Economic Modelling 126 (2023) 106380

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.journals.elsevier.com/economic-modelling

Unconventional monetary policy and economic inequality ☆

Karen Davtyan

Department of Applied Economics, Autonomous University of Barcelona, Spain

ARTICLE INFO

JEL classification:
C32
D31
E52

Keywords:
Unconventional monetary policy
Identification
Inequality

ABSTRACT

This paper evaluates the distributional effects of US unconventional monetary policy (UMP) implemented as an additional measure to confront recessions. In line with the literature, the results show that the UMP reduces the unemployment rate, moderately increases prices, and stabilizes financial conditions. Yet, it also increases income and wealth inequality, with a stronger effect on the latter. Central bank balance sheet policies tend to be the key measures that shape its general effects. The UMP raises capital income more than labor earnings, which leads to the relatively higher increase in income at the upper part of the distribution and as a result to the growth of income inequality. Also, the UMP increases stock prices more than house prices, which results in the relatively larger growth of wealth at the top end of the distribution, leading to the rise of wealth inequality. These results indicate the need for complementary fiscal policy measures.

1. Introduction

In the period preceding the global financial crisis, a key leading practice in the implementation of conventional monetary policy (CMP) was to set the level of the policy interest rate. In response to the global financial crisis, many central banks substantially lowered their policy rates up to the zero lower bound (Rossi, 2021). To improve deteriorated economic conditions and to ease financial conditions, they also resorted to unconventional monetary policy (UMP) measures such as forward guidance and large scale asset purchases (LSAPs, known also as quantitative easing or balance sheet policy). Monetary authorities have used forward guidance to communicate the implementation of monetary policy, including the likely future path of the policy rate. At the same time, LSAPs have been implemented with the announcement of the amounts of asset purchases and the time horizon for transactions (Swanson, 2021). Thus, in comparison to the CMP, the UMP is more multidimensional and it can directly affect asset prices (Eberly et al., 2020).

Given the broader spectrum of the UMP measures, they have widely been utilized to confront recessions. The records of the implementation of the UMP measures have been used to evaluate their macroeconomic and financial effects while their distributional impact has not systematically been explored yet. The examination of the distributional impact is especially important given the nature of the UMP that can directly affect asset prices. Moreover, in addition to general concerns about economic inequality (Kuhn et al., 2020), it is also perceived as a concern for the transmission and effectiveness of monetary policy (Voinea et al., 2018). In any case, as with any remedy, it is important to know all its effects. The objective of this paper is to provide evidence on the distributional impact of the UMP.

The contribution of this paper is comprehensive and consistent evidence on the impact of the UMP on income and wealth inequality in the case of the US. The consistent framework allows comparing the effects of the UMP on income and wealth inequality. The economic mechanism of these effects is considered examining the distributional channels of monetary policy. This paper also uncovers the type of the UMP that drives the general impact of the UMP.

The (general) UMP shock is identified with zero and sign restrictions in line with the identification approach by Arias et al. (2019) for the case of the CMP. An alternative identification of the UMP shock with instrumental variables (Eberly et al., 2020) provides similar results. The LSAP shock is also identified to disentangle it from the general shock of the UMP. This paper computes proxy inequality measures, which are at the same frequency as other variables. To complement the analysis with standard inequality measures, this paper applies a mixed frequency framework (Foroni and Marcellino, 2016) given that the inequality data are available at the lower frequency.

The results indicate that the UMP fosters real economic activity, moderately increases prices, and eases financial conditions. At the same

☆ This paper was mainly written during my previous work in the Department of Statistics at the University Carlos III of Madrid. 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, Thomas Piketty, Raul Ramos, Barbara Rossi, Moritz Schularick, and the editor Sushanta Mallick and three anonymous referees. I also thank Boris Hofmann and Jonathan Wright for sharing their data. All errors are my own.

E-mail address: karen.davtyan@uab.cat.

https://doi.org/10.1016/j.econmod.2023.106380
Received 8 December 2022; Received in revised form 21 May 2023; Accepted 22 May 2023
Available online 28 May 2023

time, it raises economic inequality. The estimated general effects of the UMP are mainly driven by LSAPs. The UMP leads to the relatively larger increase in capital income than in labor earnings. This impact of the UMP 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 the 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 the UMP 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 the wealth distribution mostly own non-financial assets such as houses while the portfolio of the group at the top of the wealth distribution is mainly composed of financial assets such as stocks. Using standard inequality measures, this paper finds that the UMP lowers the bottom and the middle wealth shares whereas it raises the top wealth share. The impact of UMP measures on wealth inequality is generally stronger. In particular, the variance decomposition analysis reveals that the UMP accounts for the higher variation in wealth inequality than in income inequality.

The topic on the distributional impact of the UMP 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 the CMP. 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 US that contractionary CMP increases economic inequality. Dolado et al. (2021) show that expansionary monetary policy raises earnings inequality between low and high skilled workers in the US. 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) shows that expansionary CMP reduces income inequality while the UMP raises it in the euro area. For the UK, Mumtaz and Theophilopoulou (2020) provide evidence that expansionary monetary policy raises wealth inequality and accounts for its substantial variation.

The most closely related papers are the works by Lenza and Slacalek (2018), Saiki and Frost (2020), and Evgenidis and Fasianos (2021) who also focus their analyses on the distributional effects of the UMP. 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 the UMP and then distribute them on the survey data for 2014. This paper complements their work by estimating the dynamic responses of inequality measures to the UMP.

Saiki and Frost (2020) show that the UMP 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 the UMP in Japan. The current paper provides additional evidence and estimates the impact of the UMP on wealth inequality too.

In the case of Great Britain, Evgenidis and Fasianos (2021) find that the UMP widens wealth inequality. Their main identification approach of the UMP shock is through the recursive scheme. The current paper presents further evidence by differently identifying the UMP shock. Besides, this paper evaluates the effects of the UMP on both income and wealth inequality to relate these effects within a consistent framework.

