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"The Distributive Effects of Conventional and Unconventional Monetary Policies"

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Abstract

The paper evaluates the distributional effects of conventional and unconventional monetary policies for the USA. The distributional effects are evaluated for the overall impact on the income distribution, using Gini index. The paper also assesses the effects of conventional and unconventional monetary policies on the different parts of income distribution, employing corresponding percentile ratios. The obtained results show that contractionary conventional monetary policy reduces income inequality while expansionary unconventional monetary policy raises it. In particular, the results indicate that the distributional impact of conventional monetary policy is stronger. Nevertheless, its impact on the lower part of income distribution is not significant while unconventional monetary policy has a significant effect on it. In addition, the variance decomposition analysis reveals that unconventional monetary policy explains the higher share of the variation in Gini index of income inequality.

JEL classification: C32; D31; E52

Keywords: Inequality; conventional and unconventional monetary policies; identification

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1. Introduction

To respond to the global financial crisis, central banks have generally started to conduct unconventional monetary policies in parallel with conventional policy measures. Consequently, unconventional monetary policy measures are currently taken to ease financial conditions by providing external funding. While there are already available studies on the macroeconomic impact of unconventional monetary policy (e.g., Baumeister and Benati, 2013; Chung et al., 2012; Gambacorta et al., 2014; Lenza et al., 2010), its distributive effect has not been essentially explored yet. The objective of the paper is to fill this gap by evaluating the distributive impact of unconventional monetary policy in comparison with the distributional effect of conventional monetary policy.

In response to the global financial crisis, many central banks have substantially lowered their policy rates. To improve deteriorated economic conditions, they have also resorted to unconventional monetary policy instruments when their monetary policy rates have hit the effective zero lower bound. In particular, as unconventional monetary policy measures, the large scale asset purchases have been implemented by the Federal Reserve since the financial crisis (Baumeister and Benati, 2013). These operations have changed the relative supply of short term and long term bonds, and other assets, consequently affecting their prices and the flow of funds in the economy. This can benefit high-income households who hold these bonds and assets. Thus, unconventional monetary policy might also influence the income distribution in the economy.

The main objective of unconventional monetary policy measures is to lower long term interest rates in order to support private borrowing of households and businesses, thereby fostering aggregate demand and real economic activity. 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., 2012).

Thus, the implementation of unconventional monetary policy can facilitate to overcome the recent financial crisis. At the same time, it might also affect income distribution. On the one hand, unconventional monetary policy might increase the financial and the businesses income of high-income households. On the other hand, it could also restore labor earnings for low-income households. As a result, unconventional monetary policy might affect income inequality. The overall distributional impact of unconventional monetary policy is studied in the paper in comparison with the distributive effect of conventional monetary policy.

The paper evaluates the distributional effects of conventional and unconventional monetary policies for the USA. The distributional effects are evaluated for the general impact on the income distribution, using Gini index. The paper also assesses the effects of conventional and unconventional monetary policies on the different parts of income distribution, employing corresponding percentile ratios. The obtained results show that contractionary conventional monetary policy reduces income inequality while expansionary unconventional monetary policy raises it. In particular, the results indicate that the distributional impact of conventional monetary policy is stronger. Nevertheless, its impact on the lower part of income distribution is not significant while unconventional monetary policy has a significant effect on it. In addition, the variance decomposition analysis reveals that unconventional monetary policy explains the higher share of the variation in Gini index of income inequality.

The rest of the paper is organized as follows. Section 2 discusses the distributive channels of monetary policy. Section 3 presents the empirical methodology while Section 4 describes the data. Section 5 provides the obtained results and Section 6 includes the concluding remarks.

2. The Distributive Channels of Monetary Policy

The overall distributive impact of monetary policy depends on the different channels through which monetary policy can affect income inequality. Coibion et al. (2012) classify five such channels, which are also considered by other authors (e.g., Saiki and Frost, 2014). These channels are the following:

1. The *income composition channel* refers to the heterogeneity in primary sources of income across households. Many households depend mainly on wages whereas others acquire their income from business and financial gains. So, if expansionary monetary policy increase profits more than labor earnings, the owners of assets and firms benefit

more. Taking into account that they are usually wealthier, expansionary monetary policy shocks might lead to higher income inequality via this channel.

2. The *financial segmentation channel* implies the reallocation of income towards the agents involved in financial markets who can benefit from expansionary monetary policy shocks. Considering the fact that these agents generally earn more income than the agents not engaged in financial markets, expansionary monetary policy would raise inequality through this channel.

3. The redistribution of income based on the structure of owned assets is represented by the *portfolio channel*. Normally, low income households have mainly currency whereas upper income households tend to possess various securities. Therefore, by causing inflation and financial market booms, expansionary monetary policy would harm low income households and benefit upper income households via this channel, leading to the increase in inequality.

4. The impact of unexpected inflation on nominal contracts is expressed by *the savings redistribution channel*. The unexpected increase in inflation would benefit borrowers and would hurt savers. Considering that usually savers are wealthier than borrowers, expansionary monetary policy shocks would reduce inequality through this channel.

5. The *earnings heterogeneity channel* describes the tendency that the labor income of the poorest population is mostly exposed to business cycle fluctuations. At the same time, low income households usually receive a bigger share of their income from government transfers than other households do. Since government transfers are normally countercyclical, expansionary monetary policy might decrease income inequality via this channel.

Thus, through these channels monetary policy could have different distributional effects. Supposedly, through the first three channels, expansionary monetary policy increases income inequality and reduces it via the last two channels. Nevertheless, the channels can operate with different intensity with conventional and unconventional monetary policies. That is, conventional and unconventional monetary policies could have disproportionate effects on these channels.

Moreover, the magnitude of their impact through these channels might be different, too, and, consequently, they can have different overall distributive effects. However, the objective of the paper is not to assess the relative contribution of each channel but to evaluate the overall effect of all the channels.

Talking into account that monetary policy affects as prices as well as real economic activity[1], Nakajima (2015) specifies two general distributive channels of monetary policy: inflation and income channels. They incorporate the channels specified by Coibion et al. (2012). Inflation channel contains the financial segmentation channel, the portfolio composition channel, and the savings redistribution channel. Income channel includes the income composition channel and the earnings heterogeneity channel. Considering these aggregated channels, the paper uses prices and real GDP as the general distributive channels of monetary policy[2]. It employs the federal funds rate as a conventional monetary policy tool. Federal Reserve assets are used as an unconventional monetary policy instrument. An income inequality measure is also considered in order to assess the overall distributive effects of conventional and unconventional monetary policies.

3. Empirical Methodology

The paper considers structural vector autoregression (VAR) models for the analysis of the distributive effects of conventional and unconventional monetary policies. The distributive impact of monetary policy is evaluated through structural VAR models as it is commonly implemented in the related literature (among others, Bernanke and Mihov, 1998; Christiano et al., 1996; Gambacorta et al., 2014; Uhlig, 2005) since the publication of the seminal paper by Sims (1980). The considered baseline VAR model of order p, VAR(p), is the following[3]:

$$y_t = A_0 + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t, \tag{1}$$

[1] The mandate of the Federal Reserve includes the promotion of maximum employment.
[2] The considerations of the variables for the empirical analysis are analogous to Paper 3.
[3] The notations of the section are generally in line with the representations used by Lütkepohl (2005).

Where $y_t = (y_{1t}, \cdots, y_{4t})'$ is the vector of endogenous variables, which are described below; A_0 is (4×1)vector of intercepts terms; A_js $(for\ j = 1, \ldots, p)$ are (4×4) coefficient matrices and $u_t = (u_{1t}, \cdots, u_{4t})'$ is an error term. The error termu_t is assumed to be a zero-mean independent white noise process with positive definite covariance matrix $E(u_t u_t') = \Sigma_u$. Thus, it is assumed that error terms are independent stochastic vectors with $u_t \sim (0, \Sigma_u)$.

The vector of endogenous variables $y_t$generally consists of real GDP, prices, a monetary policy instrument, and an income inequality measure: $y_t = (Y_t, P_t, S_t, Z_t)'$. In the baseline cases for the evaluations of the distributive effects of conventional and unconventional monetary policies, the paper commonly uses real GDP, prices, and Gini index of income inequality. The baseline cases only diverge by the usage of different monetary policy instruments. The federal funds rate and Federal Reserve assets are used as monetary policy instruments for the baseline models of conventional and unconventional monetary policies, respectively.

In general, reduced-form disturbances are linear combinations of underlying structural shocks:

$$u_t = B\varepsilon_t, \tag{2}$$

where B is a (4×4) matrix of parameters andε_t is a (4×1) vector of structural shocks. Consequently, 6 restrictions are necessary for just identification. In the empirical analysis, Cholesky decomposition of the covariance matrix is used for the identification of impulse response functions (IRFs). The ordering of the variables in the VAR model is the same as presented above: $y_t = (Y_t, P_t, S_t, Z_t)'$. Accordingly, the following contemporaneous restrictions are imposed on the matrix B:

$$\begin{pmatrix} u_Y \\ u_P \\ u_S \\ u_Z \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_Y \\ \varepsilon_P \\ \varepsilon_S \\ \varepsilon_Z \end{pmatrix} \tag{3}$$

In this low-triangular matrix, the zeros provide 6 required restrictions for just identification of the structural shocks to analyze them through the impulse response functions (IRFs). The application of high frequency data in this paper makes the assumptions behind by the contemporaneous scheme more realistic. Therefore, in the current case, monetary policy shocks are identified directly within the framework of this contemporaneous identification.

Along with the IRFs, the variance decomposition analysis is also implemented for structural VAR models. In the current work, this analysis is also carried out since it is very useful for the objective of the paper to evaluate the distributive effects of conventional and unconventional monetary policies. The variance decomposition analysis is based on Cholesky decomposition of the covariance matrix as described above. This analysis allows decomposing the total variance of a time series into the percentages attributable to structural shocks, which are orthogonal and have unit variances. The VAR model can be expressed through structural shocks using the vector moving average representation:

$$y_t = A_0 + F(L)\varepsilon_t, \tag{4}$$

where $F(l)$ is a polynomial in lag operators. The variance of y_{it} $(for\ i = 1, \ldots, 4)$ is given by

$$Var(y_{it}) = \sum_{k=1}^{4}\sum_{j=0}^{\infty} F_{ik}^{j^2}\, Var(\varepsilon_{kt}) = \sum_{k=1}^{4}\sum_{j=0}^{\infty} F_{ik}^{j^2}, \tag{5}$$

where $\sum_{j=0}^{\infty} F_{ik}^{j^2}$ is the variance of y_{it} generated by the kth shock. This implies that

$$\frac{\sum_{j=0}^{\infty} F_{ik}^{j^2}}{\sum_{k=1}^{4}\sum_{j=0}^{\infty} F_{ik}^{j^2}} \tag{6}$$

is the percentage of the variance of y_{it} explained by the kth shock. It is also possible to study the variance of a variable explained by a structural shock at a given horizon. The percentage of the variance of y_{it} due to the kth shock at horizon h is given by

$$\frac{\sum_{j=0}^{h-1} F_{ik}^{j^2}}{\sum_{k=1}^{4}\sum_{j=0}^{h-1} F_{ik}^{j^2}} \tag{7}$$

Thus, the variance decomposition analysis enables decomposing the total variance of a time series into the percentages attributable to each structural shock.

4. Data

4.1. The Description of the Dataset

The empirical analysis is implemented for the USA. The general estimation sample is from 1983 to 2013. The sample is considered from 1983 because of the structural break occurred in the relationship between income inequality and the macroeconomics variables in around this period (Cutler and Katz, 1991; Galli and von der Hoeven, 2001). The sample runs until 2013 because the data on income inequality are only available until that year. Considering that the federal funds rate has reached the zero lower bound since 2009, the estimation sample for the conventional monetary policy models is from 1983 to 2008. The data on the quarterly frequency are used in line with the related literature (e.g., Christiano et al., 1996; Peersman and Smets, 2001). In the case of the unconventional monetary policy models, the estimation sample is from 2009 to 2013. Following Gambacorta et al (2014), the data on the monthly frequency are used in this case.

