Does monetary policy affect income inequality in the euro area?*

Anna Samarina†

De Nederlandsche Bank

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Abstract

This paper examines how monetary policy affects income inequality in 10 EMU countries over the period 1999–2013, through macroeconomic and financial (credit and asset prices) channels. We find that these effects are heterogenous across countries and channels. While expansionary monetary policy reduces inequality in three core EMU economies (France, Belgium, the Netherlands), Spain and Portugal, it increases inequality in Germany, Austria, Finland, and Italy, and has no impact in Greece. The strong evidence is found for the credit channel, as credit growth reacts to a monetary policy shock and influences income distribution. Loose monetary policy reduces income inequality by boosting house and stock prices growth when the real estate and equity ownership is distributed broadly across the population, but raises inequality when the ownership is concentrated among high-income households. The macroeconomic channel and fiscal redistribution matter, too.

Keywords: income inequality, monetary policy, Euro area, credit, asset prices

JEL Classification: D63, E50, E52, G21

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†De Nederlandsche Bank, Westeinde 1, 1017 ZN Amsterdam, The Netherlands. Email: a.samarina@dnb.nl.

1 Introduction

In recent decades, many advanced countries have seen rising wealth and income inequality (Piketty, 2014; OECD, 2015), with possibly serious repercussions. In particular, greater inequality worsens the efficiency of resource allocation, constrains aggregate demand and output growth (Galor and Moav, 2004; Carroll et al., 2014; Ostry et al., 2014) and depresses consumption and investment (Onaran et al., 2011; OECD, 2015). More uneven income distribution leads to higher household indebtedness, fuels asset market bubbles, and raises financial instability (Skott, 2013; Coibion et al., 2014; Kumhof et al., 2015). Growing income inequality is also named among the causes of the Global Financial Crisis (Stockhammer, 2015).

In this context, the distributional effects of monetary policy have been of increasing concern in policy discussions (e.g., Yellen, 2014; Bernanke, 2015), also in the euro area (Draghi, 2015). However, the literature about the impact of monetary policy on income inequality is scant (see next section for a review).[1] A few empirical studies are inconclusive. Some find that restrictive monetary policy raises income and earnings inequality (Galbraith et al., 2007; Furceri et al., 2016; Coibion et al., 2017; Mumtaz and Theophilopoulou, 2017), while O'Farrell et al. (2016) report a weak effect of monetary policy through interest rate and asset prices on income inequality. Studies on unconventional monetary policy find that it reduced income inequality in the U.S. (Montecino and Epstein, 2015) and Italy (Casiraghi et al., 2016). For Japan, Saiki and Frost (2014) report that quantitative easing increased income inequality, but Inui et al. (2017) find these effects insignificant. Except for Casiraghi et al. (2016), who examine Italy, none of these studies look at the euro area. None include the channels of monetary policy transmission mechanism to explain how monetary policy affects inequality.

This paper offers several contributions. First, it examines the distributional effects of ECB monetary policy in 10 EMU countries over the period 1999–2013. In particular, we analyze how expansionary monetary policy impacts income inequality in euro area

[1] In contrast, there is an extensive literature on the effects of financial development and financial liberalization on income inequality; see De Haan and Sturm (ming) for a discussion.

economies and whether these effects are heterogeneous across countries. Second, we distinguish macroeconomic and financial (credit and asset prices) channels, through which monetary policy could affect income inequality. We extend the benchmark analysis to consider a disaggregated macroeconomic channel and fiscal redistribution. Finally, we address the mixed-frequency data problem in a MF-VAR model.

Monetary policy may influence income inequality through macroeconomic and financial channels (Draghi, 2015). The macroeconomic channel transmits effects of policy shocks through GDP and its components to income distribution. Expansionary monetary policy affects economic activity, investment, wages, and could reduce income inequality. Meanwhile, higher inflation raises uncertainty and lowers real income, raising inequality. These macroeconomic effects are well understood (see e.g., Bulíř and Gulde, 1995; Albanesi, 2007). But low interest rates resulting in higher credit growth and asset prices boom can also increase wealth and income inequality. In line with the 'credit channel' literature, monetary policy influences the real economy through the bank credit, which could affect income distribution. Additionally, rising asset prices benefit asset owners and raise their capital incomes, resulting in larger income disparities. Thus, through the financial channel (credit and asset prices) monetary policy may also have distributional effects.

To examine these channels, we use data on GDP and its components, bank credit, and asset prices (house and stock prices). We construct impulse responses of income inequality to an expansionary monetary policy shock and examine the transmission channels. Given that the data on income inequality are annual, while all macroeconomic, financial, and monetary variables are quarterly, we employ a two-step estimation procedure as in MF-VAR deal with the mixed-frequency data.

The paper is organized as follows. Section 2 discusses how monetary policy may impact income inequality, based on the literature. Sections 3 and 4 present the data and methodology, respectively. Section 5 provides the main results, extensions, and robustness checks. Section 6 elaborates on the results and section 7 concludes.

2 Channels of monetary policy impact on income inequality

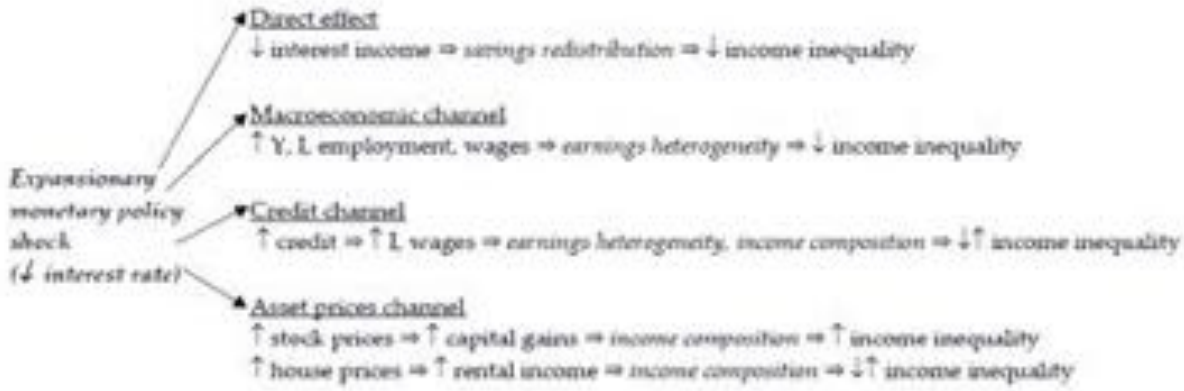
The redistributive effects of monetary policy on income[2] have not received much attention in the literature, with most studies offering theoretical contributions and focusing on wealth distribution. Coibion et al. (2017) distinguish five channels through which monetary policy can influence inequality; two of them are directly related to income distribution, namely the income composition and the earnings heterogeneity channels.