The current paper is also related to the large literature on the evaluation of the economic effects of the UMP with the identifcation approaches based on sign restrictions (among others, Arias et al., 2019; Baumeister and Benati, 2013; Boeckx et al., 2017; Gambacorta et al., 2014) and external instruments (among others, Eberly et al., 2020; Gertler and Karadi, 2015; Rogers et al., 2018). A recent comprehensive review of the identifications methods and the economic effects of the UMP can be found in the article by Rossi (2021). The current paper provides complementary evidence on the economic effects of the UMP using those two identification approaches, which give similar results.

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

The main objective of UMP 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 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, the UMP measures help to recover prices for houses, which are the main class of assets in the portfolio of low and middle income households. At the same time, LSAPs 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 mostly own these bonds and assets.[1]

Thus, the implementation of the UMP could facilitate to overcome the financial crisis. At the same time, it might also affect the income and the wealth distribution. On the one hand, it could restore the labor earnings and the wealth of low income households. On the other hand, the UMP might increase the capital income and the wealth of high 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 distribution channels specified by Coibion et al. (2017) and Koedijk et al. (2018), 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. The 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 US 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.

[1] The ownership of bonds and assets across income quantiles can be inferred from Table 1 while the more explicit distribution of household portfolios across wealth groups can be found in the work by Kuhn et al. (2020).

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 (Díaz-Giménez et al., 2011).

- *Capital income heterogeneity*: The returns of various assets are differently affected by monetary policy, and the portfolio composition of households differs along the 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. That is, it can either increase or reduce inequality depending on household savings.

Monetary policy could have different distributional effects through the channels. They can operate with different intensity with the CMP and the UMP, which include different types of tools. That is, the CMP and the UMP could have disproportionate effects via the channels. Moreover, the magnitude of their impact through the channels might be different too, and consequently, they can have different overall distributional effects (Guerello, 2018).

This paper aims to evaluate the distributional effects of the UMP via the income composition, the earnings heterogeneity, and the portfolio channels. First of all, the current paper controls for real economic activity, prices, and financial conditions in the considered model for the analysis. Since the distributional effects of monetary policy through the channels generally depend on relative components, this paper mainly uses relative measures to capture the channels. In particular, to examine the earnings heterogeneity and the income composition channels, the current paper includes the unemployment rate and the ratio of capital income to labor earnings in the model. 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 the UMP. These types of models are commonly used for the evaluation of the effects of monetary policy in the literature (among others, Arias et al., 2019; Baumeister and Benati, 2013; Boeckx et al., 2017; Gertler and Karadi, 2015). Besides, they have a flexible structure, which allows using a mixed frequency framework and different identification approaches of a monetary policy shock. Moreover, the use of a VAR model is particularly suited for the empirical analysis given that the considered variables can affect each other and it is important to treat them as endogenous, which a VAR model allows. The current section describes the specification and the estimation of the VAR model, including a mixed frequency approach, and the identification of the UMP shock.

3.1. Specification

In line with Arias et al. (2019), the structural VAR model of order p, is formulated as follows:

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

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 $j = 1, \ldots, p$) are (6×6) matrices of parameters, and ε_t is a (6×1) vector of structural shocks. It is assumed that conditional on $Y_0, \ldots, Y_{1-p}$, 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[2] (Sims et al., 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 $B_j = A_j \mathrm{A}^{-1}$ (for $j = 0, \ldots, p$), $v_t' = \varepsilon_t' \mathrm{A}^{-1}$ and the reduced form error covariance matrix is $\mathbb{E}(v_t v_t') = \Sigma_v = \mathrm{A}^{-1'} \mathrm{A}^{-1}$.

The vector of endogenous variables Y_t consists of a measure of real economic activity, prices, a financial indicator, an economic inequality measure,[3] and the CMP and the UMP instruments: $Y_t = (u_t,\ p_t,\ m_t,\ z_t,\ i_t,\ s_t)'$. 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 yield spread that is defined as a spread between the 10-year and the 3-month treasury constant maturity rates.

It is common in the literature (e.g., Eberly et al., 2020; Gertler and Karadi, 2015) to include the variables for a real economic activity, prices, and financial market frictions in the specification of VAR models to control for economic conditions when the effects of monetary policy are evaluated. The consideration of these variables is also important for explaining inequality dynamics. The effects of real economic activity and prices on inequality are discussed within the description of the distributional channels of monetary policy in Section 2. The impact of financial conditions on inequality is documented in the literature (e.g., Agnello et al., 2012; Baiardi and Morana, 2018).

Both indicators of the CMP and the UMP are included in the specification of the model in order to disentangle the UMP shock from the CMP shock, as discussed in Section 3.3. As a general indicator of the UMP, the yield spread is considered because the objective of conducted the UMP was to lower the long term interest rate, that is the spread between the long term and the short term interest rates, given that the short term interest rate was mostly at the zero lower bound during the implementation of UMP measures. The yield spread is considered as the UMP indicator also in the literature (among others, Baumeister and Benati, 2013; Eberly et al., 2020).

The variables of the model specification also capture the dynamics of inequality and the distributional effects of the UMP. The specification

[2] In the case of the CMP, an explicit cointegration analysis of the variables can be found in the paper by Davtyan (2017).

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

includes the key variables discussed in Section 2 on the distributional channels of monetary policy. For instance, as a measure of real economic activity, the unemployment rate is considered because it is closely related to labor income (the earnings heterogeneity channel). The direct measure of labor income is also considered. It is included in the specification as a denominator of the income inequality ratio. This ratio measures the relation between capital income and labor earnings and serves as a proxy of income inequality as well as it allows examining the income composition channel. Analogously, the wealth inequality ratio is also considered to measure the relation between stock and house prices (the portfolio channel). That is, the objective is to capture the relative dynamics between these variables as proxy inequality measures.

3.2. Estimation

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.