In the baseline models, Gini index is used as an income inequality measure. The data source is the OECD, which provides consistently measured series for income inequality. Gini index is measured for total population and it is expressed in percent. It is for disposable income, i.e., after taxes and transfers. Gini index for disposable income is used in order to control for the distributional effects of fiscal policy.

Federal Reserve Economic Database, FRED, is the data source for the other variables of the baseline models: real gross domestic product, GDP, (based on the prices of 2009), GDP deflator (with the base year of 2009), the federal funds rate (expressed in percent), and Federal Reserve total assets. Real GDP, GDP deflator, and Federal Reserve total assets are seasonally adjusted. The federal funds rate is the effective rate, which is the average of daily figures.

To demonstrate the evolution of unconventional monetary policy, as an indicator, the time series for Federal Reserve total assets is presented in Figure 1. There is a visible structural shift in

Federal Reserve balance sheet in the fourth quarter of 2008. For the comparison with the evolution of the federal funds rate, it is useful to display them together. However, the data for Federal Reserve total assets are available since 2003. Therefore, the monetary base[4] is employed to depict their evolution for the whole considered period. Figure 2 shows their evolution from 1983 to 2013. As can be seen, since the end of 2008, the federal funds rate has approached to its zero lower bound while the monetary base has substantially increased. Thus, it is since the end of 2008 when the Federal Reserve has started to implement unconventional monetary policy. To describe the general statistical characteristics of the variables used in the empirical analysis, they are summarized in Table 1.

Table 1: Descriptive Statistics

The Time Period	**1983-2008**		**2009-2013**	
Variables	**Mean**	**SD**	**Mean**	**SD**
Real GDP (billions of USD, based on the prices of 2009)	10793.5	2521.47	15032.22	433.86
GDP Deflator (annual average index, 2009=100)	75.46	13.16	103.33	2.64
The Federal Funds Rate (effective, annual average, in percent)	5.33	2.5	0.14	0.04
Federal Reserve Total Assets (billions of USD)	871.85	251.84	2698.79	520.76
The Total Monetary Base (billions of USD)	482.47	231.37	2439.16	557.47
Gini Coefficient (GINI) (in percent)	35.81	1.45	38.74	0.85

Note: For the period from 1983 to 2008, the mean and the standard deviation, SD, for Federal Reserve Total Assets are calculated using the data available since 2003.

[4] The data source for this total monetary base is also FRED.

Figure 1: Federal Reserve Total Assets (Billions of USD)

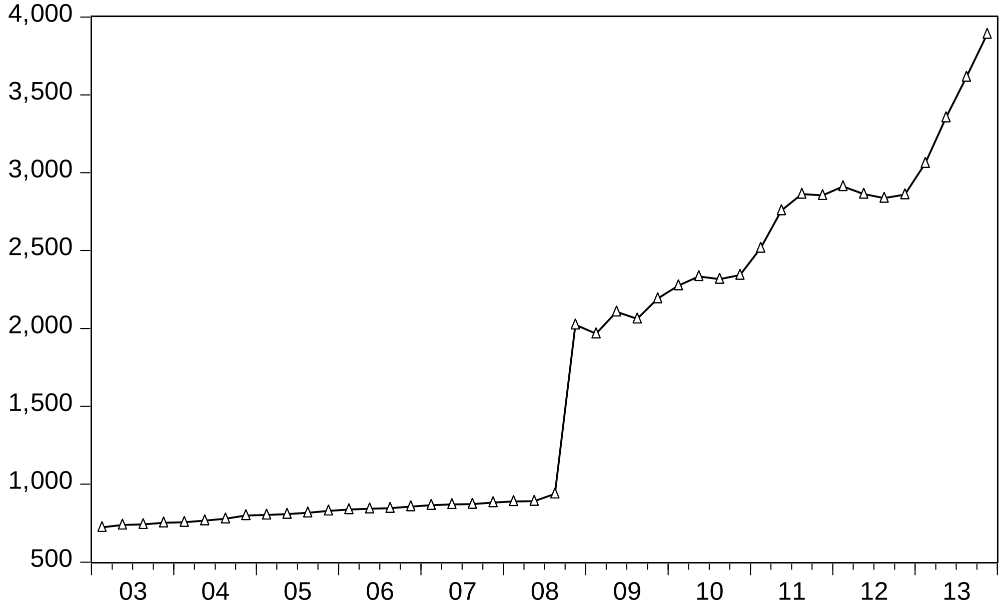
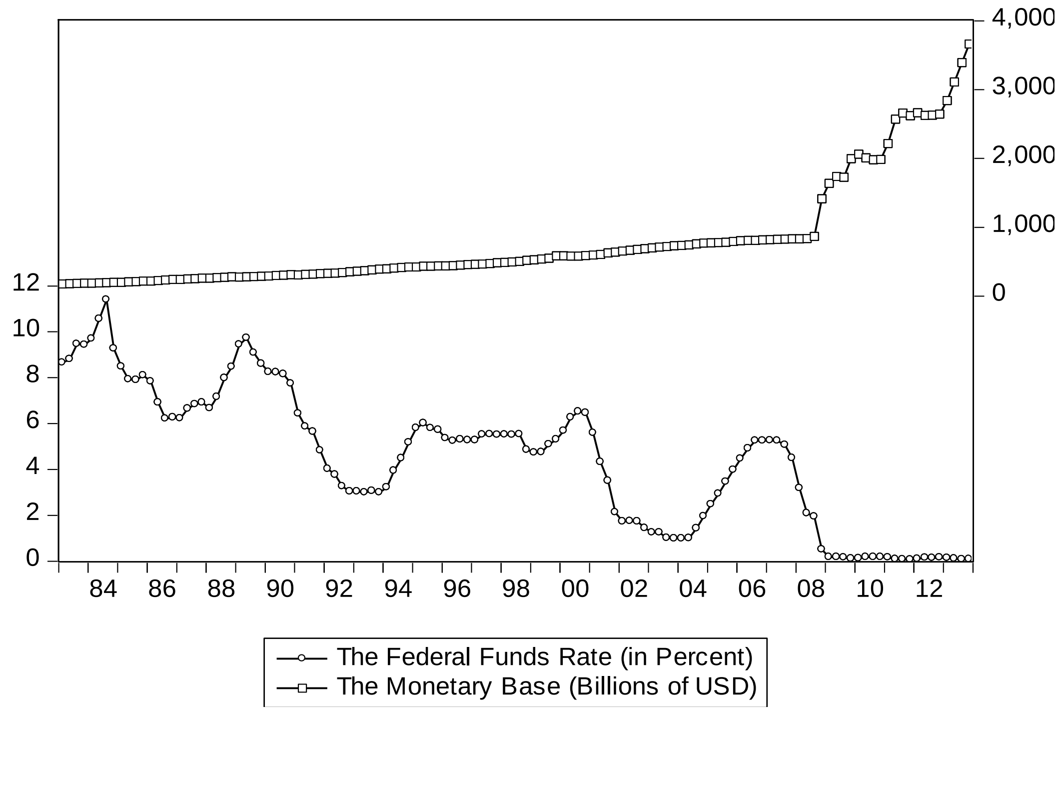


Figure 2: The Federal Funds Rate and the Monetary Base



4.2. Interpolation

The data for the considered variables of the empirical analysis are generally available in a higher frequency. The exception is the data for income inequality measures. The time series for them are only available on the yearly frequency. Therefore, to apply the contemporaneous identification in the empirical analysis, income inequality measures are interpolated into a higher frequency[5]. The disaggregation of the data for income inequality measures is justifiable since their time series have low variation.

Gini index of income inequality is disaggregated by the index type. That is, the interpolation has been implemented in such a way that, for each reference period, the average of the disaggregated series equals to the corresponding aggregate value. The disaggregation of the series for Gini index is carried out by the mathematical method proposed by Boot et al. (1967). The disaggregation of the series by this method is implemented using the first difference approach. By applying this disaggregation procedure, the series for Gini index of income inequality is interpolated from the yearly frequency to the quarterly and the monthly series.

As another measures of income inequality, the paper also employs the percentile ratios. The percentile ratios are calculated using the percentiles provided in the report by DeNavas-Walt and Proctor (2015). In particular, the paper considers the ratio between the 90^{th} and the 50^{th} percentiles (the 90-50 ratio), and the ratio between the 50^{th} and the 10^{th} percentiles (the 50-10 ratio). The percentiles provided in the report are based on the data from the Current Population Survey (CPS) of the U.S. Census Bureau. The percentiles are based on income before taxes and it does not include noncash benefits (DeNavas-Walt and Proctor, 2015). However, it is still informative to use this available data to calculate the new measures of income inequality for evaluating the distributional effect of monetary policy. For the usage in the empirical analysis, the yearly percentile ratios are interpolated into the quarterly and the monthly series. The interpolation is performed in the same way as it is implemented for the interpolation of the series for Gini index.

[5] All the interpolations used in the paper have been implemented by the specialized ECOTRIM software created by Eurostat.

The series for real GDP and GDP deflator are also interpolated for evaluating the distributional effect of unconventional monetary policy. The time series for real GDP is disaggregated by the flow type. For each reference period, the sum of the disaggregated series equals to the corresponding aggregate value. The series for GDP deflator is interpolated by the index type as it is described earlier. The interpolation of the series for real GDP and GDP deflator is implemented by the statistical method suggested by Fernandez (1981). For the interpolation by this method, two reference indicators are used for each series. Following Gambacorta et al. (2014), as reference indicators for real GDP, the paper uses the series for industrial production index, and real retail and food services sales. As reference indicators for GDP deflator, in line with Uhlig (2005), the paper employs the consumer price index and the producer price index[6]. By implementing these interpolation procedures, the data for real GDP and GDP deflator are disaggregated from the quarterly frequency to the monthly series.

5. Empirical Analysis

As it is shown in (Davtyan, 2016), there is a cointegration relation among real GDP, GDP deflator, the federal funds rate, and Gini index of income inequality. Therefore, no stationary transformation is performed for the variables and they are used in levels. The same approach is also applied not only in the baseline case of conventional monetary policy but also in the other cases explored in the paper. In particular, the variables are used in levels when, instead of Gini index of income inequality, another measure of income inequality is employed in the empirical analysis. The measures of income inequality generally have similar dynamic behavior (Congressional Budget Office, 2011). The same approach is also applied when the distributional effect of unconventional monetary policy is examined in the paper. The implementation of the analysis in levels allows for implicit cointegration relations among the considered variables (Peersman and Smets, 2001; Sims et al., 1990).

The baseline VAR model of conventional monetary policy includes the variables with the following ordering: real GDP (GDP83L)[7], GDP deflator (GDPDX83L), Gini coefficient (GINI),

[6] The source for all these reference series is FRED.
[7] In the parentheses, the abbreviations of the variables are stated as they are used in the empirical analysis. The last letter L in the abbreviations indicates the performed natural logarithmic transformation.

and the federal funds rate (FFR). For the evaluation of the distributive effect of unconventional monetary policy, the corresponding version of the baseline VAR model is considered. It contains the variables with the following ordering: real GDP (GDP09L), GDP deflator (GDPDX09L), Federal Reserve total assets (TAL), and Gini index (GINI).

Following Christiano et al. (1996) and Coibion et al. (2012), the VAR models of conventional monetary policy are considered with a yearly lag (i.e., 4 lags in the case of the quarterly data). Since, in the case of unconventional monetary policy, the estimation sample is relatively short and the objective is to have a parsimonious VAR model, Schwarz criterion is used to determine the lag order of the model (Lütkepohl, 2005). The application of this criterion indicates the order of two for the VAR model. Besides, Gambacorta et al. (2014) use the same order for their VAR model, which is also estimated with monthly data and applied within the framework of unconventional monetary policy.