The first one addresses households heterogeneity in terms of income sources (Romer and Romer, 1999; Luetticke, 2015; Gornemann et al., 2016); it implies that expansionary monetary policy may increase income inequality by raising capital income more than labor income, as the share of capital income is higher for rich households (Inui et al., 2017). The second channel suggests that monetary policy may affect low- and high-income households differently, while their aggregate earnings vary depending on skills and productivity (Romer and Romer, 1999; Areosa and Areosa, 2016) as well as labor market flexibility and job creation (Inui et al., 2017). The earnings heterogeneity channel shows that an interest rate decrease raises aggregate income which disproportionately benefits low-income households, reducing income inequality (Auclert, 2017). The additional channel to be considered is savings redistribution (Fisher channel) (Doepke and Schneider, 2006; Auclert, 2017; Coibion et al., 2017): expansionary monetary policy raises inflation which benefits borrowers and hurts savers. This lowers consumption inequality and may reduce income disparities.

Thus, the overall impact of monetary policy on income inequality is ambiguous. This section incorporates the described theoretical channels to explain how expansive monetary policy could affect income distribution directly as well as through the macroeconomic and financial channels of monetary policy transmission mechanism.The financial channel is split into the credit channel and the asset prices channel. Figure 1 illustrates our theoretical framework.

[2] According to the definition of the LIS (Luxembourg Income Study), total household income consists of labor income, rental income (from real estate property), financial income (from interest and dividends), and transfer income (social security and private transfers).

Figure 1: Channels of monetary policy shock on income inequality



Direct effect

An expansive monetary policy shock could have a direct distributional effect on income: a lower interest rate reduces interest incomes from deposit savings. As savers are mainly rich households at the top end of income distribution with substantial capital income, a drop in their aggregate earnings may reduce income inequality.

Macroeconomic channel

Monetary policy can influence income inequality via general equilibrium effects on output, labor demand, and income (Sterk and Tenreyro, 2015; Kaplan et al., 2016; Auclert, 2017). An interest rate decrease lowers the real debt value and costs of financing. This stimulates consumption of durables, aggregate demand, and productive investment. Higher goods prices and lower capital costs encourage firms to increase production and employment. This benefits working and middle class people, who rely on wages as their main source of income. In line with the earnings heterogeneity channel, rich households at the top end of the income distribution will be less affected by loose monetary policy (Coibion et al., 2017; Gornemann et al., 2016). Consequently, an expansionary monetary policy shock increases labor earnings and lowers income inequality, as found by Coibion et al. (2017); Mumtaz and Theophilopoulou (2017).

Several studies note that distributional effects of monetary policy run through inflation (Romer and Romer, 1999; Erosa and Ventura, 2002; Doepke and Schneider,

2006; Albanesi, 2007). However, there is no consensus on whether higher inflation due to loose monetary policy decreases or increases inequality. Inflation has more pronounced effects on wealth distribution: the value of assets and liabilities is sensitive to price changes (Erosa and Ventura, 2002; Doepke and Schneider, 2006). The impact of inflation on income is indirect, via the real side of the economy. Hence, in the analysis of the macroeconomic channel we focus only on output and its components.

Financial channel: credit

The 'credit channel' literature discusses how the impact of monetary policy on the real economy depends on credit market conditions. Lower interest rate due to expansionary monetary policy affects balance sheets of firms and households, reducing their interest payments, raising net worth and collateral value. With stronger financial positions, firms expand investment and production (Bernanke and Gertler, 1995; Kishan and Opiela, 2000). At the same time, lower risk perception and asymmetric information problems are complemented by stronger balance sheets of banks due to lower costs of funding capital (Disyatat, 2011; Jiménez et al., 2012). In line with the bank lending channel, banks increase credit supply (Bernanke and Blinder, 1992; Kashyap and Stein, 2000; Kishan and Opiela, 2000).

The impact of bank credit growth (a proxy for credit channel) on income inequality may depend on the *earnings heterogeneity* and *income composition* of households. That is, it matters which income groups benefits more from credit growth. If bank lending growth supports investment in the productive, tradable sectors, it raises wages for low- and middle-income households, employed in such sectors. This contributes to reducing income disparities. However, the bank credit expansion may increase income inequality if credit grows faster in the sectors investing into real estate and financial assets. This benefits high-income households relatively more through higher capital gains from financial assets or higher wages and profits in those sectors (Van Arnum and Naples, 2013).

The bank lending channel is particularly important in the euro area where banks

play a major role in financial intermediation and monetary policy transmission (ECB, 2008; Giannone et al., 2012). The effects of ECB monetary policy on bank lending are found to be heterogeneous across euro area countries (Angeloni et al., 2002; De Santis and Surico, 2013), which could imply different impacts of credit channel on countries' income distribution.

Financial channel: asset prices

The second analyzed financial channel is asset prices. Rising asset prices due to expansionary monetary policy increase the net worth of firms issuing equity or owning stocks and lower the costs of financing capital, which encourages firms to invest (Mishkin, 2001). Lower interest rates also result in higher house prices, which increases properties' value and boosts housing construction (Mishkin, 2001). As a result, output grows. This could improve the economic situation and reduce income disparities if firms raise employment and wages.

Asset prices could also impact income inequality by affecting dividends (Kus, 2012; Montecino and Epstein, 2015; O'Farrell et al., 2016) and rental incomes. It is important to distinguish between types of asset prices since they might have varying implications for inequality depending on the income composition of households. Equity prices affect mainly high-income households at the top end of the income distribution as they hold most of financial assets (Saiki and Frost, 2014; Casiraghi et al., 2016). In the euro area asset holdings are concentrated among the richest households (Adam and Tzamourani, 2016; Claeys et al., 2015; Denk and Cazenave-Lacroutz, 2015).[3] An interest rate decrease resulting in rising equity prices leads to capital gains on financial intermediaries' and firms' balance sheets; thanks to higher profits they can increase bonuses and dividend payments (Brunnermeier and Sannikov, 2012; O'Farrell et al., 2016). Higher capital gains benefit high-income households disproportionately more, which could widen the income gap between rich and poor, thus raising inequality.

[3]Denk and Cazenave-Lacroutz (2015) find that two-thirds of all stocks in the euro area are owned by the top 20% of households, while less than 10% of households in the bottom half of the income distribution invest in stocks.

While capital gains from equity prices are concentrated among few richest households, house prices affect the median households (middle and upper-middle class) representing a much larger proportion of population in the euro area (Adam and Tzamourani, 2016). Higher house prices due to an expansionary monetary policy shock imply higher value of property, which benefits households with rental incomes. Poor households will be affected less as they are less likely to own real estate, while for rich households rental income constitutes a small share of total income. However, the effect of house prices on income distribution may depend on the home ownership rate which is heterogenous across euro area countries and income composition (share of rental income in total income) of households.[4]

To sum up the above discussion, expansionary monetary policy may reduce income inequality by stimulating economic activity (macroeconomic channel) and lowering savings income of rich households. The impact of financial channel depends on the allocation of credit growth and the type of asset prices considered.

3 Data

The analysis focuses on 10 Euro area economies over the period 1999Q1–2014Q4. Countries include Austria, Belgium, France, Finland, Germany, Greece, Italy, the Netherlands, Portugal, and Spain.[5] We do not include the 'new' EMU countries as they adopted the euro much later. The data before 1999Q1 are not analyzed due to the presence of a structural break: monetary policy reaction functions and structural characteristics of countries before 1999 are different from those after countries became EMU members (Mandler et al., 2016).