The current 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: $\mathsf{Y}_t = (z_t, u_t, p_t, m_t, i_t, s_t)'$ and $\mathsf{Y}_t^* = (z_t^*, u_t, p_t, m_t, i_t, s_t)'$, 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

$$\underset{(6\times6)}{H(L)} = \begin{bmatrix} \underset{(1\times1)}{\omega(L)\ I} & \underset{(1\times5)}{0} \\ \underset{(5\times1)}{0} & \underset{(5\times5)}{I} \end{bmatrix}$$

This model in Eqs. (3) and (4) is cast in a state space form. Given $p \le l+1$, 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

$$\underset{(6(l+1)\times1)}{\mathsf{X}_t} = (\mathsf{Y}_t^*, \cdots, \mathsf{Y}_{t-l}^*)'$$

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

$$\underset{6(l+1)\times6(l+1)}{C} = \begin{bmatrix} \Phi_1 \ \cdots \ \Phi_p & 0_{6\times6(l+1-p)} \\ I_{6l} & 0_{6l\times6} \end{bmatrix}$$

$$\underset{6(l+1)\times6}{D} = \begin{bmatrix} \Sigma_\eta^{1/2} \\ 0_{6l\times6} \end{bmatrix}$$

$$\underset{6\times6(l+1)}{E} = \begin{bmatrix} H_0 & \cdots & H_l \end{bmatrix}$$

Since Y_t is observed 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 et al. (2019). In particular, a uniform-normal-inverse-Wishart distribution is considered for the priors over the orthogonal reduced-form parametrization. The prior density parametrization is also in line with the approach by Arias et al. (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 are also implemented.

3.3. Identification

The identification of the UMP shock is implemented in line with the approach by Arias et al. (2019) for the case of the CMP. This paper combines zero and sign restrictions on the parameters[4] 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 the UMP 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

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

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.

are imposed in accordance with this normalization to consider an expansionary monetary policy shock.

On the monetary policy rule, the following contemporaneous restrictions are imposed. First of all, the current paper takes into account the dual mandate of maximum employment and price stability of the Federal Reserve System (Eberly et al., 2020) and imposes sign restrictions on the parameters of the unemployment rate and prices. In particular, given the normalization of the monetary policy indicator, it is considered 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 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.

Since monthly macroeconomic data are used for estimation, it is plausible to impose common zero restrictions on impact for the impulse response functions (IRFs). In particular, this paper imposes zero restrictions on the contemporaneous responses of the unemployment rate, prices, income inequality,[5] and the federal funds rate. The zero restriction on the response of the federal funds rate is a key restriction to disentangle the UMP shock from a CMP shock (Baumeister and Benati, 2013; Boeckx et al., 2017).

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 given it might change within a month. 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. All the restrictions are summarized in Table 2.

Alternatively, this paper identifies the UMP shock using the structural VAR–instrumental variables (SVAR–IV) approach, which does not use zero and sign restrictions. 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 et al. (2020), who also use the SVAR–IV methodology to estimate the effects of the CMP and the UMP. In particular, Following Eberly et al. (2020), the general effects of the UMP 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. They refer to it as a slope shock and this term is also used in the current paper to indicate the general the UMP shock.

For the slope shock, an external instrument is considered from Eberly et al. (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[6] 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 median IRFs together with 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 US. The monthly estimation sample is from 2008:M1 to 2019:M12. The sample is chosen to coincide with the period of the implementation of the UMP 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 the UMP 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 et al. (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 LSAPs, the series of their announcements is considered and it is from Hesse et al. (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. As an alternative measure for real economic activity, this paper uses the monthly estimates of the real gross domestic product (GDP) from IHS Markit. 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 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 (Kumar et al., 2023). The federal funds effective rate is considered as a CMP tool. As a general indicator of the UMP 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

[5] 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.

[6] Following Stock et al. (2002), the instrument is considered strong if 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.

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 (SP500) and the S&P/Case–Shiller U.S. National Home Price Index (CSUSHPISA). 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 the 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 their availability is 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 Table 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 the UMP shock with the SVAR-IV method.

To focus on the measures of the UMP, the impact of LSAPs is disentangled from the general effect of the UMP given that they were key policy measures. The 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 et al., 2018) is considered as a monetary policy indicator of LSAPs. The LSAP shock is identified using the zero and the sign restrictions described in Section 3.3. In the current case, the IRFs are just normalized to be the responses to a 0.5 trillion USD LSAP 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 the UMP 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 Section 3.2. 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 the UMP through the standard inequality measures. Besides, the consideration of inequality measures is useful for the estimation of the impact of the UMP 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.

Fig. 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.

Finally, to assess the relative importance of the UMP shock, a variance decomposition analysis is implemented. It is informative to observe the contribution of the UMP 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 Fig. 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. Yet, the ratio is not a standard inequality measure and has a limitation to reflect the whole income distribution. Fig. 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 appears to capture the additional stimulus within the third round of quantitative easing (QE3), which lasted from September 2012 to October 2014. It reflects the proportionally higher increase of capital income in comparison with the rise in labor income in December 2012, as can be seen from Fig. A.1. 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.

The estimation results of the IRFs for the VAR model with the income inequality ratio are provided in Fig. 2. Given the normalization,

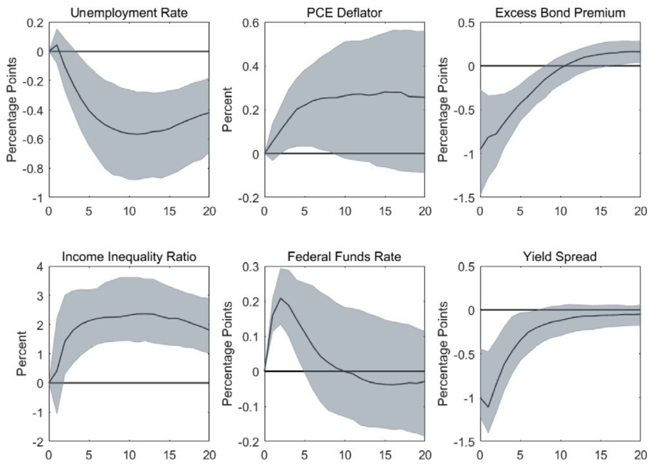

Fig. 2. IRFs to a slope monetary policy shock (the model with the income inequality ratio).
Note: The figure reports posterior median impulse responses to a one percentage point slope monetary policy shock and 68% credible intervals of the posterior distribution.