The VAR models are estimated by ordinary least squares (OLS). Talking into account that the federal funds rate has reached the zero lower bounds since 2009, the estimation sample for the conventional monetary policy models is from 1983 to 2008. In particular, the quarterly data are used in this case. For the evaluation of the distributive effects of unconventional monetary policy, the corresponding VAR models are estimated using the sample from 2009 to 2013 based on the monthly data.

The dynamic interactions among the variables are explored through the IRFs of the VAR models. They are identified by imposing the contemporaneous restrictions discussed in Section 3. This identification scheme is common in the literature (among others, Christiano et al. 1996; Sims, 1992) on the evaluation of the impact of conventional monetary policy. For the identification of unconventional monetary policy shocks, this recursive identification method is also applied in the literature (Chen et al., 2015; Jannsen et al., 2015; Meinusch and Tillmann, 2014). In particular, Jannsen et al. (2015) find that their results obtained with the contemporaneous identification are very similar to the IRFs identified through the sign restrictions proposed by Uhlig (2005).

The provided IRFs are for the responses of variables to one standard deviation increase in a monetary policy shock. In the case of conventional monetary policy models, the federal funds rate is included as a policy instrument, and, consequently, monetary policy shocks are contractionary. For the case of unconventional monetary policy models, Federal Reserve assets are used as a monetary policy instrument. Therefore, the interpretation of monetary policy shocks is different in this case. In particular, monetary policy shocks are expansionary in this framework, and their impact on the other variables is interpreted accordingly[8].

For the IRFs, Hall´s (1992) 95% confidence bands based on 1500 bootstrap replications are provided. They are presented in dotted lines while the IRFs are depicted in solid lines. In accordance with Coibion et al. (2012), the IRFs for conventional monetary policy models are presented over 20 periods (i.e., for5 years in this case of the quarterly data).In line with Gambacorta et al. (2014), the IRFs for unconventional monetary policy models are presented for 24 periods (i.e., over 2 years in this case of the monthly data).

5.1. The Results for the Baseline Models

First of all, the empirical analysis is implemented for evaluating the distributive effect of conventional monetary policy in the baseline case with the quarterly data. The usage of the higher frequency data allows the identification of a conventional monetary policy shock directly through the contemporaneous framework. The estimation results can serve as a basis point for the further analysis.

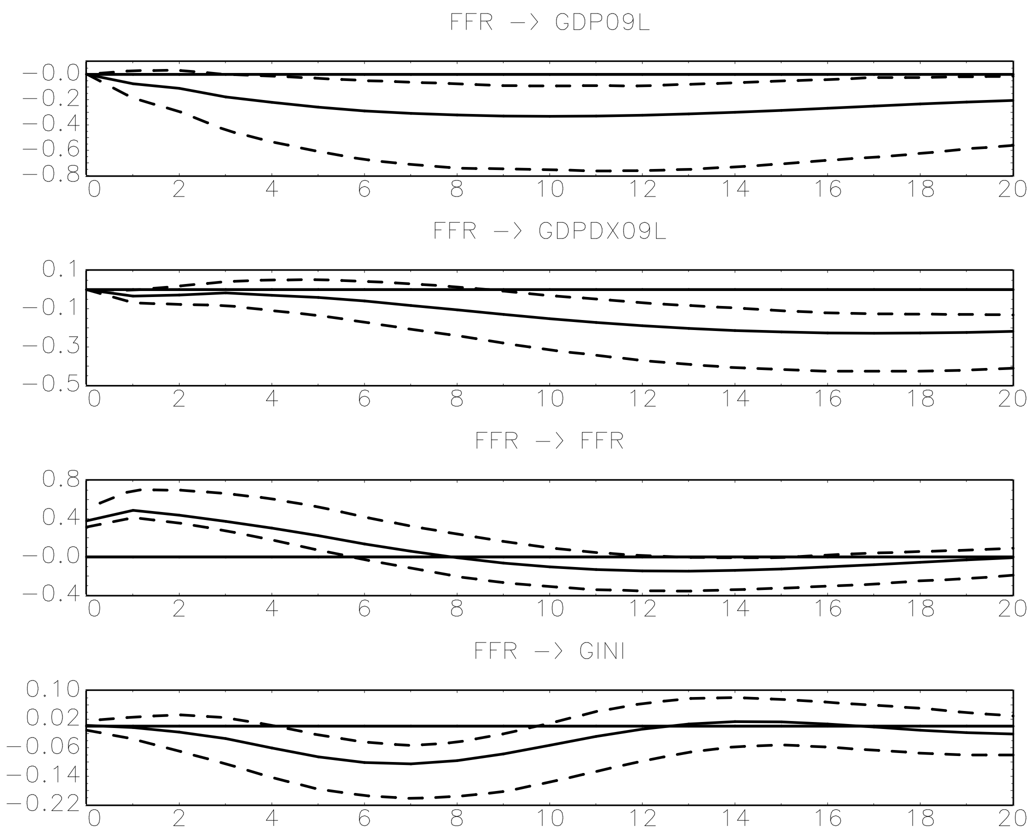
The IRFs of the baseline model of conventional monetary policy are thus identified by the contemporaneous restrictions using quarterly data. The estimated IRFs are provided in Figure 3.As can be seen, a contractionary monetary policy shock leads to a peak drop in real GDP by approximately 0.35 percent. This real effect of monetary policy is in line with the related literature (Christiano et al., 1996; Coibion, 2012; Peersman and Smets, 2001). The contractionary monetary policy shock also decreases GDP deflator with the peak effect of around 0.25 percent. It should be noted that the response of GDP deflator to the contractionary monetary policy shock is negative throughout the all considered periods. That is, even without including

[8] It is assumed that there is symmetry in the responses of contractionary and expansionary monetary policy shocks.

commodity prices (Christiano et al., 1996; Sims, 1992), the response of GDP deflator does not feature the "price puzzle."[9] Moreover, the responses of real output and prices to the contractionary monetary policy shock are mostly significant at the 95% confidence level. As can also be observed from Figure 3, a contractionary monetary policy shock decreases Gini index of income inequality up to around 0.1 percentage points. The response of income inequality is especially significant between the fourth and the tenth quarters.

Figure 3: The IRFs to a Conventional Monetary Policy Shock

(The Baseline Model)



For the baseline VAR model of unconventional monetary policy, the corresponding IRFs are estimated and they are provided in Figure 4. It can be observed from the figure that an expansionary unconventional monetary policy shock raises real GDP with the peak effect of 0.25

[9] The commonly used term "price puzzle" refers to the estimation results found in the literature (Balke and Emery, 1994; Bernanke and Blinder, 1992; Sims, 1992) that prices increase in response to a contractionary monetary policy shock.

percent. The unconventional monetary policy shock also leads to a peak increase in GDP deflator by nearly 0.15 percent. These real and nominal effects of the exogenous expansion of the Federal Reserve balance sheet are generally in line with the analogous results in the related literature (Chen et al., 2015; Gambacorta et al., 2014; Jannsen et al. 2015). Though the magnitudes of these effects are relatively smaller in comparison with the corresponding results in the case of the conventional monetary policy shock, they are still significant at the 95% confidence level.

From Figure 4, it can also be seen that the expansionary unconventional monetary policy shock significantly increases Gini index of income inequality up to approximately 0.07 percentage points. The magnitude of this effect is also relatively smaller than the corresponding distributive impact of the conventional monetary policy shock. Nevertheless, in the both cases, the period of the biggest distributive impact of monetary policy is during the second year after the shock.

5.2. The Results for the Variations in the Baseline Models

5.2.1 Monetary Policy Indicators

As an alternative variable for monetary policy stance, the yield curve is used instead of the federal funds rate in the baseline model of conventional monetary policy[10]. The slope of the yield curve is defined as a spread between short term and long term Treasury rates[11]. In particular, the yield curve indicator is calculated as a difference between the secondary market three-month Treasury bill rate and the ten-year Treasury constant maturity rate[12]. According to Estrella and Trubin (2006), the spread between these short term and long term rates serves as the best yield curve indicator. Then, in the baseline VAR model, the federal funds rate is replaced by this yield curve indicator (YCTBR) and the corresponding IRFs are re-estimated in the empirical analysis.

[10] As a monetary policy indicator, the yield curve is also used by Chen et al. (2015) and Galbraith et al. (2007).

[11] The slope of the yield curve is usually defined as a spread between long term and short term rates (Estrella and Trubin, 2006). It is defined in an opposite way in order to obtain a contractionary monetary policy shock consistently with the baseline case. That is, the computation of the yield curve indicator in this way provides the comparability of the IRFs with the results of the baseline case.

[12] These short term and long term Treasury rates are taken from FRED.

Figure 4: The IRFs to an Unconventional Monetary Policy Shock

(The Baseline Model)

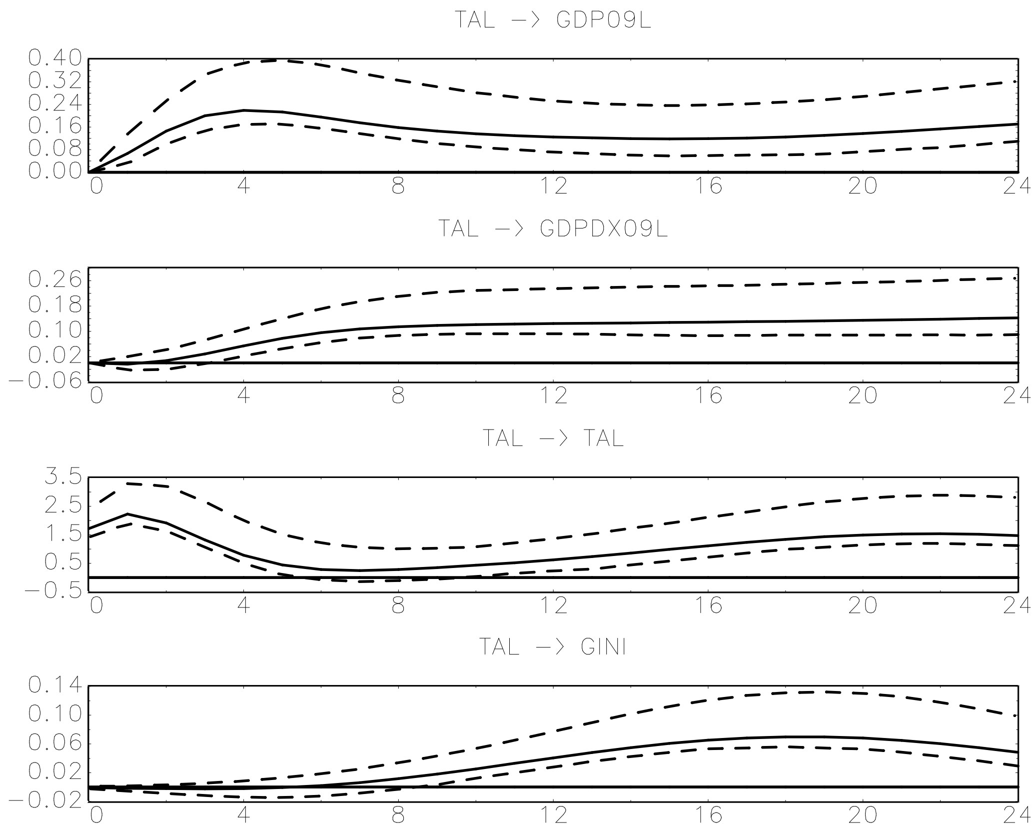
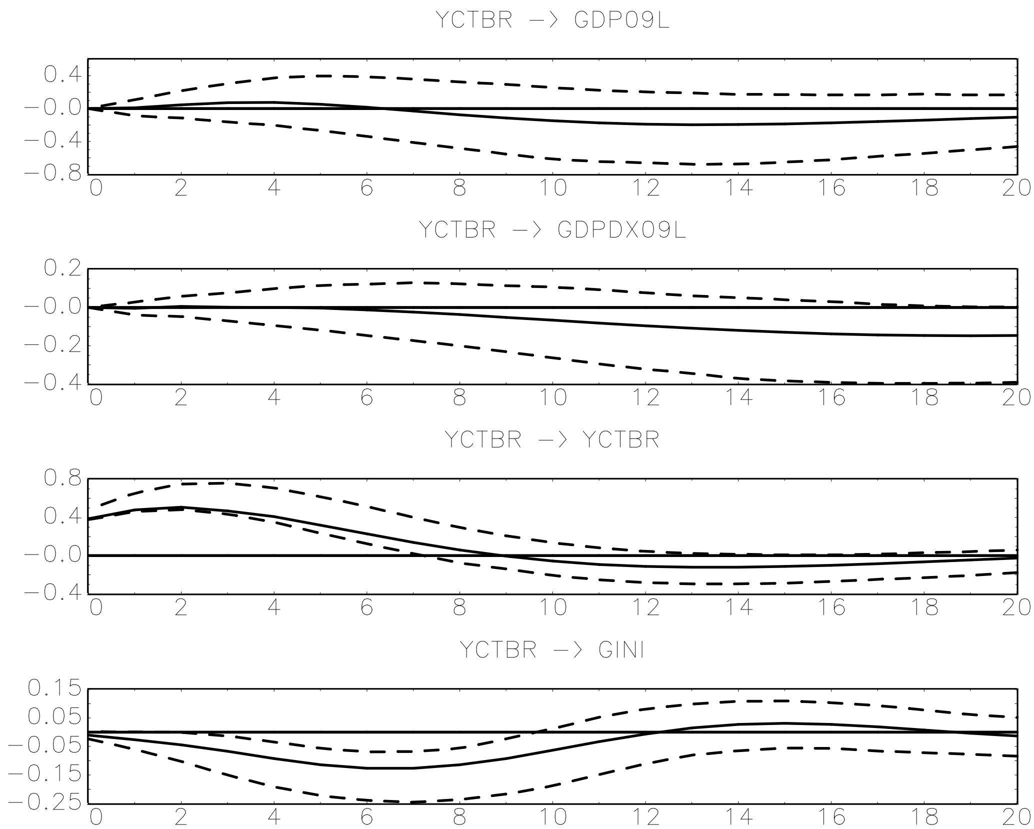


