earners mostly receive labor income whereas higher earners mainly gain capital income, the relatively higher increase of capital income compared to labor earnings leads to the growth of income inequality following the monetary policy expansion.

The results indicate that unconventional monetary policy raises stock prices more than house prices. This effect of unconventional policy measures leads to the increase in wealth inequality measured with the shares of wealth distribution. Particularly, unconventional monetary policy reduces the bottom 50% and the middle 40% wealth shares while it increases the top 10% wealth share. The results are related to the fact that the groups in the lower and the middle parts of wealth distribution mainly own non-financial assets such as houses while the portfolio of the group at the top of wealth distribution mostly consists of financial assets such as stocks. Consequently, following the monetary policy expansion, the growth of stock prices with respect to house prices results in the increase of wealth inequality. Moreover, the variance decomposition analysis shows that unconventional monetary policy explains the higher variation in wealth inequality than in income inequality.

Thus, unconventional monetary policy was helpful in recovering from the global financial crisis. Yet, it came at the cost of increased income and especially wealth inequality. These results point out the need for complimentary fiscal policy measures. Besides, this evidence might be useful for the further development of the ongoing unconventional monetary policy measures, which are currently targeted to the wider range of households.

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A Appendix

A.1 Inequality Measures

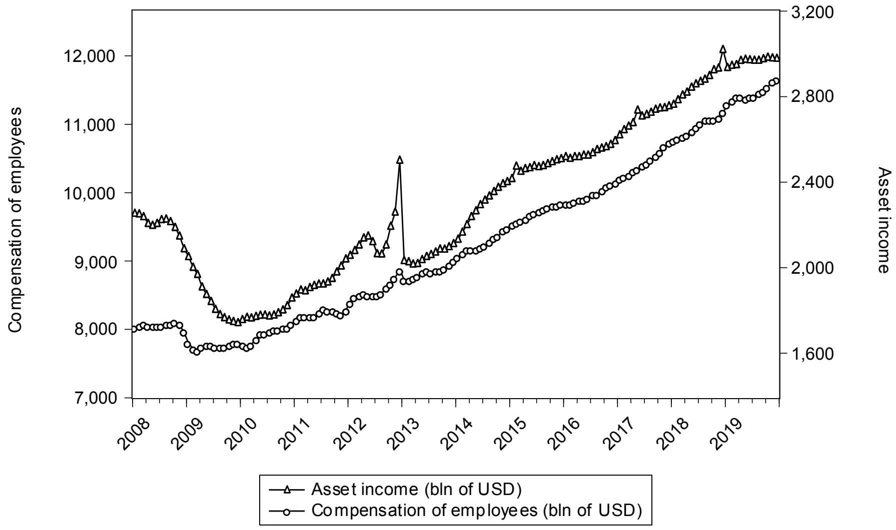
Table A.4: Statistical Information on Inequality Measures

Inequality Measures	Frequency	Mean	Max	Min	SD	RSD
Income inequality ratio	Monthly	24.97	28.21	22.26	1.47	0.06
50-10 ratio	Annual	4.25	4.39	4.11	0.10	0.02
90-50 ratio	Annual	2.87	2.93	2.75	0.06	0.02
Gini index	Annual	47.77	48.60	46.60	0.64	0.01
Lowest quintile	Annual	3.18	3.40	3.10	0.12	0.04
Middle quintile	Annual	14.35	14.70	14.10	0.19	0.01
Highest quintile	Annual	51.11	52.00	50.00	0.63	0.01
Wealth inequality ratio	Monthly	165.84	237.18	76.74	38.33	0.23
Bottom 50%	Annual	1.11	1.51	0.87	0.24	0.22
Middle 40 %	Annual	27.47	29.44	26.12	1.16	0.04
Top 10%	Annual	71.43	72.88	69.44	1.22	0.02

Note: The table reports the statistical measures for the inequality indicators. The CPS and the WID are the data sources for annual income and wealth inequality measures, respectively. Section 4 describes the computation of the income and the wealth inequality ratios.