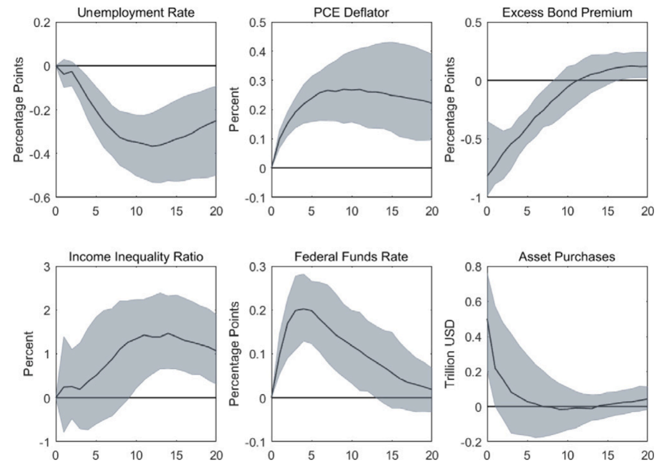

Fig. 3. IRFs to a LSAP shock (the model with the income inequality ratio).
Note: The figure reports posterior median impulse responses to a 0.5 trillion USD LSAP shock and 68% credible intervals of the posterior distribution.

the UMP 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 et al. (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 a LSAP shock[7] provided by Hesse et al. (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, responding to the decline in the unemployment rate and to the increase in prices. Thus, the response of the federal funds rate reflects the interaction between the CMP and the UMP found also in the literature (e.g., Boeckx et al., 2017; Burriel and Galesi, 2018).

Fig. 2 also shows that the UMP shock significantly increases the income inequality ratio by approximately 2 percent. That is, the UMP raises capital income more than labor earnings, leading to the increase in income inequality.[8] As Fig. A.4 shows, both capital income and labor earnings increase following the monetary policy expansion. Thus, the UMP raises income inequality via the income composition channel and this impact outweighs its alleviating effect on inequality through the earnings heterogeneity channel.

Various robustness checks of the results are implemented. First, the alternative identification of the UMP shock (SVAR–IV) is implemented. Fig. 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, the UMP fosters real economic activity, moderately increases prices, and loosens financial conditions. In response to this expansion, the federal funds rate increases. Besides, the UMP 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 A. 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.

The aforementioned results are obtained for the general effect of the UMP. Yet, they might be related to different elements of UMP measures such as forward guidance and 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 (Fig. A.3) to check whether they drive the results obtained for the overall effect of the UMP.

Fig. 3 contains the IRFs to a LSAP (announcement) shock. Their dynamics and magnitudes are similar to the initial IRFs provided in Fig. 2. A LSAP 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.

It can be claimed that the overall impact of the UMP 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 (Swanson, 2021). So, the overall effect of the UMP 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 the UMP.

5.2. Standard income inequality measures

This paper uses standard income inequality measures for the further analysis of the distributional effects of the UMP. This analysis allows to uncover the heterogeneous effects of UMP measures. Fig. 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

[7] Hesse et al. (2018) identify the LSAP shock through zero and sign restrictions on IRFs.

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

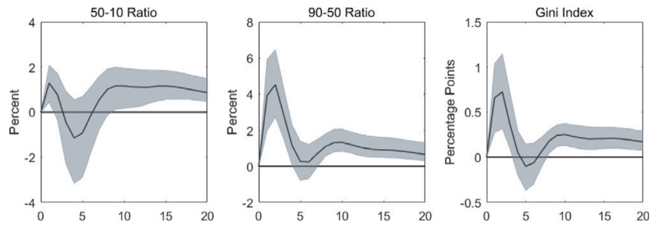

Fig. 4. IRFs of income inequality measures to a slope monetary policy shock.
Note: The figure reports posterior median impulse responses to a one percentage point slope monetary policy shock and 68% credible intervals of the posterior distribution. The income inequality measures are included in the VAR model one by one.

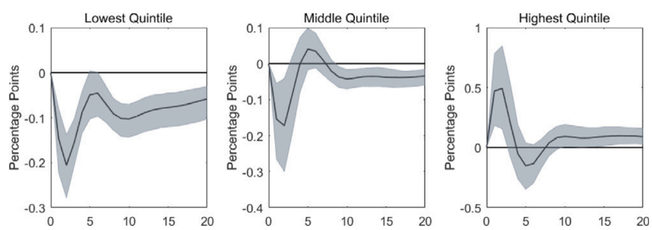

Fig. 5. IRFs of income shares to a slope monetary policy shock.
Note: The figure reports posterior median impulse responses to a one percentage point slope monetary policy shock and 68% credible intervals of the posterior distribution. The income shares are included in the VAR model one by one.

general measure of inequality. The UMP 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 the CMP. Some of the reasons for the opposite results might be related to the differences in methodologies and estimation samples. Yet, the main reason for the opposite results is probably related to the UMP measures. As the results show, UMP measures are effective in fostering real economic activity and easing financial conditions but they tend to increase capital income more than earnings. That is, the impact of the UMP via the income composition channel prevails over its effect through the earnings heterogeneity channel. Analogeousely, Guerello (2018) finds that expansionary CMP lowers income inequality while the UMP increases it. Thus, the CMP and the UMP can have different distributional effects given their different instruments, as discussed in Section 2.

This paper evaluates the impact of the UMP on the different parts of the income distribution. The lower and the upper parts of the 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 Fig. 4, the UMP 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 the income distribution.

The consideration of income shares complements the analysis on the impact of the UMP on the different parts of the income distribution. The results are presented in Fig. 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 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. Moreover, their responses are actually asymmetric to the response of the highest quintile.