Figure 5 shows the obtained IRFs when the yield curve is used as a monetary policy indicator. As can be seen, the responses of real output and prices to a conventional monetary policy shock are not as significant as in the baseline case. Nevertheless, the response of GDP deflator does not still feature the "price puzzle." The response of Gini index to the shock is actually the same as in the baseline case.

Figure 5: The IRFs to a Conventional Monetary Policy Shock

(The Model with the Yield Curve)



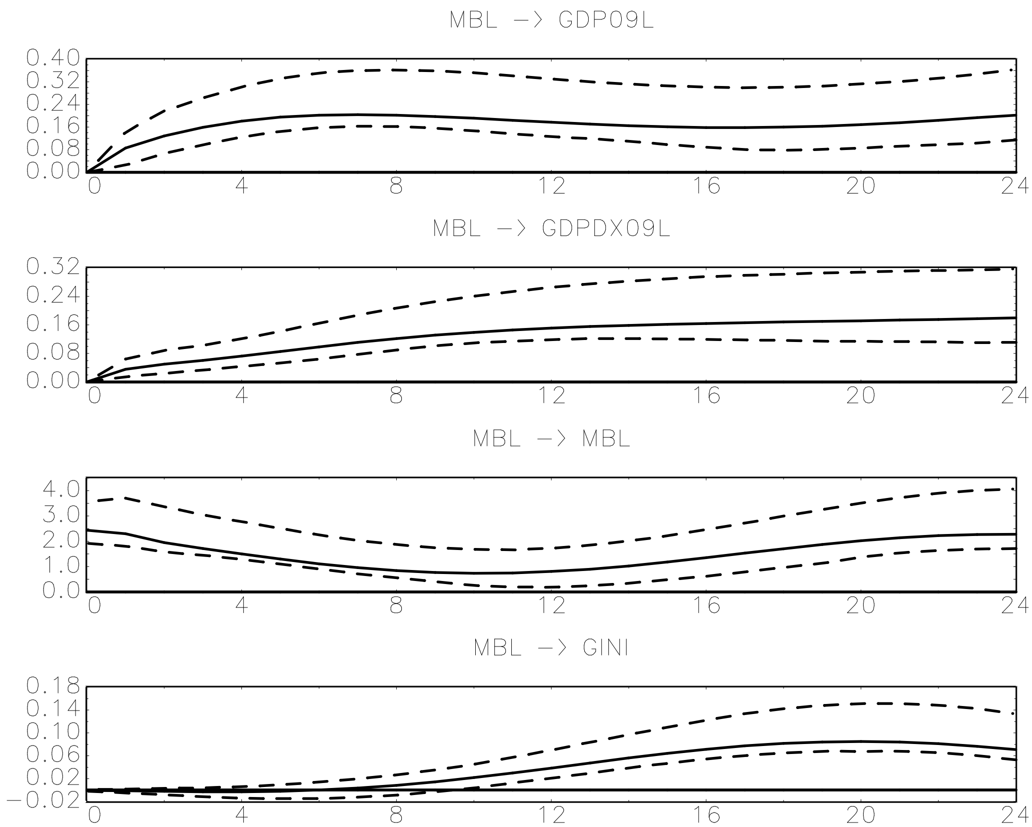
In the baseline model of unconventional monetary policy, another monetary policy instrument is used, too. Federal Reserve total assets are replaced by the monetary base[13]. As another quantitative policy instrument, the monetary base (MBL) is employed in the literature (Gambacorta et al., 2014; Saiki and Frost, 2014) for the evaluation of the effect of unconventional monetary policy. The corresponding IRFs are depicted in Figure 6. As can be observed from the figure, all the obtained results are very similar to the respective IRFs from the case when Federal Reserve balance sheet is considered as a monetary policy instrument. In particular, an unconventional monetary policy shock also significantly raises Gini index of income inequality, and its biggest impact is around 0.08 percentage points. Analogously, Saiki and Frost (2014) find that unconventional monetary policy increases income inequality in Japan.

[13] This total monetary base is from FRED, and it is seasonally adjusted.

The federal funds rate has been at its effective lower bound in the sample period considered for the case of unconventional monetary policy. However, there have still been some rate cuts during this period. Consequently, there is a risk that unconventional monetary policy shocks might be associated with these cuts in the federal funds rate. To check whether monetary policy shocks are affected by these changes in the federal funds rate, the appropriate robustness analysis of the obtained results is implemented. Following Gambacorta et al. (2014), the benchmark VAR model of unconventional monetary policy is extended by including the federal funds rate. Within the ordering of the variables, it is included just before Federal Reserve assets. That is, it is assumed that an unconventional monetary policy shock does not affect the federal funds rate on impact. The corresponding IRFs of the extended VAR model are provided in Figure A1 in Appendix 1. As can be seen, the magnitudes of the responses of the variables to unconventional monetary policy are relatively smaller than they are in the baseline case. However, the responses of real output, prices, and Gini index are still significant and they have the same dynamics as in the baseline case. All these results do not essentially change when, instead of Federal Reserve assets, the monetary base is used as a policy instrument (Figure A2 in Appendix 1).

Figure 6: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the Monetary Base)



5.2.2. The Indicators of Future Inflation and Financial Uncertainty

In the baseline model of conventional monetary policy, the response of GDP deflator to the monetary policy shock does not feature the "price puzzle." Nevertheless, a commodity price index[14] (COMPI09L) is still added to the model. It is an indicator of future inflation, which is included into the VAR models of conventional monetary policy in the related literature (Christiano et al., 1996; Sims, 1992). The corresponding IRFs are re-estimated in this extended version of the model. The obtained results are presented in Figure 7. As can be seen from the figure, a contractionary monetary policy shock significantly reduces commodity prices. The

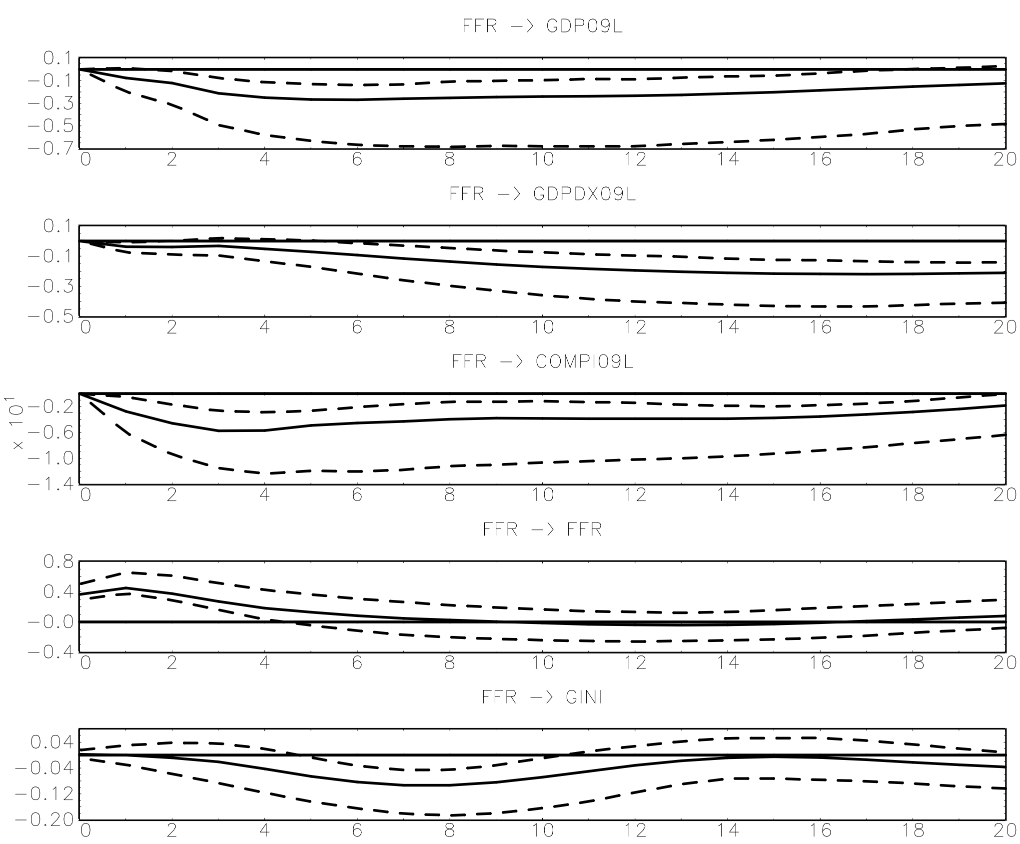
[14] The commodity price index is proxied by crude oil (petroleum) price index, which is the average of three spot prices: Dated Brent, West Texas Intermediate, and the Dubai Fateh. The both indices are very closely related and, in contrast to the former, the latter is fully available in the IMF database for the considered sample. The quarterly averages of the available monthly indices are used in the empirical analysis.

responses of the other variables are similar to the corresponding IRFs in the case of the baseline model.

The commodity price index is also added to the model when the yield curve is used as a monetary policy indicator. In that case as well, though, the “price puzzle” is not present in the response of GDP deflator. The estimation results for the corresponding IRFs are provided in Figure A3 in Appendix 2. In this case, the extension of the model makes the responses of real output and prices to a conventional monetary policy shock more significant. By contrast, the magnitudes and dynamics of the responses of Gini index to the shocks are very similar across the both cases. Moreover, the responses of Gini index are actually the same as in the baseline case.