The research on distributional effects of monetary policy confronts important data challenges related to measuring inequality. Ideally, income inequality measures are constructed using quarterly survey data on household incomes, which allows exam-

[4] Adam and Tzamourani (2016) report a high home ownership rate in Spain and Finland, but low in Germany. Also in Austria, France, and Italy poor households are less likely to own property and therefore do not loose from house price decrease.

[5] Ireland and Luxembourg are excluded due to data limitations.

ining various dimensions of inequality in a high frequency analysis. This was done in previous studies on the impact of monetary policy on income inequality (Coibion et al. (2017), Montecino and Epstein (2015) for the U.S., Mumtaz and Theophilopoulou (2015, 2017) for the UK, Saiki and Frost (2014), Inui et al. (2017) for Japan, and Casiraghi et al. (2016) for Italy). For most EMU economies such surveys are not available for more than a few years and might be incomparable across countries. Publicly available data on income inequality, measured by Gini coefficients, can be accessed from the Standardized World Income Inequality Database (SWIID) for annual data up to 2014 (Solt, 2016). This is our primary data source on inequality. In a robustness check, we use the data from the EU-Statistics on Income and Living Conditions (EU-SILC).

The main analysis uses two measures of income inequality: Gini of equivalized household market (pre-tax, pre-transfer) income and Gini of equivalized household net (post-tax, post-transfer) income. In this way we can compare the effects of monetary policy before and after redistribution. Gini coefficient measures the extent to which an income distribution among individuals differs from a perfectly even distribution. It ranges from 0 (perfect equality) to 100 (perfect inequality). Since Gini coefficients may exhibit low variability, as a robustness check we will use 90th/10th percentiles ratio from the EU-SILC to measure inequality as the gap between the income received by those in the top decile of income distribution compared to that received by those in the bottom decile. It attaches a higher weight to income differences at the tails of distribution, while the Gini puts the same weight to income differences close to the median as at the tails.[6] Note that the 90/10 percentile ratio is derived from the equivalised disposable income, thus it reflects inequality after redistribution.

The empirical analysis also includes quarterly macroeconomic and financial variables to measure the channels of monetary policy transmission. These are real GDP, headline HICP, total bank credit to private sector, a stock price index, and a house price

[6] An interesting extension of this study could be to analyze monetary policy impact on different income categories (labor/capital/transfer income) for different income groups, provided the availability of granular income data for a long time period. This merits future research, beyond the scope of the current paper.

index.[7] In subsection 5.2. we also examine GDP components as potential macroeconomic channels. Monetary policy stance is proxied by EONIA.[8] All macroeconomic, financial, and inequality variables are transformed into log levels (GDP and its components are transformed as $4\times\log$), while the interest rate is used in a raw form.

3.1 Historical trends in income inequality

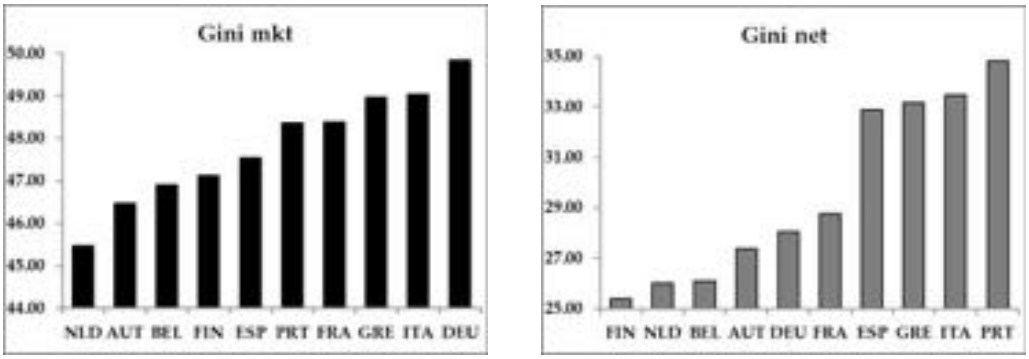
Figure 2 shows the means of market and net income inequality over 1999–2014 for 10 analyzed EMU countries, ordered by the inequality level. Income distributions are heterogenous across the euro area, with most of the core member-states characterized by lower inequality compared to the periphery. The least unequal in gross incomes are the Netherlands and Austria, while the highest gross income disparities are in Southern Europe and Germany. The latter is a surprising observation, suggesting that German incomes before redistribution are very unequal. The substantial variation across EMU is particularly evident for net inequality. The ordering of countries is comparable to the market Gini, with lowest net income dispersions in Finland, the Netherlands, and Belgium and highest in Southern European economies. Thus, periphery member-states even after redistribution have high income inequality. The Gini net for Germany is much lower than in Southern Europe, pointing to a role of redistribution policies in smoothing out income differences through taxes and transfers. As the inequality levels differ between countries, effects of monetary policy on inequality could vary as well.

Income inequality in EMU has been on the rise in recent decades, as shown in Figure 3. Gross inequality measured by market Gini increased over the analyzed period in most economies, with highest growth observed in Greece, Spain, Austria, and Germany. The exception is Belgium, where gross inequality declined over time. Net inequality increased substantially in Germany and the Netherlands, while dropped marginally in some other economies. There was a sudden upward shift in gross inequality after 2007, as visible in Austria, Portugal, and Greece. This could be due to the

[7] See Appendix A for details on data construction and sources.