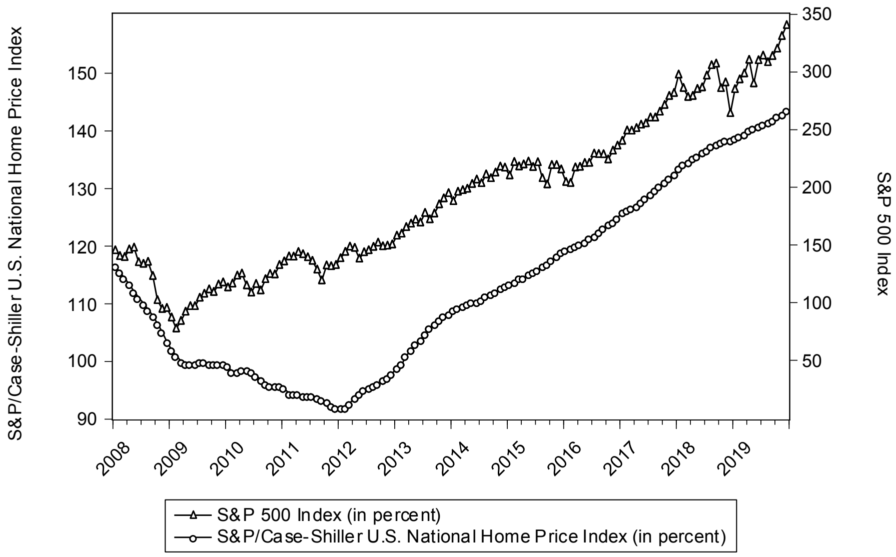
A.2 Income and Wealth Indicators

Figure A.1: Asset Income and Compensation of Employees



Note: The figure includes the graphs of the personal income receipts on assets and the compensation of employees. The data source is the U.S. Bureau of Economic Analysis.

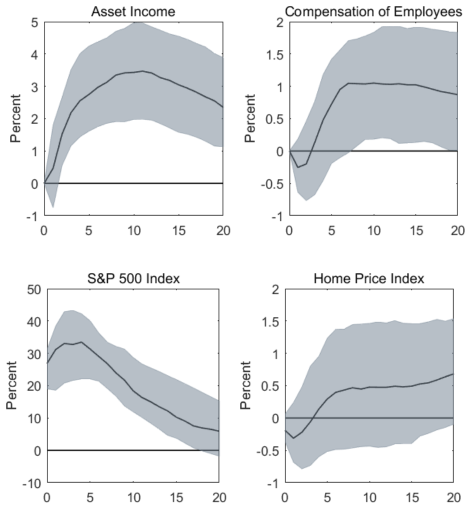
Figure A.2: Stock and House Prices



Note: The figure includes the graphs of the S&P 500 Index and the S&P/Case-Shiller U.S. National Home Price Index. The data source is S&P Dow Jones Indices LLC. The indices are scaled to the base year of 2009=100.

A.3 Responses of Income and Wealth Indicators

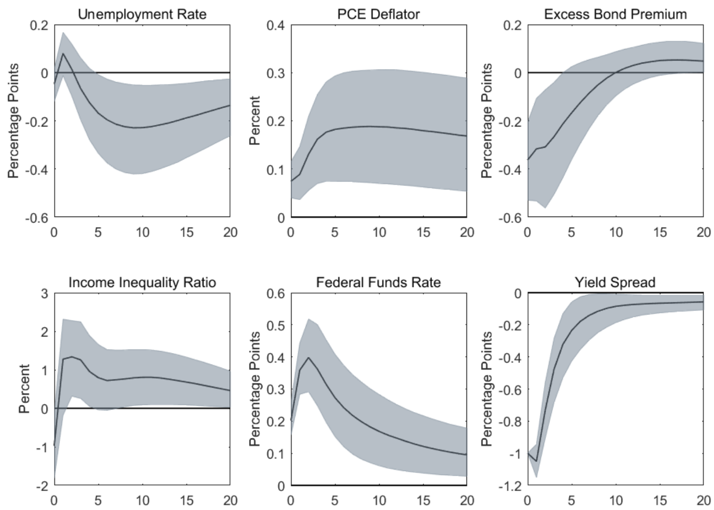
Figure A.3: IRFs of Income and Wealth Indicators to a Slope Monetary Policy Shock



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution. The income and the wealth indicators are included in the VAR model one by one.