The effects of the UMP on the income shares are in line with the results of the theoretical model by Kakar and Daniels Jr. (2019). Analogeousely, El Herradia and Leroy (2021) find that expancionary CMP increases top income shares. The current results are also in line with the empirical results of Ballabriga and Davtyan (2022) in case of the UK. In particular, using a consistent empirical framework, Ballabriga and Davtyan (2022) show that the impact of the UMP on income inequality is stronger than those of the CMP and that the UMP raises the top income share while it decreases the low and the mid income shares. At the same time, the current paper provide complimentary evidence on the impact of the UMP on various income inequality measures and also on wealth inequality, tracing out the impact through the distributional channels.

Consistently with the analysis of the percentile ratios, the UMP 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, the latter generally has higher skills, which are more complementary to capital (Dolado et al., 2021). Thus, all these results corroborate the finding that the UMP increases capital income more than labor income given that lower and middle earners mainly receive labor income whereas higher earners mostly gain capital income. That is, the impact of the UMP on income inequality through the income composition channel outweighs its impact on inequality through the earnings heterogeneity channel.

5.3. Ratio between stock and house prices

UMP measures, especially LSAPs, tend to change the relative supply of assets and consequently to affect their prices. For instance, as can be observed from Fig. 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 the UMP 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. In particular, if portfolios differ along the distribution, asset prices lead to different capital gains and so to the changes in wealth inequality. Kuhn et al. (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 US 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. Fig. 6 show that stock prices mostly grew at faster rate than house prices after

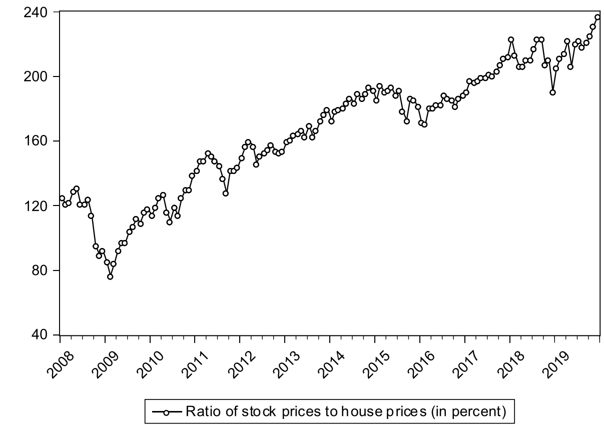

Fig. 6. Wealth inequality ratio.
Note: The figure includes the graph of the ratio of the S&P 500 Index to the S&P/Case–Shiller U.S. National Home Price Index (in percent). The data source for the stock and the house indices is S&P Dow Jones Indices LLC. The indices are scaled to 2009=100 before computing the ratio.

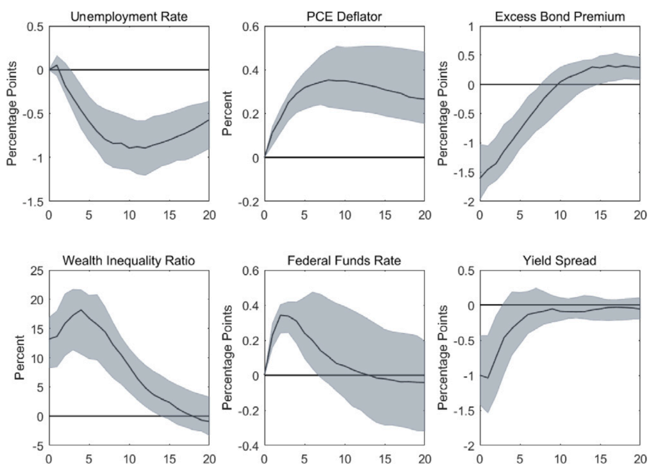

Fig. 7. IRFs to a slope monetary policy shock (the model with the wealth inequality ratio).
Note: The figure reports posterior median impulse responses to a one percentage point slope monetary policy shock and 68% credible intervals of the posterior distribution.

2009. That is, the wealth inequality ratio generally had an increasing trend during the considered period. Yet, wealth inequality is an important factor for an economic system (Grigoryan, 2013; Shao and Silos, 2017).

Fig. 7 provides the IRFs of the VAR model that includes the wealth inequality ratio as an inequality measure. As previously, the UMP shock leads to the reduction in the unemployment rate and the excess bond premium, and to the increase in prices. The federal funds rate increases in response to this expansion, reflecting the interplay between the CMP and the UMP (Boeckx et al., 2017; Burriel and Galesi, 2018).

As Fig. 7 also show, the shock significantly raises the wealth inequality ratio up to 18 percent, which is the largest response among the considered inequality indicators. That is, this response indicates that the UMP increases wealth inequality by raising stock prices more than house prices through the portfolio channel. Following the UMP shock, the positive responses of the stock and the house prices are presented in Fig. A.4. Yet, the response of house prices is not significant. As Feroli et al. (2012) show, housing market problems weakened the transmission mechanism of monetary policy after the financial crisis.

As in the case of the income inequality ratio, this paper curries out different robustness checks of the results. First, the UMP shock is

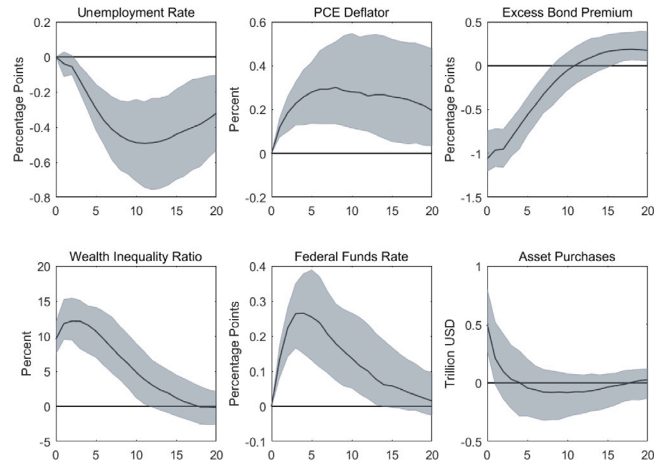

Fig. 8. IRFs to a LSAP shock (the model with the wealth inequality ratio).
Note: The figure reports posterior median impulse responses to a 0.5 trillion USD LSAP shock and 68% credible intervals of the posterior distribution.

alternatively identified with the SVAR-IV method. The results presented in Fig. A.6. As in the case of the previous results, the UMP spurs real economic activity, raises prices, and eases financial conditions. Following the expansion, the federal funds rate rises. The UMP 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 the UMP. The impact of LSAPs is evaluated as in the case of the consideration of the income inequality ratio. Fig. 8 displays the resulting IRFs, which are analogous to the results presented in Fig. 7. A LSAP 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 the UMP is mainly driven by the balance sheet policies.