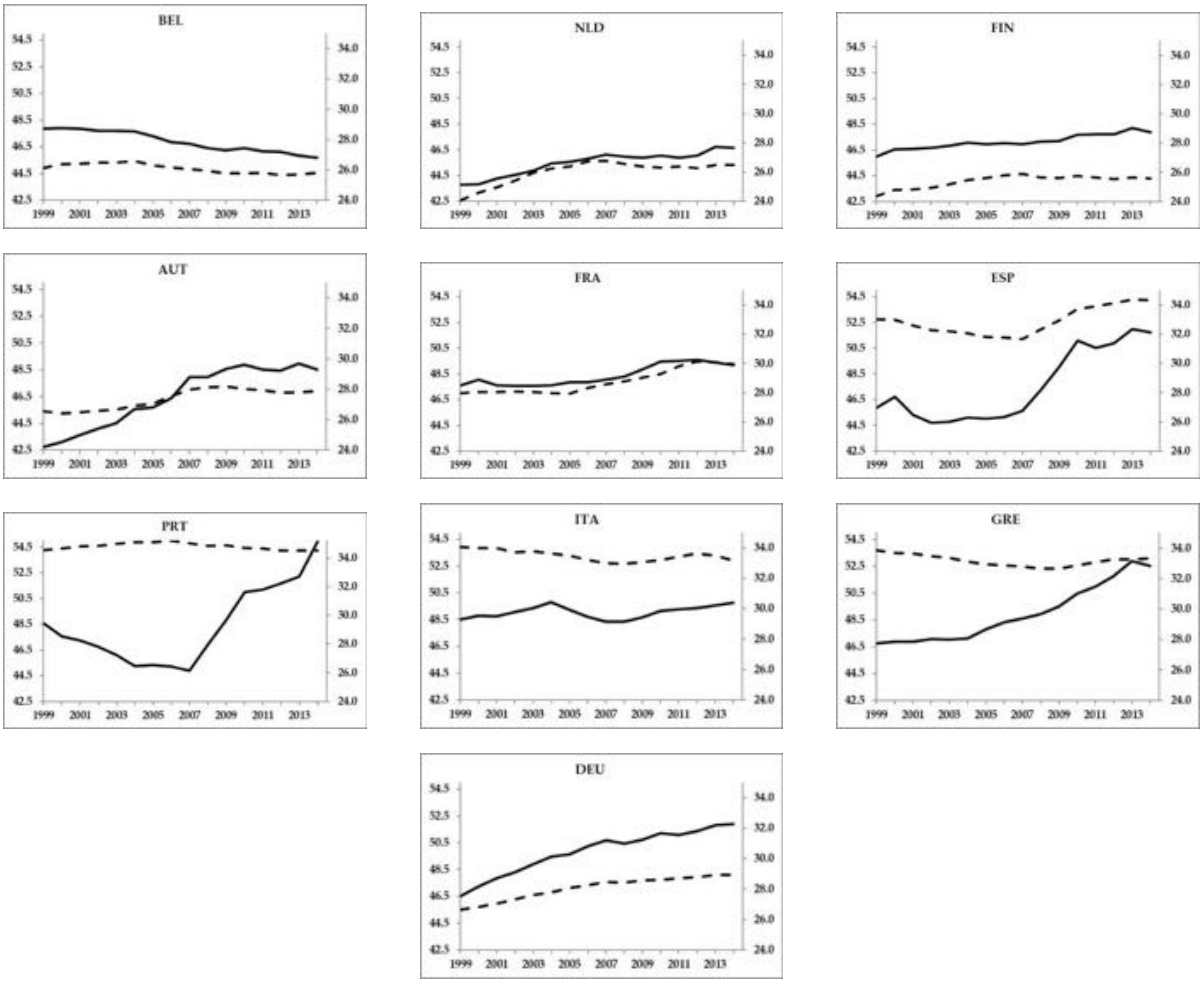
[8] As a robustness check, we use a shadow rate for the euro area to proxy monetary policy stance during the period of zero lower bound and unconventional monetary policy.

Figure 2: Income inequality in EMU economies, average over 1999–2014



Notes: Calculations based on SWIID.

Figure 3: Development of income inequality in EMU economies, 1999–2014



Notes: Calculations based on SWIID. Solid lines show Gini market, dashed lines — Gini net.

global financial crisis and the subsequent sovereign debt crisis in the euro area, which caused recession and worsened the economic situation of households, especially those at the bottom of income distribution. To account for this, as a robustness check we estimate VAR models until 2007Q3, thus excluding the effect of crisis years.

4 Methodology

When choosing a suitable methodology, we have to address a mixed frequency data problem: inequality measures are sampled annually, while macroeconomic, financial, and monetary variables are quarterly. The literature offers two approaches to deal with this issue.[9] The first one is based on MIxed DAta Sampling (MIDAS) models, extended for VAR systems by Ghysels (2016), where a low-frequency variable is regressed onto high-frequency variables using parsimonious distributed lags. This technique, however, cannot be applied for a large set of variables due to the significant computational burden. Moreover, it focuses on forecasting a coarsely observed variable and discards lots of information contained in high frequency data.

A more sophisticated approach relies on using the state-space representation of the VAR model, where a low-frequency variable is treated as a high-frequency one with missing observations. To estimate missing observations, the Kalman filter is applied (Harvey and Pierse, 1984). According to Bai et al. (2013), the Kalman filter gives more accurate forecasts than MIDAS regressions and is an optimal filter in population given that the state-space model is correctly specified and the parameters are known. The Kalman filtering approach is similar to mixed frequency VAR (MF-VAR) models when missing data occur at regular frequency (Eraker et al., 2015). Unlike the MF-VAR models based on Bayesian inference, it can be easily estimated by maximum likelihood. This approach is applied in this study.

In order to estimate the impact of monetary policy shocks on income inequality and other variables, we use a VAR framework. The benchmark VAR model is defined as:

$$Y_t = C + \sum_{j=1}^{p} A_j Y_{t-j} + \varepsilon_t, \quad \varepsilon_t \sim \mathcal{N}(0, \Sigma_\varepsilon) \tag{1}$$

where Y_t denotes a matrix of endogenous variables, $Y_t = [X_t, Z_t]$. X_t is a matrix of observed quarterly data for real GDP, HICP, EONIA, bank credit, stock price index, and house price index. Z_t denotes unobserved quarterly data for the income inequality

[9] Foroni and Marcellino (2013) review the econometric methods to deal with mixed frequency data.

measure (Gini market or net); it is a vector of annual inequality series treated as quarterly series with missing observations. Z_t is constructed as follows: it is observed every fourth quarter of a year ($t_q = 4,8,12,...,T_q$), to which we assign the annual value of inequality for this year; in remaining three quarters of a year ($t_q = 1,2,3,5,6,7,..,T_{q-1}$) the values are missing. All variables, except the interest rate and the inequality measure (in log) are included in VAR in log differences, to ensure stationarity of time series.

The identification of shocks in the VAR model is achieved through a Cholesky decomposition with the ordering: $\Delta ln(GDP_t)$, $\Delta ln(HICP_t)$, $EONIA_t$, $\Delta ln(CRED_t)$, $\Delta ln(SP_t)$, $\Delta ln(HP_t)$, $ln(GINI_t)$. Following literature on monetary policy transmission (Christiano et al., 1999), we assume that output growth and inflation respond to the interest rate shock only with a lag, while the interest rate shock reacts contemporaneously to innovations in output growth and inflation. Further, based on literature on credit and asset prices channels of monetary policy, we assume that credit growth and asset prices follow the monetary policy shock, but they do not have an immediate impact on the interest rate and, hence, are ordered after it. Credit growth is assumed to react to innovations in asset prices with a lag, while the latter respond contemporaneously to credit shocks.[10] As in Saiki and Frost (2014) and **?**, the income inequality index is ordered as the last in VAR: we assume that it does not affect contemporaneously all other variables.

Following the notations of Eraker et al. (2015), the VAR model specified in equation (1) can be rewritten in a state-space form as:

$$\begin{bmatrix} X_t \\ Z_t \end{bmatrix} = \begin{bmatrix} C_x \\ C_z \end{bmatrix} + \begin{bmatrix} A_{xx} & A_{xz} \\ A_{zx} & A_{zz} \end{bmatrix} \begin{bmatrix} X_{t-1} \\ Z_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix} \tag{2}$$

[10]The ordering of credit before asset prices is not unequivocal as the reverse order is equally plausible, as in Iacoviello and Minetti (2008); De Santis and Surico (2013). Additionally, some studies argue that policy makers observe developments in credit and asset prices when deciding about the policy rate, which implies ordering them before the interest rate (Ciccarelli et al., 2015; Mandler et al., 2016). To address these identification concerns, in a robustness check we estimate VARs with alternative orderings of financial variables.