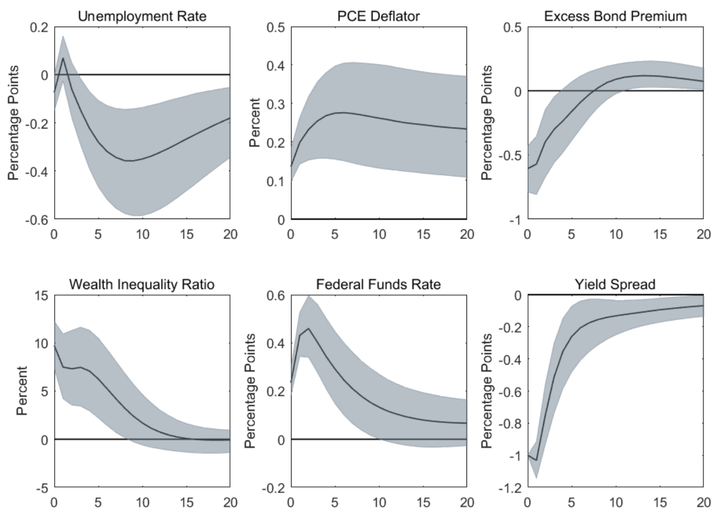
A.4 SVAR-IV Identification

Figure A.5: IRFs to a Slope Monetary Policy Shock (The Model with the Income Inequality Ratio)



Note: The figure reports median impulse responses to a one percentage point expansionary monetary policy shock and 68% confidence intervals based on bootstrap replications.

Figure A.6: IRFs to a Slope Monetary Policy Shock (The Model with the Wealth Inequality Ratio)

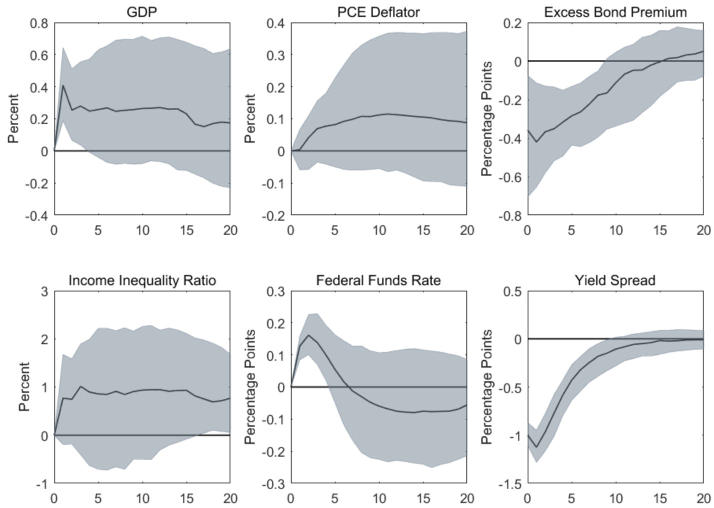


Note: The figure reports median impulse responses to a one percentage point expansionary monetary policy shock and 68% confidence intervals based on bootstrap replications.

Online Appendix

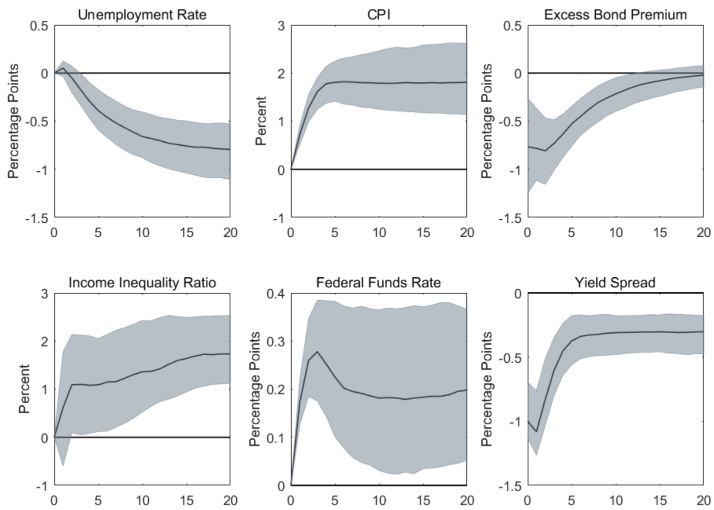
B Robustness Checks for the Model with the Income Inequality Ratio

Figure B.1: IRFs to a Slope Monetary Policy Shock (The Model with the GDP)