Figure 7: The IRFs to a Conventional Monetary Policy Shock

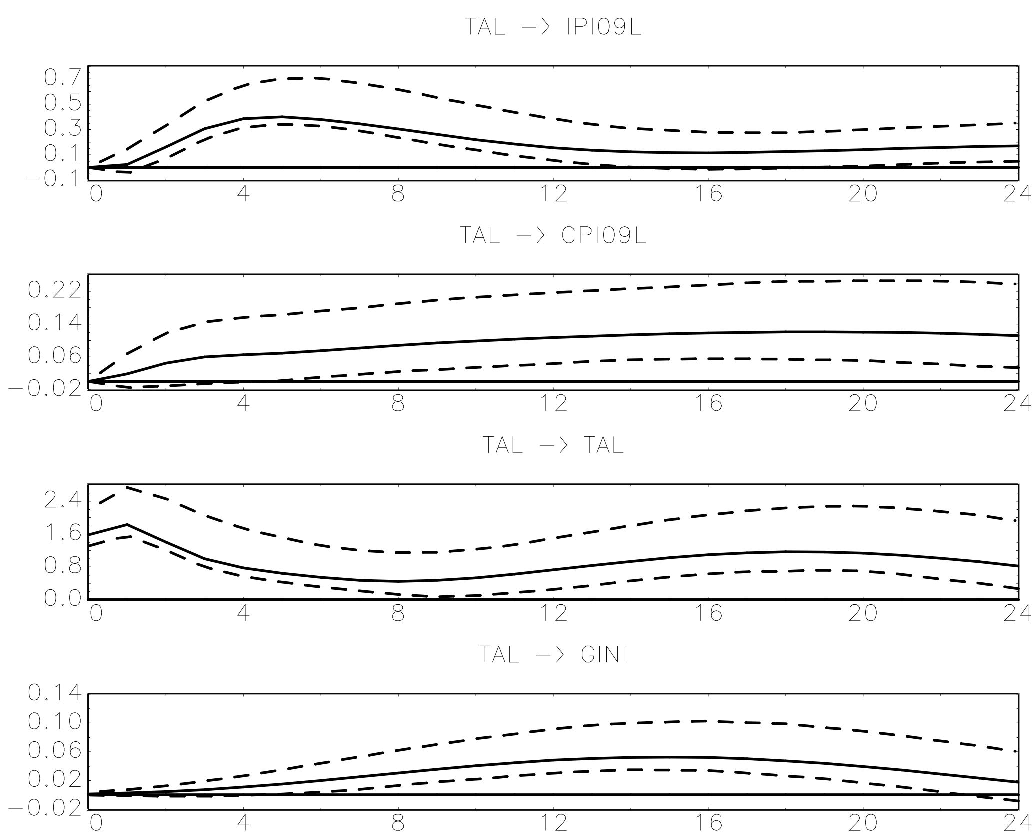
(The Extension of the Baseline Model by Commodity Prices)



Before the extension of the baseline model of unconventional monetary policy by an indicator of financial uncertainty, another modification of the model is implemented. As mentioned earlier, the interpolated data on real GDP and GDP deflator are used for the estimation of the baseline model to assess the distributive effect of unconventional monetary policy. Nevertheless, the data on the monthly frequency are available for industrial production index, IPI, and consumer price index[15], CPI, which are closely related to real GDP and GDP deflator, respectively. To check the robustness of the previously obtained results, the baseline model is modified by replacing real GDP and GDP deflator with the IPI (IPI09L) and the CPI (CPI09L), respectively. The resulting IRFs are presented in Figure 8. It can be observed that the IRFs are very similar to the corresponding results of the baseline case. They only differ by the larger response of real output in this case. In comparison with real GDP, the higher responsiveness of the IPI to an unconventional monetary policy shock is also found by Gambacorta et al. (2014).

Figure 8: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the IPI and the CPI)



[15] IPI and CPI are seasonally adjusted and they are taken from FRED. The base years of the indices are rescaled to 2009 to be in line with this base year of the other series.

For the identification of the unconventional monetary policy shocks, implied stock market volatility index[16] (VIX) is included into VAR models by some of the related literature (Gambacorta et al. 2014; Jannsen et al., 2015; Meinusch and Tillmann, 2014). It serves as a proxy for financial risk and uncertainty. According to Gambacorta et al. (2014), the inclusion of the VIX into the VAR model facilitates to disentangle exogenous unconventional monetary policy shocks from endogenous responses to financial market uncertainty. In this sense, it is analogous to the inclusion of commodity prices into the VAR models of conventional monetary policy. In that case, the commodity price index serves as an indicator for future inflation, and it is included into the VAR models for the identification of conventional monetary policy shocks (Christiano et al., 1996; Sims, 1992).

As robustness check for all the aforementioned results in the case of the consideration of unconventional monetary policy, the VIX is included in the corresponding VAR models. In the ordering of the variables, it is included just before Federal Reserve assets[17], assuming that innovations to the VIX have instantaneous impact on the balance sheet[18]. The estimated IRFs are provided in Figure 9 below (for the extension of the baseline case) and in Figures A3 to A7 in Appendix 3 (for the other results). The obtained results show that the response of the VIX to an unconventional monetary policy shock is not generally significant. The magnitudes of the responses of the other variables are relatively smaller in this case. However, these responses are still significant and they display the same dynamics as they have in the baseline case.

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[16] The data source for the VIX is Chicago Board Options Exchange, CBOE.

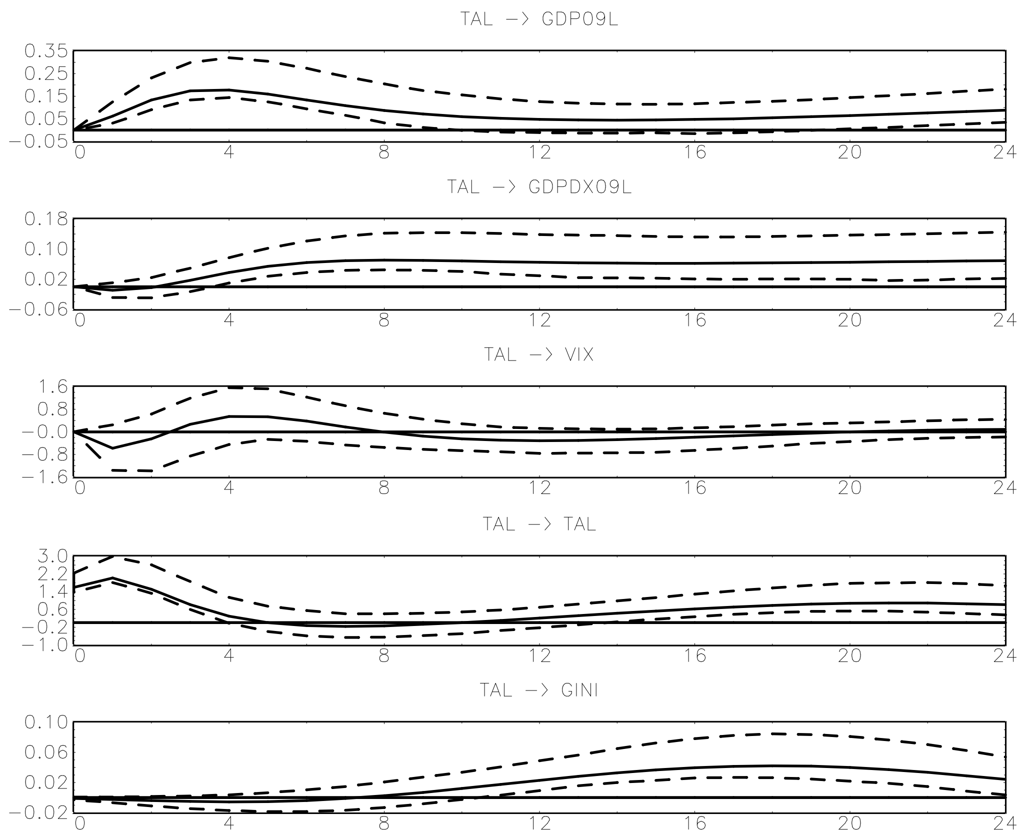
[17] Jannsen et al. (2015), and Meinusch and Tillmann (2014) include the VIX into the VAR models after the monetary policy instrument in the orderings of their considered variables. Accordingly, the VIX is included into the VAR model also just after Federal Reserve assets. The results are not essentially affected by this change of the ordering of the VIX. Therefore, the results are provided in the paper for only one scheme when the VIX is ordered just before Federal Reserve assets.

[18] Gambacorta et al. (2014) assume that unconventional monetary policy has also immediate effect on financial market uncertainty, and they identify unconventional monetary policy shocks by zero and sign restrictions. This identification approach for unconventional monetary policy shocks is within the agenda for future research and it will be used in the upcoming research work.

5.2.3. Income Inequality Measures

In order to assess the impact of conventional monetary policy on the different parts of income distribution, other income inequality measures are employed in the empirical analysis. In particular, the paper considers the 90-50 and the 50-10 percentile ratios. The baseline VAR model is modified by consecutively including the 90-50 (P9050) ratio and then the 50-10 (P5010) ratio instead of Gini index. The VAR models are then re-estimated, and the corresponding IRFs are identified by the contemporaneous restrictions. The resulting IRFs are provided in Figures A8 and A9 in Appendix 4.

Figure 9: The IRFs to an Unconventional Monetary Policy Shock (The Extension of the Baseline Model by the VIX)



As can be seen from Figures A8 and A9, the responses of real output and prices to contractionary monetary policy shocks are very similar to the corresponding results of the baseline case when Gini index is used. From Figures A8, it could be observed that a contractionary monetary policy shock leads to a decline in the 90-50 ratio. The peak drop of the percentile ratio is around 0.008 units. In line with the baseline case with Gini index, this decrease of income inequality is significant between the fourth and the tenth quarters. From Figures A9, it can be seen that the impact of the conventional monetary policy shock on the 50-10 ratio is not significant. That is, contractionary monetary policy does not affect the lower part of income distribution.

Analogously to the previous case with conventional monetary policy, the paper also considers the effects of unconventional monetary policy on the different parts of income distribution. To evaluate these effects, the same 90-50 and 50-10 percentile ratios are used in the analysis. The corresponding IRFs are provided in Figures A10 and A11 in Appendix 5. As can be seen from the figures, all the responses of real output and prices to an unconventional monetary policy shock are similar to the corresponding results in the case of the usage of Gini index. The responses of the 90-50 and the 50-10 ratios are also similar to the IRF for Gini index. In particular, the unconventional monetary policy shock significantly increases the 90-50 and the 50-10 ratios by approximately 0.003 and 0.002 units, respectively. Nevertheless, the result for Gini index is more significant. This is especially the case with the response of the 50-10 ratio. However, this response of the 50-10 ratio is still significant compared with the corresponding result in the case of the conventional monetary policy shock. On the contrary, the response the 90-50 to the conventional monetary policy shock is relatively stronger than it is in this case. Anyway, in the both cases, the results for the 90-50 ratio are significant and they are in line with each other.

5.3 Variance Decomposition

In order to assess the relative importance of conventional and unconventional monetary policy shocks, the variance decomposition analysis is also implemented in the current paper. It allows decomposing the total variance of Gini index of income inequality into the percentages attributable to a monetary policy shock identified by the same contemporaneous restrictions. It is very informative to observe these percentages over the considered periods for both conventional and unconventional monetary policy shocks. In particular, the results are presented for the first two years after the shocks according to the considered period for the IRFs of the unconventional monetary policy models.

The paper provides the results for the variation of Gini index due to a conventional monetary policy shock in Table 2. As can be observed from the table, the conventional monetary policy shock explains up to 11.48 percent of the variation in Gini index of income inequality.