If Z_t is observed, the observation equation is specified as

$$Y_t^{obs} = \begin{bmatrix} I & 0 \\ 0 & I \end{bmatrix} \begin{bmatrix} X_t \\ Z_t \end{bmatrix}. \tag{3}$$

If Z_t is not observed, the observation equation changes to

$$Y_t^{obs} = \begin{bmatrix} I & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} X_t \\ Z_t \end{bmatrix}. \tag{4}$$

Given that the missing data occur at regular frequencies (annual and quarterly), the observation equation shifts between (3) and (4) systematically.

The estimation procedure is implemented in two steps. First, the Kalman filter is used in a state-space VAR model (2) to interpolate unobserved quarterly inequality values in Z_t based on the observations of X_t.[11] Second, the imputed quarterly inequality is included in the VAR model (1) to estimate impulse responses of variables to a monetary policy shock. Based on Schwarz information criterion (SIC), the lag length is set to 1 in both steps.

5 Empirical analysis

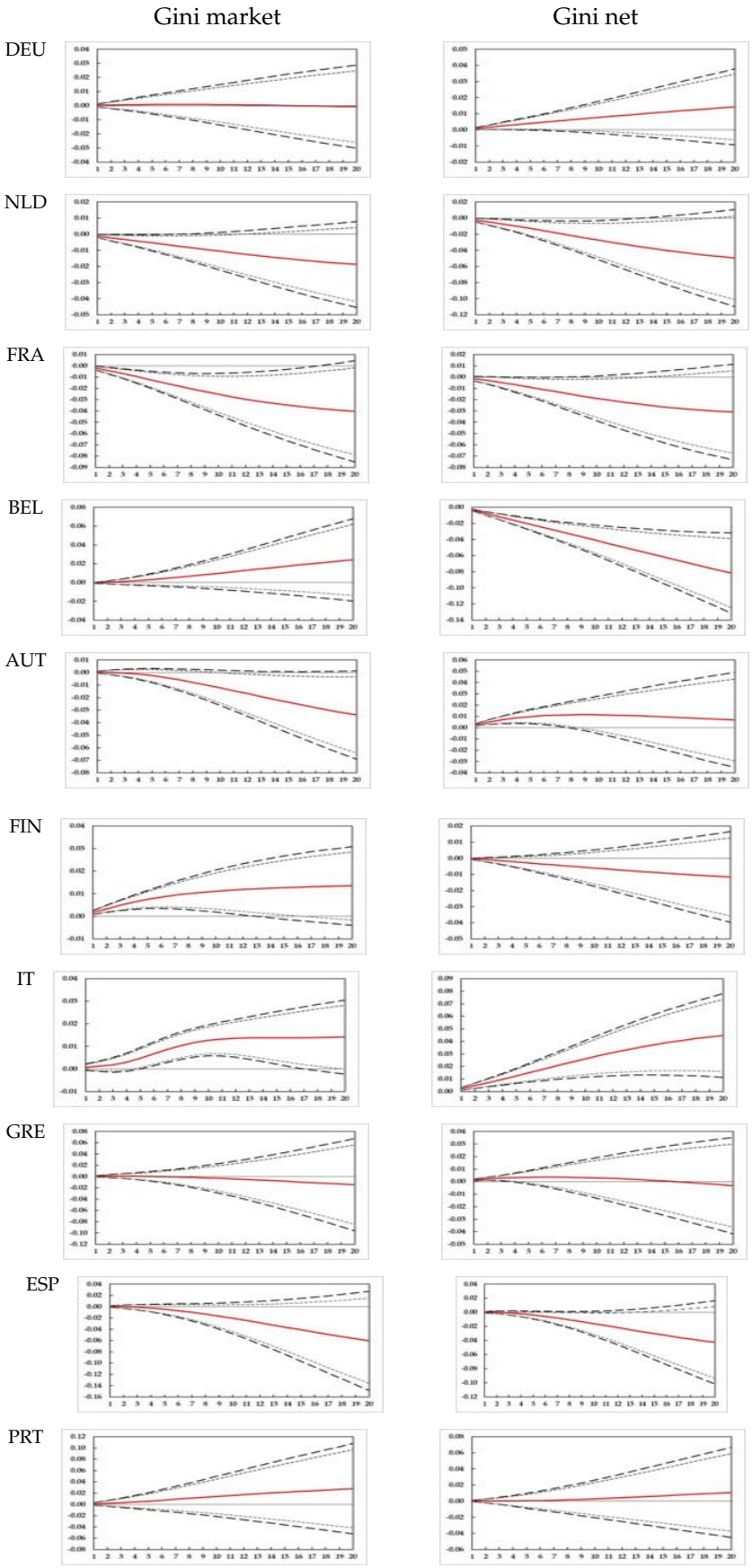
5.1 Direct effect of monetary policy shocks on income inequality

We estimate two VAR models for each country — with Gini market or Gini net as a measure of income inequality — and calculate cumulative impulse response functions. To evaluate a direct effect of an expansionary monetary policy shock on income inequality, we look at responses of inequality to one standard deviation decrease in the interest rate, EONIA (see Figure 4).

Figure 4 shows that a negative interest rate shock reduces gross income inequality in three core EMU countries (France, the Netherlands, Austria) and Spain, but

[11] The Kalman filter is estimated using the Matlab toolbox for state-space estimation of econometric models developed by Casals et al. (2016). The author thanks Anh Dinh Minh Nguyen for the code for the Kalman filter and the assistance with Matlab.

Figure 4: Responses of income inequality to an expansionary monetary policy shock



Notes: The figure plots cumulative impulse responses of income inequality measures to one st.dev. expansionary monetary policy shock. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Table 1: **Contribution of a monetary policy shock to the variance of Gini**

Income inequality	DEU	NLD	FRA	BEL	AUT	FIN	ITA	GRE	ESP	PRT
Average 1-10 quarter horizon										
Gini market	0.1	4.7	9.2	1.9	4.3	15.9	7.1	0.5	3.4	1.1
Gini net	4.0	6.2	4.3	33.4	8.3	2.1	33.6	1.7	5.1	0.1
Average 11-20 quarter horizon										
Gini market	0.1	6.4	13.5	4.9	13.6	12.9	7.4	0.9	8.8	1.6
Gini net	3.9	8.5	8.5	40.8	2.8	2.7	42.7	1.2	8.9	0.4

increases it in Finland and Italy. These responses are significant and persistent in a five-year horizon. In the remaining four countries market Gini does not respond to an expansionary policy shock. For net income inequality, the effects are more pronounced. A negative policy shock decreases net inequality in three core EMU economies (France, Belgium, the Netherlands) and Spain, raises net inequality in Germany, Austria, and Italy, but is insignificant in Finland, Greece, and Portugal. Thus, a direct interest rate effect is heterogenous across countries. In terms of magnitude, a change in income inequality in response to a monetary policy shock is small, varying between 0.3% and 2.5% of mean Gini at the five-year horizon (0.1-0.5% after one year). In addition, a negative interest rate shock has a stronger 'reducing' effect on inequality than 'increasing': decrease in income inequality amounts to 0.5-2.5%, while increase constitutes 0.3-1.3% of mean Gini at the five-year horizon.