5.4. Standard wealth inequality measures

This paper evaluates the effect of the UMP on wealth inequality using standard inequality measures too. In particular, the bottom 50%, the middle 40%, and the top 10% shares of net personal wealth are considered. Yet, these measures are not the most common standard inequality indicators and they are considered because the availability of wealth inequality measures is much more limited than the availability of income inequality measures. So, the results should be interpreted with some caution. In any case, the consideration of available standard wealth inequality measures is useful for complementing the empirical analysis.

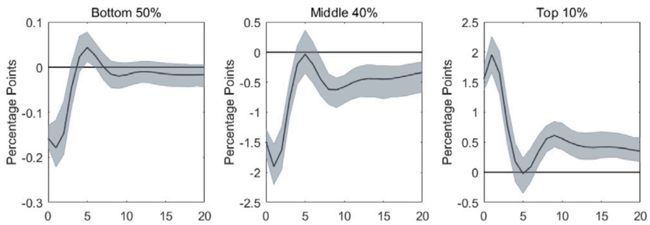

Fig. 9. IRFs of wealth shares to a slope monetary policy shock.
Note: The figure reports posterior median impulse responses to a one percentage point slope monetary policy shock and 68% credible intervals of the posterior distribution. The wealth shares are included in the VAR model one by one. The middle 40% is the share between percentiles 50 and 90.

Fig. 9 displays the estimation results of the impact of the UMP on the different parts of the 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. The results are similar to the evidence provided for wealth shares by Evgenidis and Fasianos (2021).

The responses of different parts of the wealth distribution are in line with the response of the wealth inequality ratio. The group at the bottom of the wealth distribution generally posses less non-financial assets than the group in the middle of the 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 the wealth distribution mostly possesses financial assets such as stocks. Therefore, the relatively larger increase of stock prices with respect to house prices generally leads to the redistribution of wealth to the top through the portfolio channel.

5.5. Variance decomposition

This paper implements a variance decomposition analysis to evaluate the contribution of the UMP 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.

Thus, analogous to the results of Mumtaz and Theophilopoulou (2020) for the UK, this paper finds that the UMP 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. At the same time, the distributional impact depends on the proportional effects of the UMP on the capital and the labor income, and the stock and the house prices, as discussed in Sections 5.1 and 5.3.

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.

6. Conclusion

This paper evaluates the distributional impact of US the UMP conducted in response to 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, the UMP measures increase income and wealth inequality, having a stronger effect on the latter. The estimated overall effects of the UMP are mainly driven by LSAPs. The UMP 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 the UMP increases capital income more than labor earnings. This impact of the UMP results in the growth of income inequality measured with standard indicators. In particular, the UMP 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 the distribution. Besides, UMP 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 the UMP raises stock prices more than house prices. This effect of UMP measures leads to the increase in wealth inequality measured with the shares of the wealth distribution. Particularly, the UMP 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 the wealth distribution mainly own non-financial assets such as houses while the portfolio of the group at the top of the wealth distribution mostly consists of financial assets such as stocks. Consequently, following the monetary policy expansion, the relatively larger growth of stock prices with respect to house prices results in the increase of wealth inequality. Moreover, the variance decomposition analysis shows that the UMP explains the higher variation in wealth inequality than in income inequality.

Thus, the UMP was helpful in recovering from the global financial crisis. Yet, it came at the cost of increased income and especially wealth inequality. This distributional impact of the UMP points out the need for complementary fiscal policy measures. Especially, given the complementary effects of the UMP, they will probably be used permanently along with the CMP in the future.

Declaration of competing interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A

A.1. Inequality measures

See Table A.1.

A.2. Income and wealth indicators

See Figs. A.1 and A.2.

A.3. LSAPs

See Fig. A.3.

A.4. Responses of income and wealth indicators

See Fig. A.4.

A.5. SVAR-IV identification

See Figs. A.5 and A.6.

Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.econmod.2023.106380.

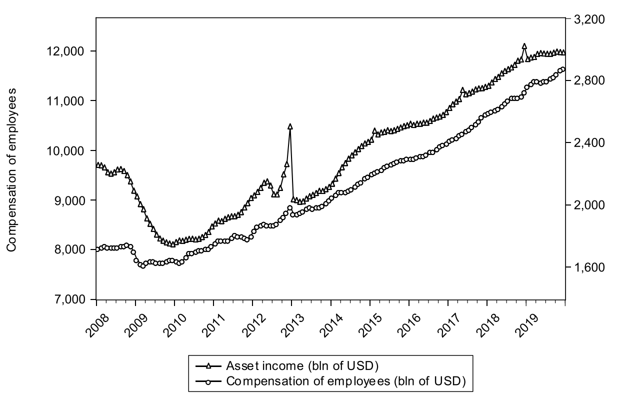

Fig. A.1. Asset income and compensation of employees.
Note: The figure includes the graphs of the personal income receipts on assets and the compensation of employees. The data source is the U.S. Bureau of Economic Analysis.

Table A.1
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.