The variation of Gini index attributable to an unconventional monetary policy shock is presented in Table 2, too. The results provided in the table indicate that the unconventional monetary policy shock significantly influences the variation in Gini index with the highest impact of 40.71 percent. Thus, the impact of the unconventional monetary policy shock on the variation in Gini index of income inequality is stronger than it is in the case of the conventional monetary policy shock.

6. Conclusion

The empirical analysis in the paper is implemented in line with its objective to assess the distributional effects of conventional and unconventional monetary policies in comparison with each other. The evaluation of these distributional effects is performed for the USA. For the estimation of the distributive impact of conventional monetary policy, the sample period is from 1983 to 2008 based on the quarterly data. The estimation sample for assessing the distributive effect of unconventional monetary policy covers the period from 2009 to 2013 and it is based on the monthly data. The distributive impact of conventional and unconventional monetary policies is evaluated through structural VAR models. Based on them, the paper estimates the IRFs and the variance decomposition, which are identified by imposing the contemporaneous restrictions. In particular, conventional monetary policy shocks are contractionary whereas unconventional monetary policy shocks are expansionary.

In the baseline case of the conventional monetary policy model, the estimation results of the IRFs indicate that a contractionary monetary policy shock reduces Gini index of income inequality up to approximately 0.1 percentage points. In the baseline case of the unconventional monetary policy model, the obtained results show that an expansionary monetary policy shock raises Gini index of income inequality up to around 0.07 percentage points. In the both cases, the distributional effects of monetary policy are significant at the 95% confidence level. The obtained results are robust for the different variations and extensions of the baseline models. In addition, the estimated IRFs show that conventional and unconventional monetary policies generally increase the percentile ratios, which measures inequality within the different parts of income distribution. In particular, they have the analogous significant effects on the 90-50 percentile ratios. The obtained IRFs also indicate that the contractionary impact of conventional monetary policy is not significant on the 50-10 percentile ratio while the expansionary effect of unconventional monetary policy on this ratio is still significant.

The paper also provides the results for the variance decomposition of Gini index attributable to conventional and unconventional monetary policy shocks. The results are presented for the first two years after the shocks. They indicate that the unconventional monetary policy shock explains the higher share of the variation in Gini index of income inequality than the conventional monetary policy shock.

In summary, the distributive effect of conventional monetary policy is stronger but its impact on the lower part on income distribution is not significant. That is, contractionary monetary policy does not affect the lower part of the distribution. Nevertheless, unconventional monetary policy significantly increases inequality in the lower part of income distribution. Additionally, the higher share of the variation in Gini index is attributable to unconventional monetary policy. Thus, this distributive impact of unconventional monetary policy should also be considered along with the other macroeconomic policies for the planned measures to reduce income inequality.

Table 2: The Variation of Gini index due to Conventional (CMP) and Unconventional (UCM) Monetary Policy Shocks

Periods (in Quarters)	CMP Shock	SE	Periods (in Months)	UMP Shock	SE
1	0.13%	1.44	1	0.92%	2.93
			2	1.03%	3.26
			3	1.07%	3.83
2	0.05%	1.5	4	0.99%	4.37
			5	0.78%	4.8
			6	0.53%	5.1
3	0.35%	2.22	7	0.46%	5.39
			8	0.93%	5.86
			9	2.26%	6.68
4	1.02%	3.28	10	4.66%	7.82
			11	8.1%	9.08
			12	12.26%	10.28
5	2.62%	4.86	13	16.72%	11.32
			14	21.06%	12.18
			15	25%	12.9
6	5.32%	6.74	16	28.4%	13.51
			17	31.26%	14.05
			18	33.6%	14.54
7	8.63%	8.44	19	35.5%	14.98
			20	37.03%	15.37
			21	38.27%	15.71
8	11.48%	9.52	22	39.27%	16.02
			23	40.07%	16.28
			24	40.71%	16.5

Note: The variations of Gini index are in percent. Standard errors (SE) are provided based on 1500 bootstrap replications.

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Appendix 1: Robustness Checks for the Extensions of the VAR Models by the FFR

Figure A1: The IRFs to an Unconventional Monetary Policy Shock
(The Extension of the Baseline Model by the FFR)

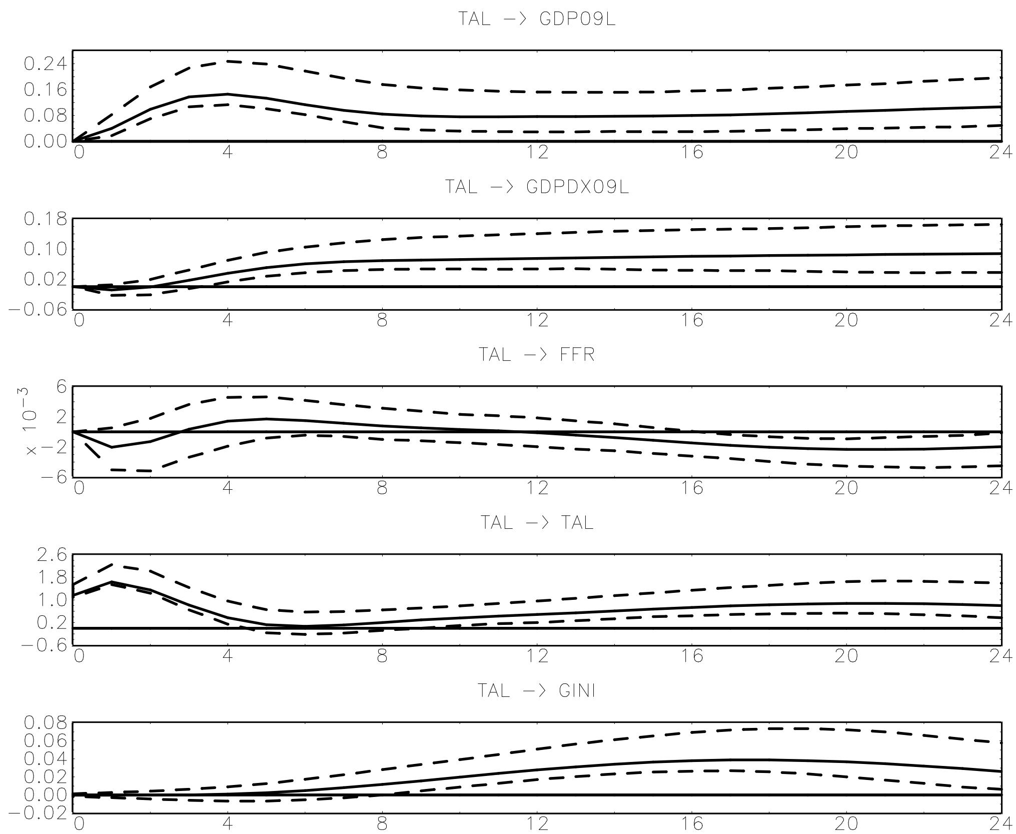
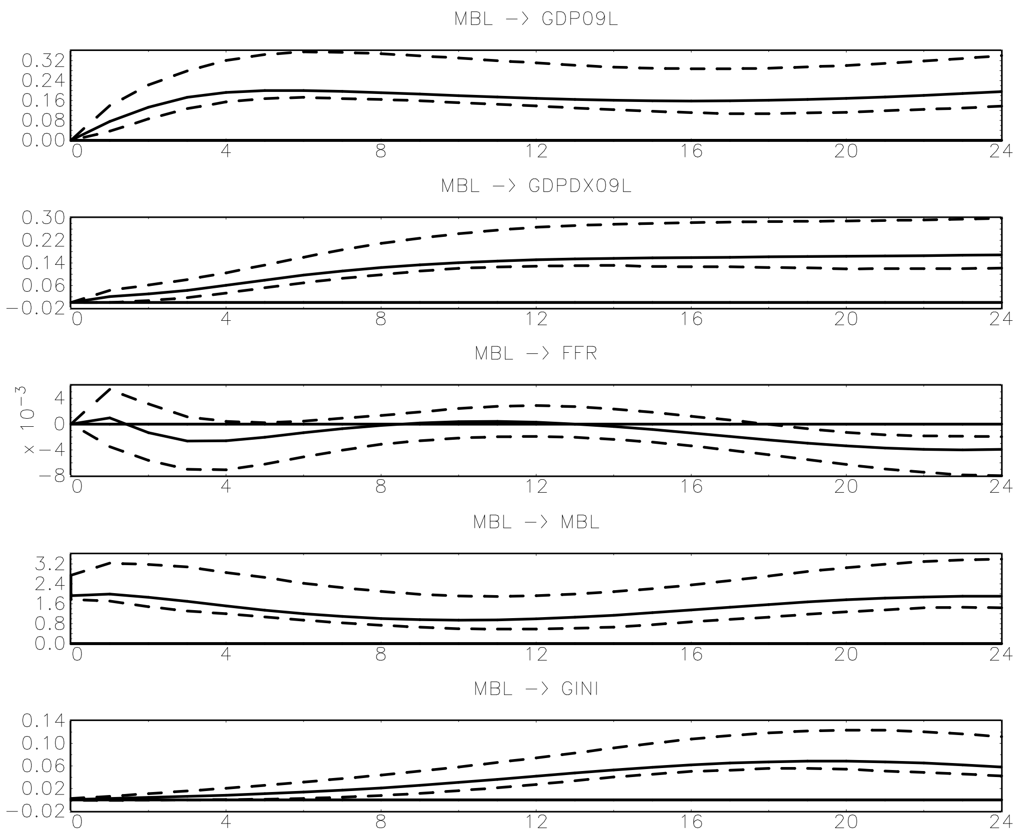


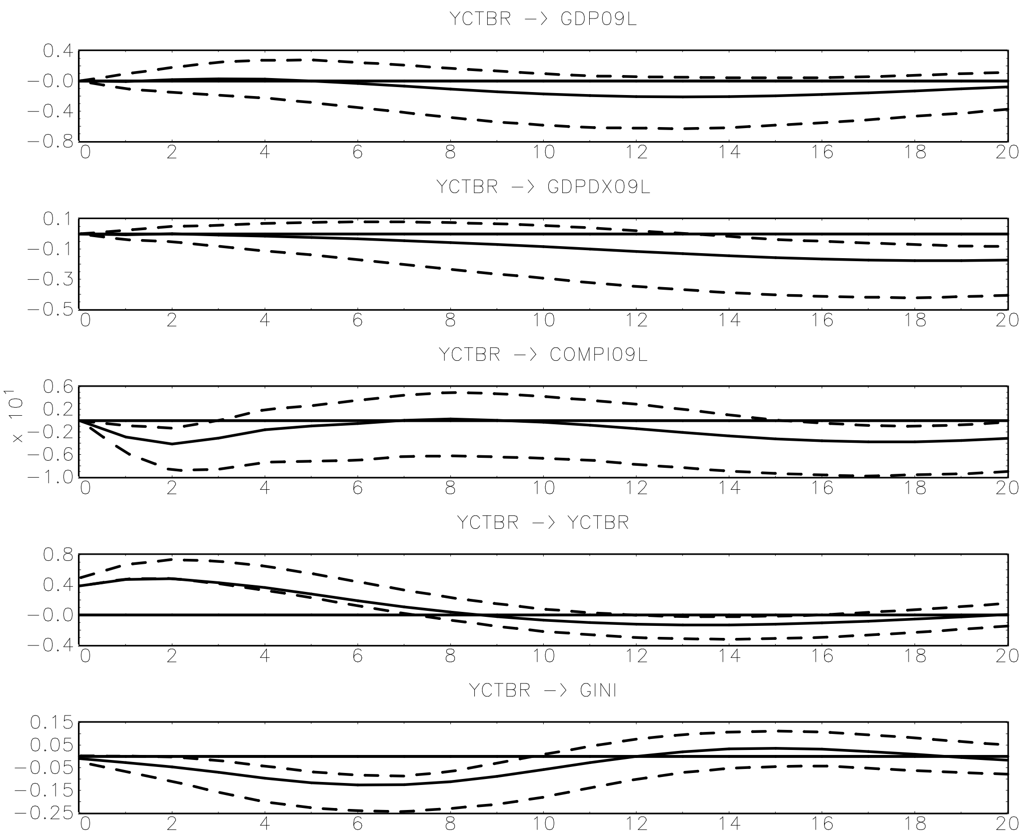
Figure A2: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the Monetary Base Extended by the FFR)