Table 1 reports the contribution of a monetary policy shock to the forecast error variance of income inequality. The estimated contribution is small in most countries, below 10% of variance of Gini at 1-10 quarters horizon. Noteworthy, a monetary policy shock contributed to 13-16% of variance of Gini market in Finland, and to 33-43% of variance of Gini net in Italy and Belgium, at up to 20 quarters horizon. This suggests that while a variation in inequality in most of analyzed economies cannot be attributed to a monetary policy impact, an expansive policy shock contributed substantially to changes in net income inequality in Italy and Belgium.

5.2 Channels of monetary policy effects on income inequality

Given the heterogeneity of responses of inequality across countries to a monetary policy shock, in this subsection we look at macroeconomic and financial channels that could explain these effects. We examine cumulative impulse responses of GDP, bank credit, stock and house prices to a negative interest rate shock, and cumulative responses of income inequality to one standard deviation decrease in the 'channel' variables (see Figures A.1-A.10 in Appendix). In this way we can trace how expansionary monetary policy impacts inequality through macroeconomic and financial variables.

The macroeconomic channel is evident in four countries. An expansionary policy shock leads to higher GDP growth, which reduces income inequality in France and Finland, but increases inequality in Germany and Austria. Apart from Finland, the effect of macroeconomic channel is in line with a direct interest rate effect.

The bank credit channel turns out significant in most countries. In all cases a negative interest rate shock reduces growth in bank credit. This is opposite to the 'credit channel' literature arguing that expansionary monetary policy stimulates credit growth. Perhaps this is due to the global financial crisis years, when lower interest rates coincided with a credit crunch. We will account for this in a robustness check for a pre-crisis period. Lower credit growth has diverse effects on inequality — increases income inequality in Germany, Austria, Belgium, and Finland, but reduces inequality in the Netherlands, France, and Greece. The impact of credit growth on income distribution could depend on several factors, for instance how credit is being allocated and used in the economy and who benefits most from it.

An expansionary policy shock raises stock prices growth in four Southern European economies and Finland, which leads to an increase in gross income inequality in Italy and Greece, while reduces it in Spain, Portugal, and Finland. For Gini net, impulse responses are similar except for Finland where higher stock prices growth increases net income inequality, and Greece where the stock prices channel is not evident.

Lastly, we find evidence for the house prices channel in four countries. A negative interest rate shock boosts house prices growth in Spain, Portugal, and Germany,

which raises income inequality in Germany, but reduces inequality in Spain and Portugal. Noteworthy, the Netherlands experiences a decrease in house prices growth in response to a negative policy shock, which lowers market inequality. This result is puzzling as house prices are expected to grow after an interest rate cut. It could be due to the post 2007-crisis years, when house prices in the Netherlands were falling while monetary policy remained accommodative for most of the period.

In sum, this benchmark analysis suggests that monetary policy in the euro area has significant effects on income inequality, although they are heterogenous across countries. While an expansionary policy shock raises inequality in four economies, it reduces it in the other four, and is insignificant in remaining two. Channels of monetary policy impact are heterogenous as well and do not follow a clear pattern. To understand the results better, we consider some extensions and robustness checks.

5.3 Extension: additional channels

We continue the analysis by examining two additional channels through which monetary policy can affect inequality: GDP components and fiscal redistribution.

In previous subsection, we found that the macroeconomic channel is insignificant in six countries, while heterogenous in remaining four. As an extension, we examine GDP components as additional macroeconomic channels which could have a more direct and visible effect on income distribution. In a VAR model we include the following variables, one by one, ordered after GDP:[12] consumption, investment, household consumption, and wages, all in real terms.[13]

The impulse responses for GDP components are mostly insignificant, except for Spain and Belgium (available on request).In Spain an expansionary policy shock reduces income inequality (gross and net) through higher investment growth. Consistent with the literature, accommodative monetary policy alleviates inequality by lowering

[12] Alternative ordering (GDP components before GDP) did not affect the outcomes.

[13] Additionally, we included two components of household consumption, i.e. consumption of durables and consumption of non-durables and other goods. Consumption of durables can influence productive investment and is more sensitive to interest rate changes (Sterk and Tenreyro, 2015), which makes it a potential distributional channel of monetary policy. The results for these consumption categories were insignificant for all countries (available one request).

costs of capital and stimulating investment, which leads to higher output and employment. This is evident in Spain, where low and middle-income households rely on labor as their main income source. For Belgium we find that a negative policy shock lowers real wage growth, which increases both inequality measures. The growth of nominal wages was below HICP inflation in Belgium during 2008–2010, which explains why a lower interest rate led to a lower real wage growth.

Given that EMU members do not implement independent monetary policies, they cannot use them as a national stabilization tool. In these circumstances, there is room for national fiscal policy, which is heterogenous across states and can be used to address asymmetric macroeconomic shocks (Calmfors, 2003; Canova and Pappa, 2007). Fiscal policy can also redistribute income through social transfers and taxes (Bastagli et al., 2012; Heshmati and Kim, 2014). Thus, the effect of monetary policy on disposable income inequality could be supported by fiscal redistribution — euro area countries adjust their fiscal policies in response to ECB monetary policy decisions, to address income disparities. To examine the channel of fiscal redistribution, we include fiscal expenditures/revenues in a VAR model. They are ordered after the interest rate: we assume that countries first observe a monetary policy shock, and then respond with fiscal instruments. We examine fiscal expenditures separately from revenues, as they have different impacts on inequality (Heshmati and Kim, 2014; Hills et al., 2014).

The effect of fiscal redistribution is significant in four countries (see Figure A.11 in Appendix). An expansive monetary policy shock leads to higher fiscal revenues in Spain, which lowers net income inequality. Meanwhile, fiscal revenues drop in Italy, which increases inequality. A negative interest rate shock leads to a reduction in fiscal expenditures in Finland, resulting in higher net income inequality (due to lower social transfers). The opposite is observed in Austria — fiscal expenditures rise in response to an expansionary monetary shock, which increases net inequality. These findings suggest that fiscal redistribution in some euro area countries complements monetary policy in influencing income distribution.

5.4 Robustness analysis

Several sensitivity checks are conducted to probe the robustness of our results. To preserve space, most of impulse responses are available on request.

First, we test how sensitive are the results to the ordering of variables in VAR. For that we calculate generalized IRFs, which do not depend on the ordering. The outcomes are comparable to the benchmark ones. Additionally, in Belgium a negative interest rate shock increases Gini net through higher GDP growth.

Next, we experimented with alternative orderings of financial variables. We re-estimated VAR models while ordering credit, stock prices, and house prices before the interest rate as well as ordering financial variables after the interest rate in different combinations. The impulse responses from these models are mostly in line with our baseline model. In addition, when financial variables are ordered before the interest rate, an expansionary policy shock raises income inequality in Austria (via higher stock prices growth) and Belgium (via higher GDP growth).