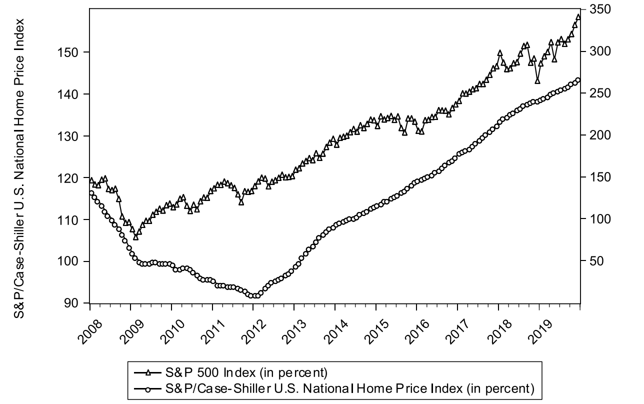

Fig. A.2. Stock and house prices.
Note: The figure includes the graphs of the S&P 500 Index and the S&P/Case–Shiller U.S. National Home Price Index. The data source is S&P Dow Jones Indices LLC. The indices are scaled to the base year of 2009=100.

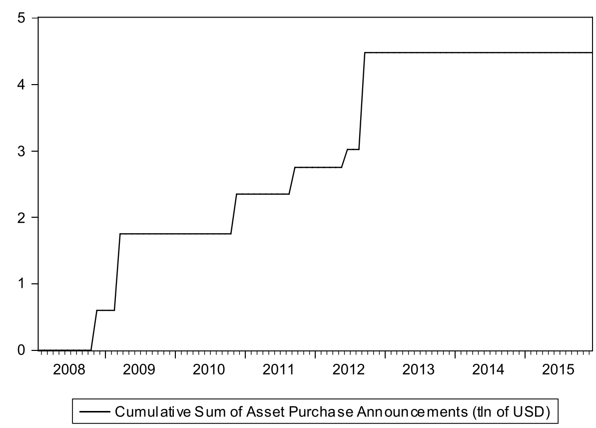

Fig. A.3. LSAP announcements.
Source: Hesse et al. (2018).

Fig. A.4. 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 slope 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.

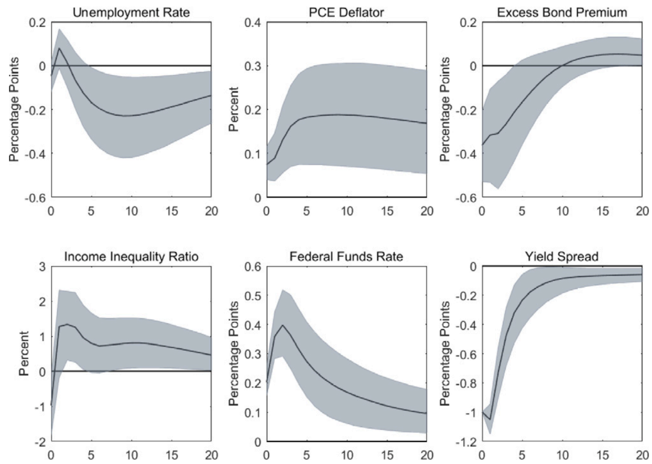

Fig. A.5. IRFs to a slope monetary policy shock (the model with the income inequality ratio).
Note: The figure reports median impulse responses to a one percentage point slope monetary policy shock and 68% confidence intervals based on bootstrap replications.

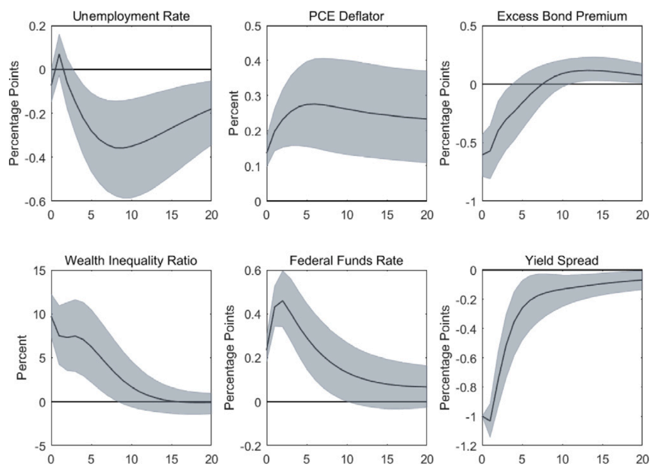

Fig. A.6. IRFs to a slope monetary policy shock (the model with the wealth inequality ratio).
Note: The figure reports median impulse responses to a one percentage point slope monetary policy shock and 68% confidence intervals based on bootstrap replications.

References

Adam, K., Tzamourani, P., 2016. Distributional consequences of asset price inflation in the euro area. Eur. Econ. Rev. 89, 172–192.

Agnello, L., Mallick, S.K., Sousa, R.M., 2012. Financial reforms and income inequality. Econom. Lett. 116 (3), 583–587.

Albanesi, S., 2007. Inflation and inequality. J. Monetary Econ. 54 (4), 1088–1114.

Arias, J.E., Caldara, D., Rubio-Ramirez, J.F., 2019. The systematic component of monetary policy in SVARs: An agnostic identification procedure. J. Monetary Econ. 101, 1–13.

Baiardi, D., Morana, C., 2018. Financial development and income distribution inequality in the euro area. Econ. Model. 70, 40–55.

Ballabriga, F., Davtyan, K., 2022. Distributional impact of monetary policy in the UK: from conventional to unconventional policy. J. Econ. Policy Reform 25 (4), 435–450.

Baumeister, C., Benati, L., 2013. Unconventional monetary policy and the great recession: Estimating the macroeconomic effects of a spread compression at the zero lower bound. Int. J. Central Bank. 9 (2), 165–212.

Baumeister, C., Hamilton, J.D., 2015. Sign restrictions, structural vector autoregressions, and useful prior information. Econometrica 83 (5), 1963–1999.

Boeckx, J., Dossche, M., Peersman, G., 2017. Effectiveness and transmission of the ECB's balance sheet policies. Int. J. Central Bank. 13 (1), 297–333.