Appendix 2: Robustness Check of the VAR Model with the Yield Curve

Figure A3: The IRFs to a Conventional Monetary Policy Shock
(The Model with the Yield Curve Extended by Commodity Prices)



Appendix 3: Robustness Checks for the Extensions of the VAR Models by the VIX

Figure A4: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the Monetary Base Extended by the VIX)

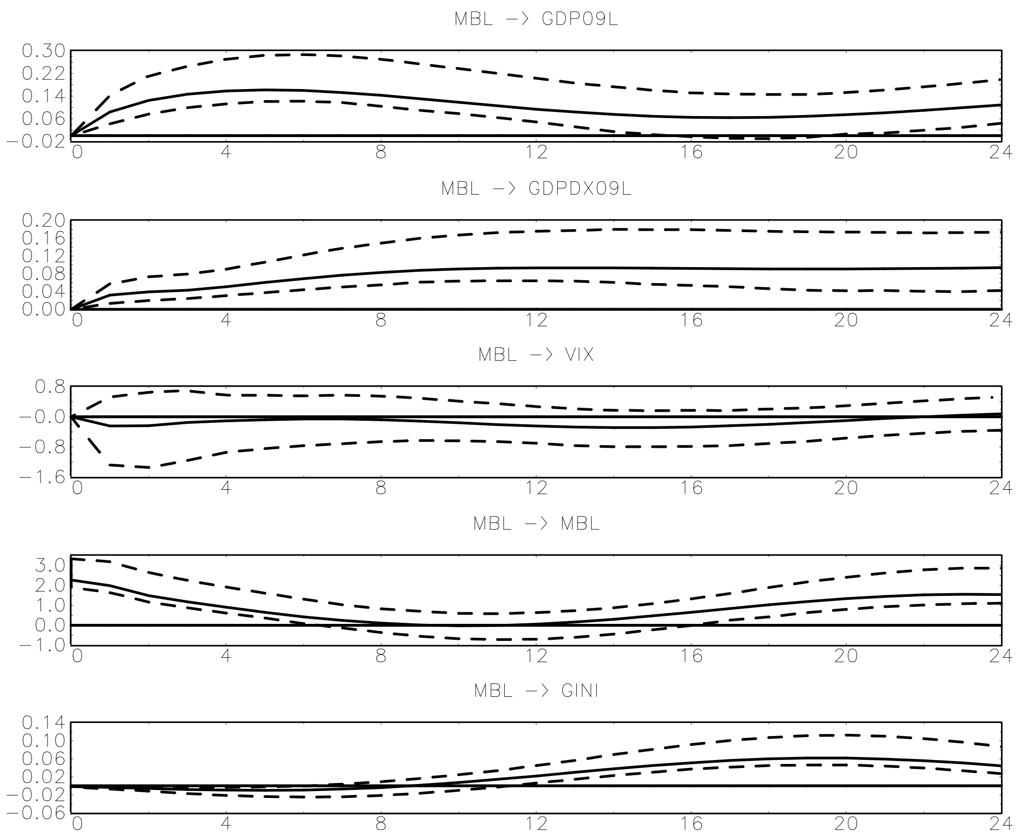


Figure A5: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the IPI and the CPI Extended by the VIX)

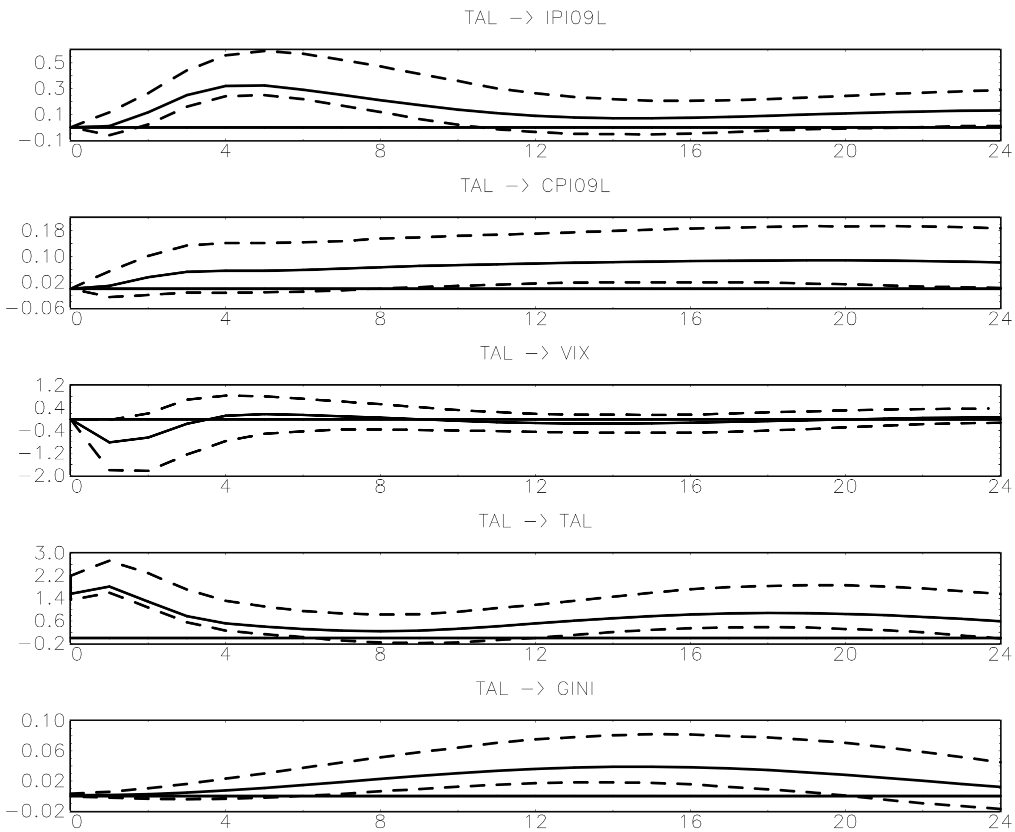


Figure A6: The IRFs to an Unconventional Monetary Policy Shock

(The Extension of the Baseline Model by the FFR and the VIX)

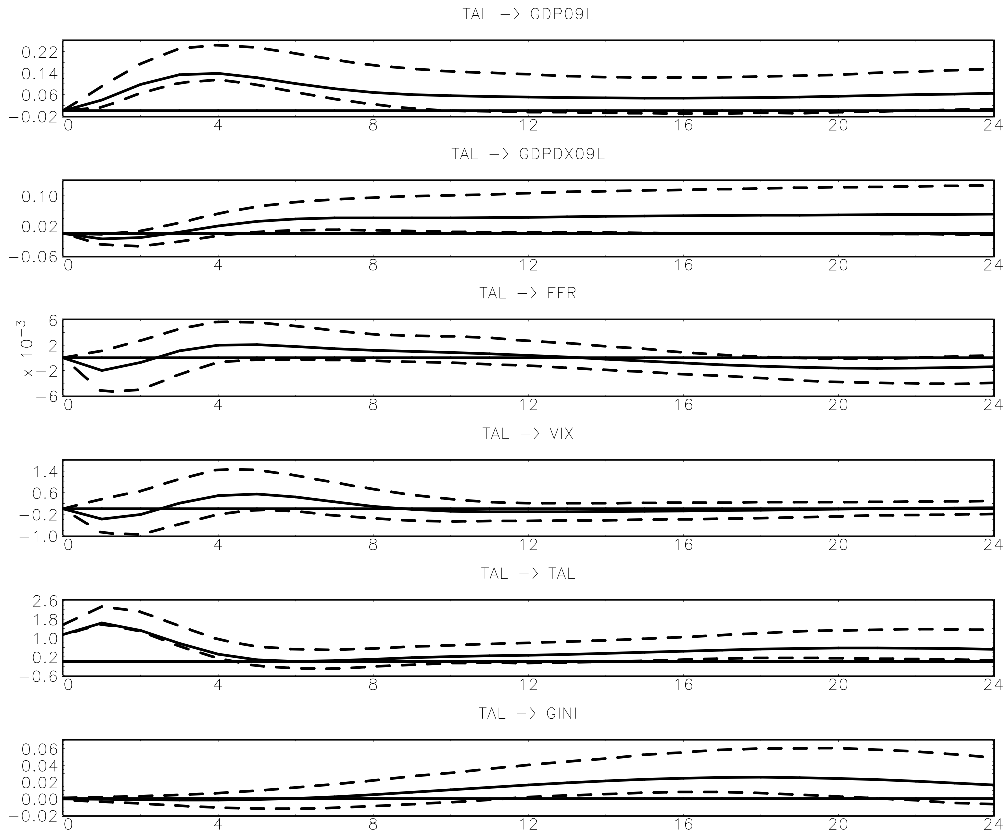
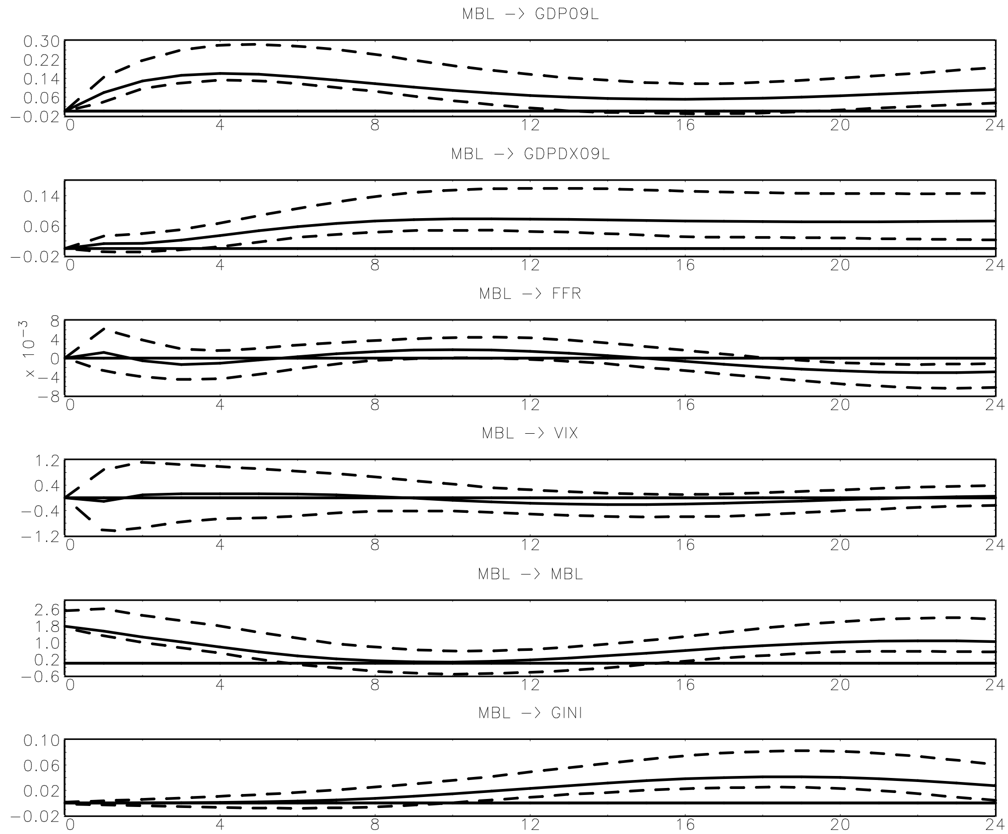