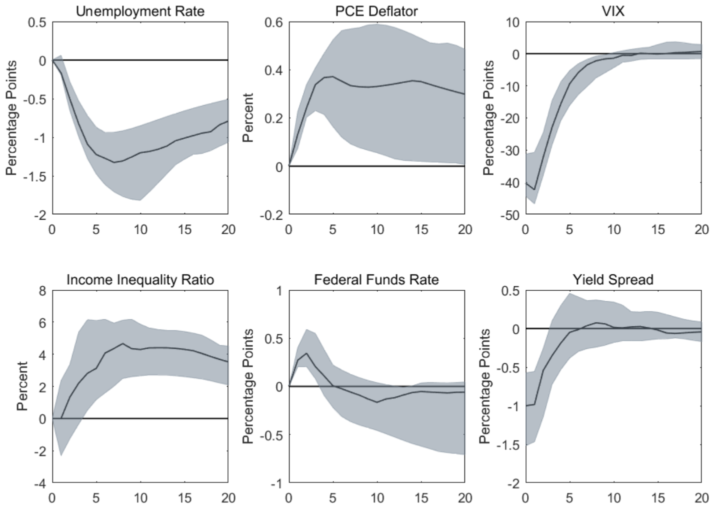
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Figure B.2: IRFs to a Slope Monetary Policy Shock (The Model with the CPI)



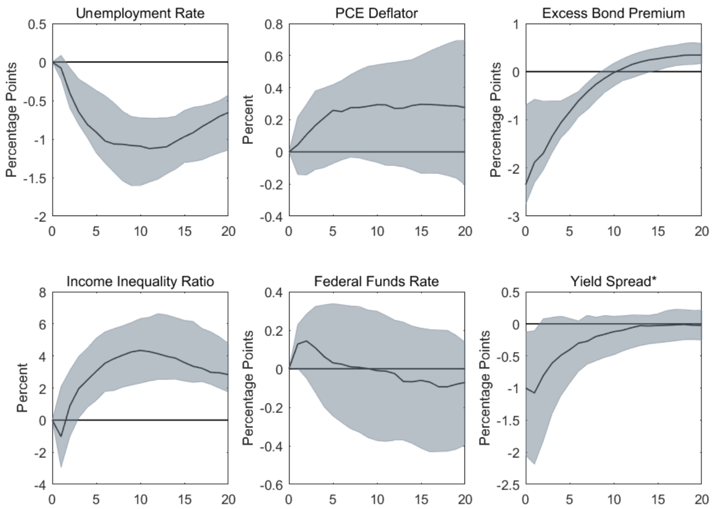
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Figure B.3: IRFs to a Slope Monetary Policy Shock (The Model with the VIX)



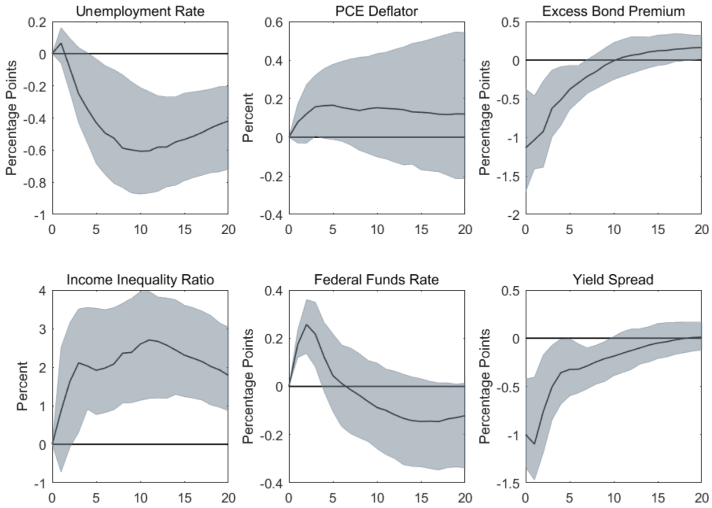
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Figure B.4: IRFs to a Slope Monetary Policy Shock (The Model with the Alternative Measure of the Yield Spread)



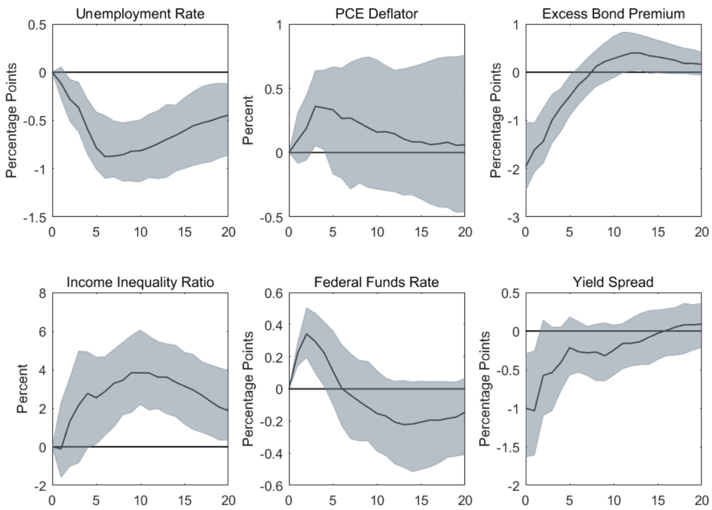
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.
* The yield spread is measured as the difference between the 10-year government bond rate and the federal funds rate.