This paper analyzes the impact of conventional monetary policy on income inequality. Since the sample period ends before the introduction of quantitative easing in the euro area, we cannot analyze its distributional effects. It would be an interesting extension for future research. Nevertheless, from the onset of the global financial crisis the ECB implemented several non-standard monetary policy measures, which might not be properly reflected in the overnight interest rate. As a robustness check, to proxy for monetary policy stance at the zero lower bound and capture unconventional monetary policy, we use a shadow rate estimated for the euro area by Wu and Xia (2016). The results are similar to the main ones in six countries. In Portugal, a negative shadow rate shock increases income inequality, although house price channel becomes insignificant. For Spain, the interest rate effect as well as credit and house price channels disappear. Additionally, an expansionary policy shock raises market Gini in Austria through higher house prices growth. Finally, in Finland a lower shadow rate raises gross inequality via higher GDP growth, while house price channel is insignificant.

Next, we use an alternative proxy for net income inequality, based on the 90/10

percentile ratio of income distribution from the EU-SILC database. It is more variable than Gini and measures dispersion between high- and low-income households. The impulse responses using this proxy differ from the results for Gini net. Opposite to the earlier findings, a negative interest rate shock reduces 90/10 income inequality in Germany, raises it in Greece and France, and is insignificant in the Netherlands, Spain, Portugal, and Austria (see Figure A.12 in Appendix).[14] In the remaining four countries the effect is the same as for Gini net. The GDP channel is qualitatively similar. The credit channel is different in four countries: an expansionary policy shock lowers credit growth which worsens 90/10 inequality in Greece, France, and Portugal, but reduces it in Belgium. The stock and house prices channels remain significant in Spain (similar as for Gini net), and Finland (higher house price growth raises inequality). These differences in results could be due to differences in measurement of inequality and data sources. Importantly, the credit channel has a stronger, while asset prices – a weaker, impact on inequality between 90th and 10th percentiles of disposable income distribution than is the case for Gini net.

Since the ECB conducts monetary policy for all euro area countries, it is expected to react to the euro area-wide macroeconomic indicators, rather than address each each country's output and inflation. To account for this, we add in a VAR model EMU-level GDP and HICP, ordered before country-level GDP and HICP. The benchmark results were not sensitive to this modification.

Finally, we consider the pre-crisis period — behavior of the analyzed time series could have changed during and after the crisis, with implications for the monetary policy impact on inequality. We re-estimate the benchmark model for the period 1999Q1–2007Q3 and report cumulative impulse responses in Figures A.13-A.22 in Appendix.

The findings for the pre-crisis period differ somewhat from the full sample. A direct effect of an expansionary policy shock is similar in most countries, but becomes insignificant in Germany and the Netherlands, while increases gross and net income inequality in Finland. The macroeconomic channel is similar in France and Austria,

[14]The impulse responses for channels are available on request.

while insignificant in Finland. The credit channel became insignificant in most countries. Similarly as in the full sample, a negative interest rate shock before the crisis reduces credit growth; this lowers income inequality in France, Portugal, and Italy. The stock price channel is comparable to the main analysis. Additionally, an expansionary policy shock lowers income inequality in the Netherlands through higher stock prices growth. The house price channel became insignificant in Portugal and the Netherlands. Also, in the pre-crisis period a negative interest rate shock increased house price growth which raised income inequality in Germany and Austria, while reduced market inequality in Spain, France, Belgium, and Finland. As for fiscal redistribution, an expansionary monetary policy shock is followed by an accommodative fiscal response, which increased net income inequality in Finland and Italy (through lower revenues) but reduced it in Greece (through higher expenditures).

6 Discussion

This section discusses the results, summarized in Table 2. We support them with some statistics for real estate ownership and equity holdings of households, based on the first wave (2013) of Household Finance and Consumption Survey (HFCS), (see Table A.2).

In our sample of 10 EMU countries, five experienced a decrease in income inequality (gross, net or both) due to accommodative monetary policy, while four saw an increase of inequality. Based on this evidence, we conclude that distributional effects of loose monetary policy in the euro area are heterogenous, although the dominating impact seems to be inequality-reducing. Differences in the effects across countries could be explained by different channels. In all countries, an expansionary monetary policy shock leads to higher GDP and asset prices growth, but lower bank credit growth, even before the crisis. This has implications for income inequality.

Loose monetary policy increases net income inequality in Germany through a lower interest rate, as well as through higher GDP and house prices growth, and lower credit growth. The macroeconomic channel implies that higher output growth benefits high-income households more, without necessarily contributing to employment and wages

of low- and middle-income groups. Note that the GDP channel is insignificant in the pre-crisis period. The significant relation in the full sample could be because the acceleration of GDP growth in Germany in recent years coincided with an increase in income inequality, as Figure 2 shows. The credit channel is in line with our expectations: lower credit growth hinders investment and production, resulting in lower employment and wages and larger income disparities. The house price channel can be explained by low home and other real estate ownership in Germany, with mainly rich households at the top 20% of income distribution owning a property and benefiting from house prices growth (Adam and Tzamourani, 2016).

In the Netherlands, expansionary monetary policy lowers income inequality directly and through lower credit and house prices growth and, in pre-crisis, also via higher stock prices growth. Denk and Cazenave-Lacroutz (2015) argue that larger credit may fuel income inequality by providing high-income households with better investment opportunities, compared to low- and middle-income ones. This could explain how lower credit growth reduces inequality in the Netherlands. Based on the HFCS data, home ownership rate is high among Dutch households at the top 20% of income distribution, but low among the bottom 20%. Thus, slower house prices growth lowers rental incomes for rich, which can reduce income disparities. The inequality-decreasing effect of stock prices growth is puzzling, as equity holdings in the Netherlands are concentrated mainly among high-income households.

For France, the effect of expansionary monetary policy is inequality-reducing via lower interest rate, higher GDP growth, lower credit growth, and before crisis, also via higher house prices growth. The credit channel is similar as in the Netherlands and occurs when credit expansion benefits the rich. In France, real estate ownership is relatively low, with 55% of households owning home and 25% – other real estate property. However, more than half of medium-income households are homeowners, which could explain the inequality-reducing impact of house prices before the crisis.