Figure A7: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the Monetary Base Extended by the FFR and the VIX)



Appendix 4: The Impact of Conventional Monetary Policy on the Different Parts of Income Distribution

Figure A8: The IRFs to a Conventional Monetary Policy Shock

(The Model with the 90-50 Ratio)

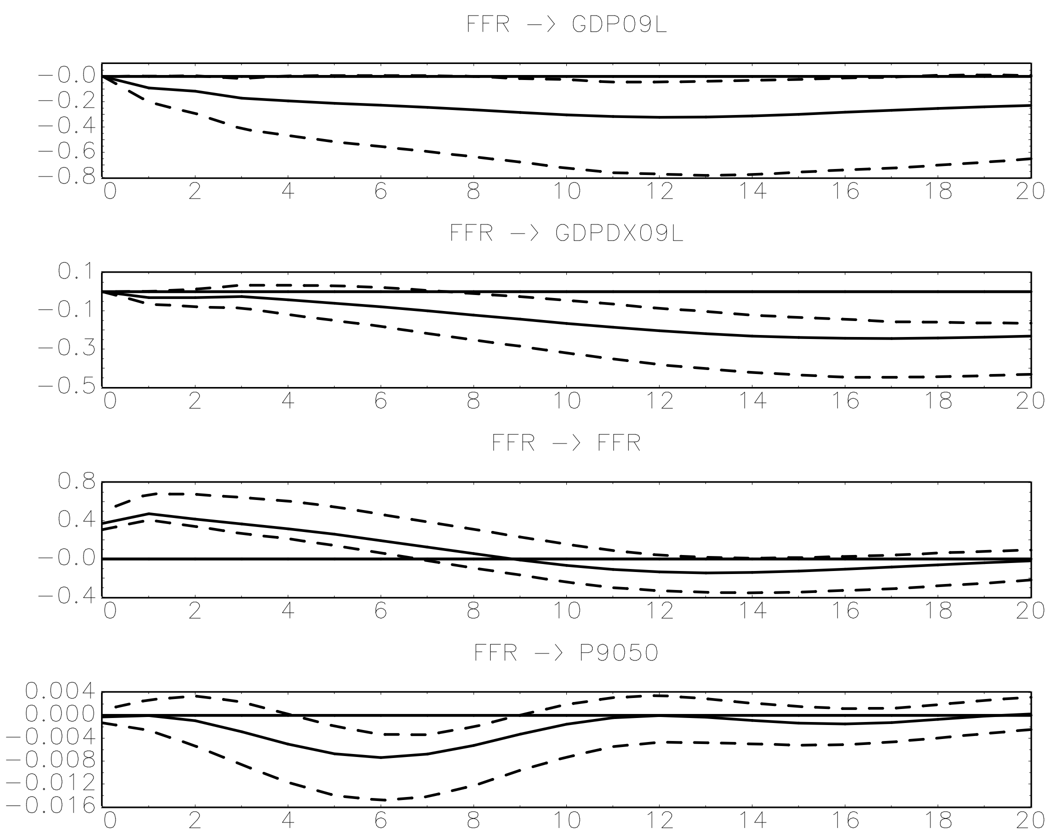
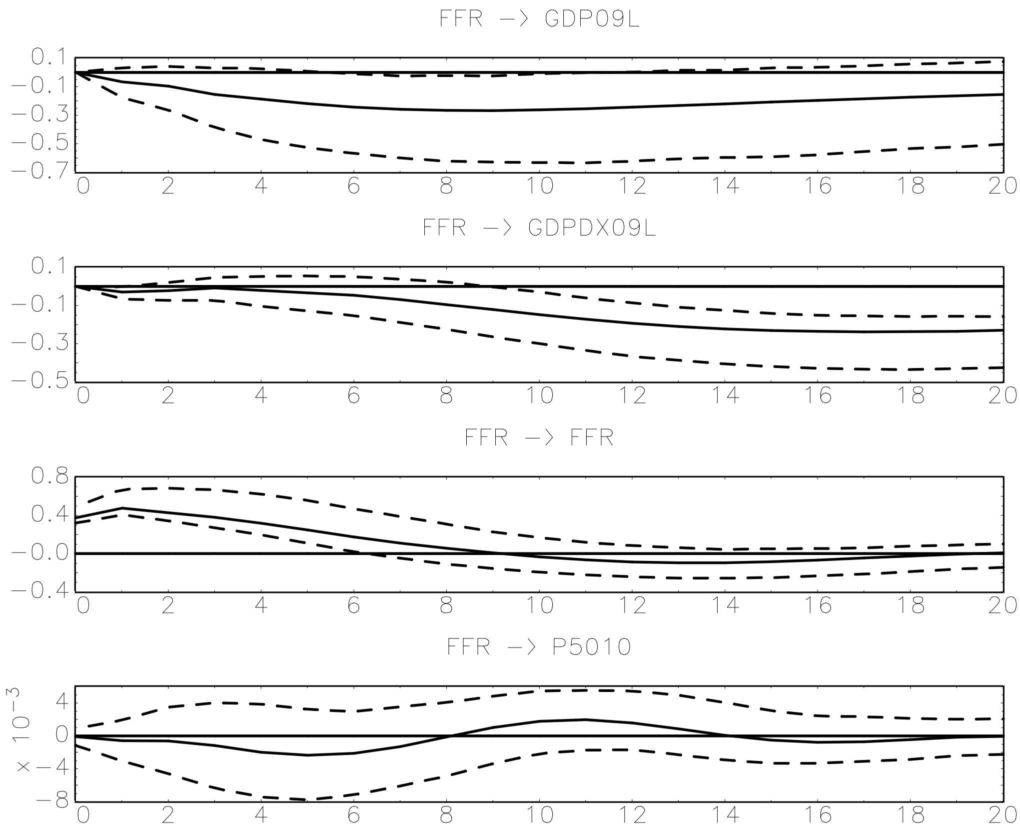


Figure A9: The IRFs to a Conventional Monetary Policy Shock

(The Model with the 50-10 Ratio)



Appendix 5: The Impact of Unconventional Monetary Policy on the Different Parts of Income Distribution

Figure A10: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the 90-50 Ratio)

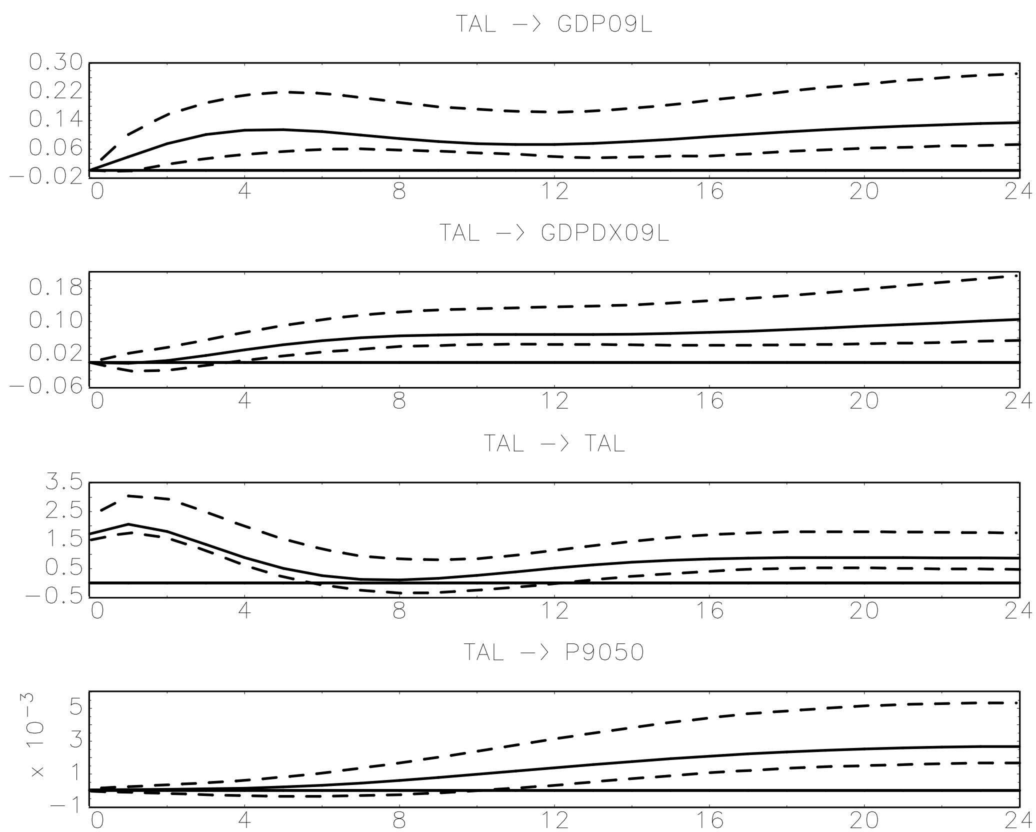
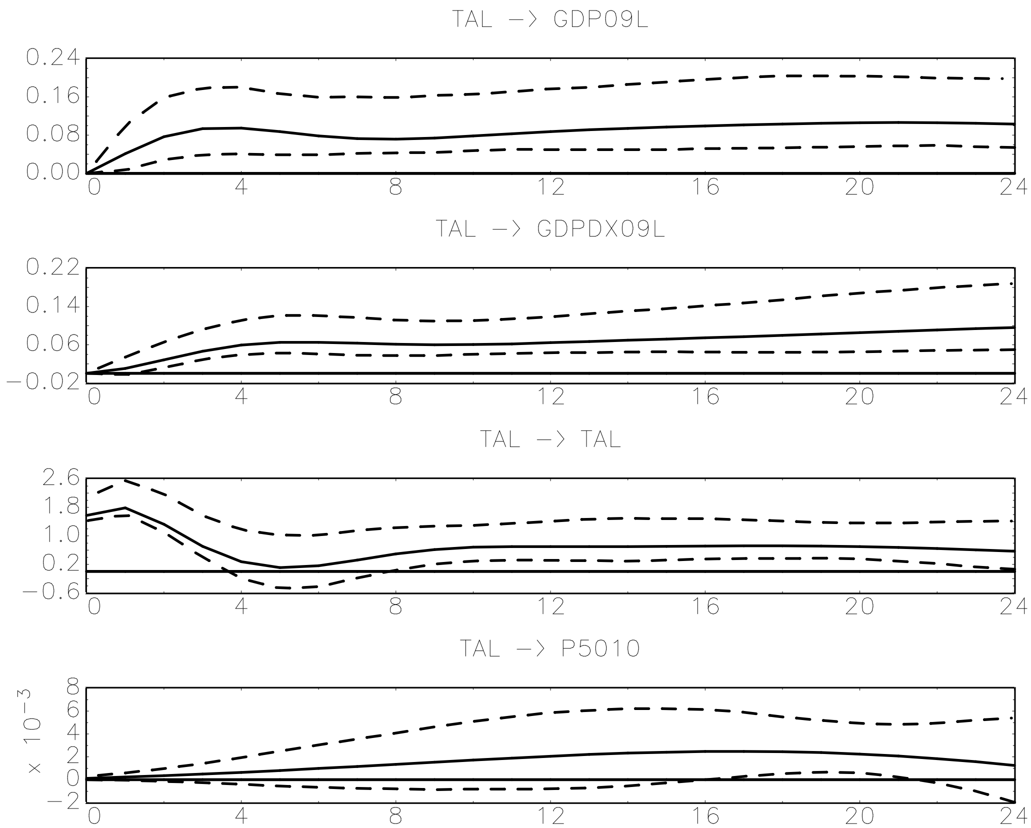


Figure A11: The IRFs to an Unconventional Monetary Policy Shock

(The Model with the 50-10 Ratio)



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