Burriel, P., Galesi, A., 2018. Uncovering the heterogeneous effects of ECB unconventional monetary policies across euro area countries. Eur. Econ. Rev. 101, 210–229.

Coibion, O., Gorodnichenko, Y., Kueng, L., Silvia, J., 2017. Innocent Bystanders? Monetary policy and inequality. J. Monetary Econ. 88 (C), 70–89.

Davtyan, K., 2017. The distributive effect of monetary policy: The top one percent makes the difference. Econ. Model. 65, 106–118.

Díaz-Giménez, J., Glover, A., Ríos-Rull, J.-V., 2011. Facts on the distributions of earnings, income, and wealth in the United States: 2007 update. Federal Reserve Bank Minneapolis Quart. Rev. 34 (1), 2–31.

Doepke, M., Schneider, M., 2006. Inflation and the redistribution of nominal wealth. J. Polit. Econ. 114 (6), 1069–1097.

Dolado, J.J., Motyovszki, G., Pappa, E., 2021. Monetary policy and inequality under labor market frictions and capital-skill complementarity. Am. Econ. J.: Macroecon. 13 (2), 292–332.

Eberly, J.C., Stock, J.H., Wright, J.H., 2020. The Federal Reserve's current framework for monetary policy: A review and assessment. Int. J. Central Bank. 16, 5–71.

El Herradia, M., Leroy, A., 2021. Monetary policy and the top 1%: Evidence from a century of modern economic history. Int. J. Central Bank. 17 (5), 237.

Evgenidis, A., Fasianos, A., 2021. Unconventional monetary policy and wealth inequalities in Great Britain. Oxf. Bull. Econ. Stat. 83 (1), 115–175.

Feroli, M., Harris, E.S., Sufi, A., West, K.D., 2012. Housing, monetary policy, and the recovery. Chicago Booth Research Paper, (12–16).

Foroni, C., Marcellino, M., 2016. Mixed frequency structural vector auto-regressive models. J. R. Stat. Soc. Ser. A (Statistics in Society) 179 (2), 403–425.

Gambacorta, L., Hofmann, B., Peersman, G., 2014. The effectiveness of unconventional monetary policy at the zero lower bound: A cross-country analysis. J. Money Credit Bank. 46 (4), 615–642.

Gertler, M., Karadi, P., 2015. Monetary policy surprises, credit costs, and economic activity. Am. Econ. J.: Macroecon. 7 (1), 44–76.

Gilchrist, S., Zakrajšek, E., 2012. Credit spreads and business cycle fluctuations. Amer. Econ. Rev. 102 (4), 1692–1720.

Grigoryan, A.H., 2013. A model for anocracy. J. Income Distribut. 22 (1), 3–24.

Guerello, C., 2018. Conventional and unconventional monetary policy vs. households income distribution: An empirical analysis for the euro area. J. Int. Money Finance 85, 187–214.

Hesse, H., Hofmann, B., Weber, J.M., 2018. The macroeconomic effects of asset purchases revisited. J. Macroecon. 58, 115–138.

Kakar, V., Daniels Jr., G.E., 2019. Role of cash and costs of inflation for different income groups in the US. Econ. Model. 80, 303–319.

Koedijk, K., Loungani, P., Monnin, P., 2018. Monetary policy, macroprudential regulation and inequality: An introduction to the special section. J. Int. Money Finance 85, 163–167.

Kuhn, M., Schularick, M., Steins, U.I., 2020. Income and wealth inequality in America, 1949–2016. J. Polit. Econ. 128 (9), 3469–3519.

Kumar, A., Mallick, S., Mohanty, M., Zampolli, F., 2023. Market volatility, monetary policy and the term premium. Oxf. Bull. Econ. Stat. 85 (1), 208–237.

Lenza, M., Slacalek, J., 2018. How does monetary policy affect income and wealth inequality? Evidence from quantitative easing in the euro area. ECB Working Paper Series 2190.

Mariano, R.S., Murasawa, Y., 2010. A coincident index, common factors, and monthly real GDP. Oxf. Bull. Econ. Stat. 72 (1), 27–46.

Mumtaz, H., Theophilopoulou, A., 2020. Monetary policy and wealth inequality over the great recession in the UK. An empirical analysis. Eur. Econ. Rev. 130, 103598.

Piketty, T., Zucman, G., 2014. Capital is back: Wealth-income ratios in rich countries 1700–2010. Q. J. Econ. 129 (3), 1255–1310.

Rogers, J.H., Scotti, C., Wright, J.H., 2018. Unconventional monetary policy and international risk premia. J. Money Credit Bank. 50 (8), 1827–1850.

Rossi, B., 2021. Identifying and estimating the effects of unconventional monetary policy: How to do it and what have we learned? Econom. J. 24 (1), C1–C32.

Saiki, A., Frost, J., 2020. Unconventional monetary policy and inequality: Is Japan unique? Appl. Econ. 52 (44), 4809–4821.

Shao, E., Silos, P., 2017. Wealth inequality and employment fluctuations. Econ. Model. 67, 125–135.

Shrider, E.A., Kollar, M., Chen, F., Semega, J., 2021. Income and poverty in the United States: 2020. Current Population Reports P60-273, US Census Bureau.

Sims, C.A., Stock, J.H., Watson, M.W., 1990. Inference in linear time series models with some unit roots. Econometrica 58 (1), 113–144.

Stock, J.H., Wright, J.H., Yogo, M., 2002. A survey of weak instruments and weak identification in generalized method of moments. J. Bus. Econom. Statist. 20 (4), 518–529.

Swanson, E.T., 2021. Measuring the effects of federal reserve forward guidance and asset purchases on financial markets. J. Monetary Econ. 118, 32–53.

Uhlig, H., 2005. What are the effects of monetary policy on output? Results from an agnostic identification procedure. J. Monetary Econ. 52 (2), 381–419.

Voinea, L., Lovin, H., Cojocaru, A., 2018. The impact of inequality on the transmission of monetary policy. J. Int. Money Finance 85, 236–250.