Figure B.5: IRFs to a Slope Monetary Policy Shock
(The Baseline Model with the Lag Order of Three)



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

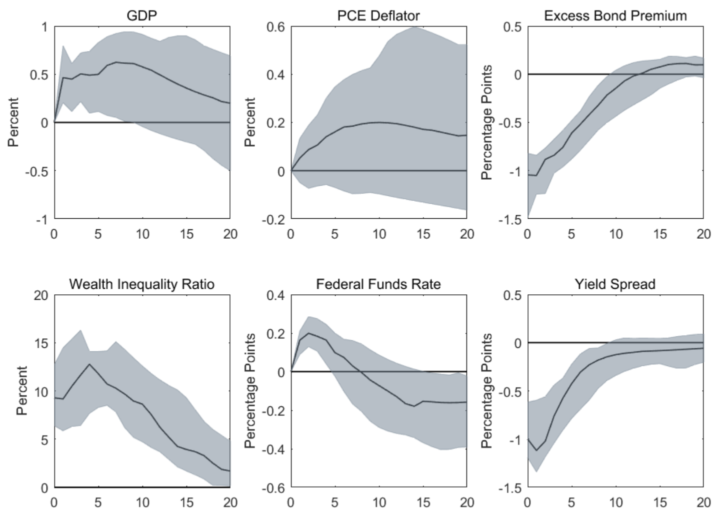
Figure B.6: IRFs to a Slope Monetary Policy Shock
(The Baseline Model with the Lag Order of Four)



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

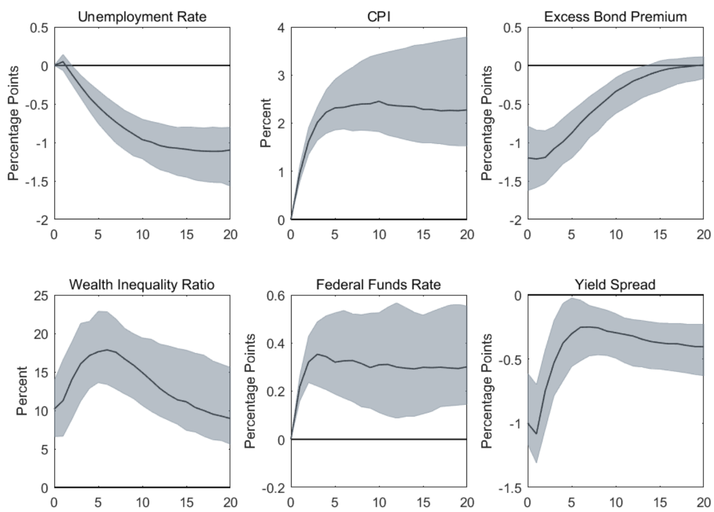
C Robustness Checks for the Model with the Wealth Inequality Ratio

Figure C.1: IRFs to a Slope Monetary Policy Shock
(The Model with the GDP)



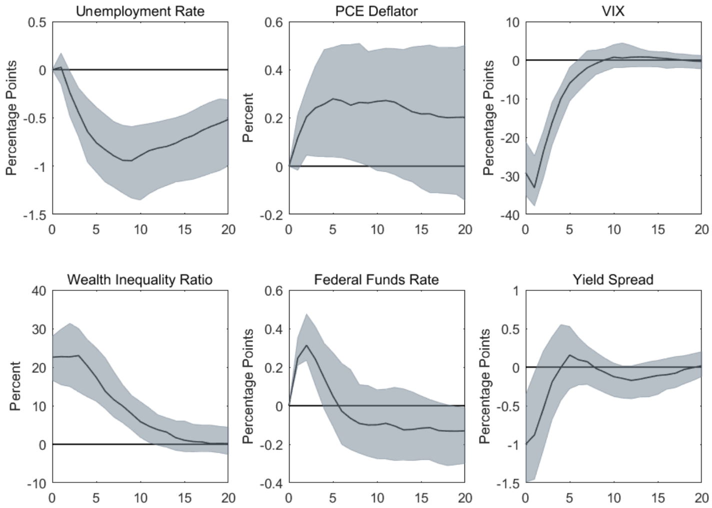
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Figure C.2: IRFs to a Slope Monetary Policy Shock
(The Model with the CPI)



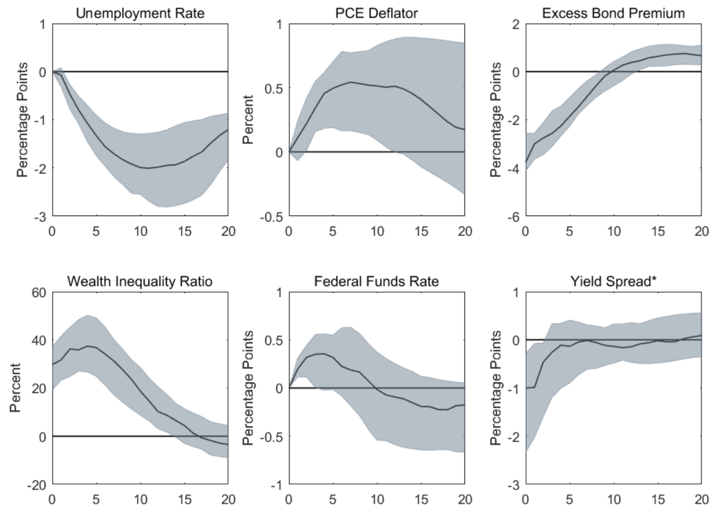
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Figure C.3: IRFs to a Slope Monetary Policy Shock
(The Model with the VIX)



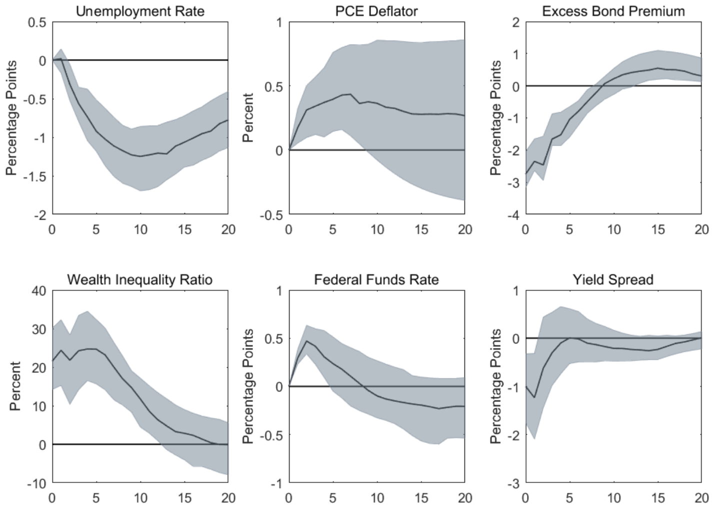
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Figure C.4: IRFs to a Slope Monetary Policy Shock
(The Model with the Alternative Measure of the Yield Spread)



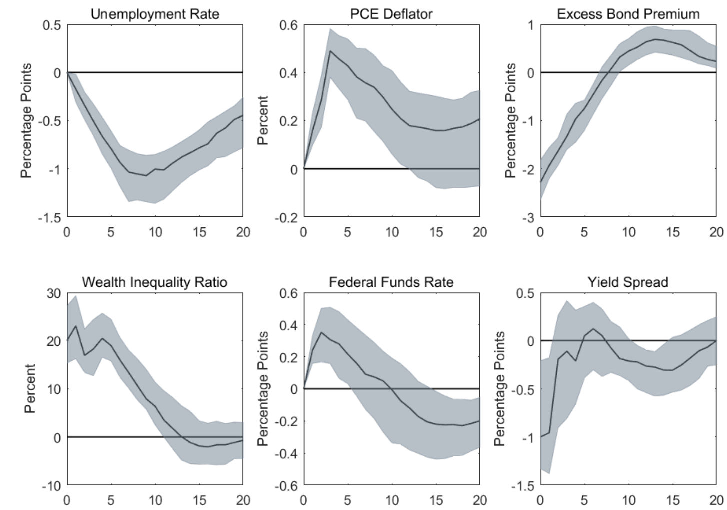
Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.
* The yield spread is measured as the difference between the 10-year government bond rate and the federal funds rate.

Figure C.5: IRFs to a Slope Monetary Policy Shock (The Baseline Model with the Lag Order of Three)



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.

Figure C.6: IRFs to a Slope Monetary Policy Shock (The Baseline Model with the Lag Order of Four)



Note: The figure reports posterior median impulse responses to a one percentage point expansionary monetary policy shock and 68% credible intervals of the posterior distribution.