Similar as in France, a higher house prices growth in Belgium (due to a negative policy shock) reducing income inequality in the pre-crisis years. This is explained by

Table 2: **Summary of results: impact of an expansionary monetary policy shock on income inequality**

Country	Interest rate effect	Macroeconomic channel	Credit channel	Stock price channel	House price channel	Fiscal channel
Germany	no effect on Gini mkt, ↑ Gini net	↑ GDP growth ↑ Gini	↓ credit growth ↑ Gini	no effect	↑ HP growth ↑ Gini	no effect
Netherlands	↓ Gini mkt, Gini net	no effect	↓ credit growth ↓ Gini	no effect	↓ HP growth ↓ Gini mkt	no effect
France	↓ Gini mkt, Gini net	↑ GDP growth ↓ Gini	↓ credit growth ↓ Gini	no effect	no effect	no effect
Belgium	no effect on Gini mkt, ↓ Gini net	↑ GDP growth, ↓ wage growth ↑ Gini	↓ credit growth ↑ Gini	no effect	no effect	no effect
Austria	↓ Gini mkt, ↑ Gini net	↑ GDP growth ↑ Gini	↓ credit growth ↑ Gini	↑ SP growth ↑ Gini	no effect	↑ expenditures ↑ Gini net
Finland	↑ Gini mkt, no effect on Gini net	↑ GDP growth ↓ Gini net	↓ credit growth ↑ Gini	↑ SP growth ↓ Gini mkt, ↑ Gini net	no effect	↓ expenditures ↑ Gini net
Italy	↑ Gini mkt, Gini net	no effect	no effect	↑ SP growth ↑ Gini	no effect	↓ revenues ↑ Gini net
Greece	no effect	no effect	↓ credit growth ↓ Gini	↑ SP growth ↑ Gini mkt	no effect	no effect
Spain	↓ Gini mkt, Gini net	↑ I growth ↓ Gini	no effect	↑ SP growth ↓ Gini	↑ HP growth ↓ Gini	↑ revenues ↓ Gini net
Portugal	no effect	no effect	no effect	↑ SP growth ↓ Gini	↑ HP growth ↓ Gini	no effect
Pre-crisis period, 1999Q1–2007Q3						
Germany	no effect	no effect	no effect	no effect	↑ HP growth ↑ Gini	no effect
Netherlands	no effect	no effect	no effect	↑ SP growth ↓ Gini	no effect	no effect
France	↓ Gini mkt, Gini net	↑ GDP growth ↓ Gini net	↓ credit growth ↓ Gini	no effect	↑ HP growth ↓ Gini mkt	no effect
Belgium	no effect on Gini mkt, ↓ Gini net	no effect	no effect	no effect	↑ HP growth ↓ Gini mkt	no effect
Austria	no effect on Gini mkt, ↑ Gini net	↑ GDP, wage growth ↑ Gini	no effect	no effect	↑ HP growth ↑ Gini	no effect
Finland	↑ Gini mkt, Gini net	no effect	no effect	↑ SP growth ↓ Gini mkt, ↑ Gini net	↑ HP growth ↓ Gini mkt	↓ revenues ↑ Gini net
Italy	↑ Gini mkt, Gini net	no effect	↓ credit growth ↓ Gini mkt	↑ SP growth ↑ Gini mkt	no effect	↓ revenues ↑ Gini net
Greece	no effect	no effect	no effect	↑ SP growth ↑ Gini	no effect	↑ expenditures ↓ Gini net
Spain	↓ Gini mkt, Gini net	↑ I growth ↓ Gini	no effect	↑ SP growth ↓ Gini	↑ HP growth ↓ Gini	no effect
Portugal	no effect	no effect	↓ credit growth ↓ Gini	↑ SP growth ↓ Gini net	no effect	no effect

high home ownership across all income groups. Additionally, a lower interest rate reduces net Gini while has no effect on market Gini. Other channels are not in line with the interest rate effect – higher GDP growth, lower wage and credit growth worsen inequality. However, these channels become insignificant in the pre-crisis period. Overall, the inequality-reducing impact of expansionary monetary policy dominates.

Expansionary monetary policy reduces market income inequality but raises net inequality in Austria. The latter effect goes through higher output and stock prices growth and lower credit growth. In the pre-crisis period, credit and stock prices effects disappear, while higher wage and house prices growth worsen inequality. Thus, the predominant impact of loose monetary policy is inequality-increasing. Capital gains from asset prices growth are distributed unevenly in Austria, with mostly high-income households owning shares and property. Moreover, economic growth is less beneficial for poor households than rich ones. We also find evidence for fiscal redistribution in response to loose monetary policy – a lower interest rate leads to higher fiscal expenditures, which raises net income inequality. This could occur if public spending benefits mainly upper-income households.[15].

The direct effect of loose monetary policy in Finland is inequality-increasing, however we can disentangle two directions of impact based on channels. A negative policy shock raises inequality via lower credit and higher stock prices growth for Gini net, while reduces inequality via higher GDP and stock prices growth (for Gini market), and higher house prices growth before the crisis. The house price effect is similar to Belgium and France – real estate ownership is high, with gains from property distributed more evenly among income groups. The ownership of equity in Finland is the highest in the euro area (22% of households), with holdings distributed among a broad range of households; hence, stock prices growth benefits a larger share of population, reducing market inequality. The opposite effect for net inequality is probably due to high taxation of capital gains. Also, loose monetary policy is complimented by fiscal tightening through lower expenditures. This implies less social transfers to the poor,

[15]For instance, Clements (1997) argues that government spending on university education exacerbates income inequality in Brazil.

which exacerbates income inequality. Fiscal redistribution is particularly relevant for Finland where expenditures on social protection are among the highest in the EU and accounted to 28% GDP during 2004-2013 (based on Eurostat data).

Income inequality increases in Italy due to expansionary monetary policy via lower interest rate and higher stock prices growth. The equity holdings are concentrated among rich households who benefit mostly from stock prices increase. In the pre-crisis period, a negative policy shock lowers credit growth which reduces market Gini. Thus, credit expansion benefits high-earners similarly as described for other countries. Fiscal revenues decrease in response to loose monetary policy. This accommodative fiscal policy raises net income inequality due to lower taxation of the rich.

For Greece, the effect of expansionary monetary policy shock on inequality is insignificant, while the total impact through channels is ambiguous. This shock increases income inequality through higher stock prices growth, but lowers it through lower credit growth. Equity is held by 2.7% of households, mostly at the top 20% of income distribution. In the pre-crisis period, fiscal policy through higher expenditures (as a response to monetary loosening) alleviates net income inequality. Expenditures on social protection in Greece are high (24% GDP over 2004-2013 based on Eurostat data) and thus have important distributional implications.

In the remaining two Southern European countries expansionary monetary policy reduces income inequality directly and/or through channels. This happens via higher stock and house prices growth. Home and other real estate ownership is high in Spain and Portugal, with over 70% of low- and medium-income households owning a property and benefiting from high house prices. The stock prices effect is unclear, given that equity holdings are low and concentrated among high-income households. Additionally, higher investment growth reduces inequality in Spain, while lower credit growth lowers it in Portugal. Fiscal redistribution matters in Spain as restrictive fiscal policy through higher revenues lowers inequality. This is perhaps due to progressive taxation that reduces income disparities (Bastagli et al., 2012).

7 Conclusion

Distributional effects of monetary policy are not yet well understood, especially in the euro area. This paper contributes to the literature by investigating the impact of expansionary monetary policy on income inequality in 10 EMU countries during the period 1999–2013. We distinguish and analyze macroeconomic and financial (credit and asset prices) channels through which monetary policy shocks are transmitted to the real economy and income distribution. We deal with a mixed frequency data problem by applying a two-step VAR estimation procedure with a Kalman filter.

We find that monetary policy has a significant impact on income inequality, with heterogenous effects across countries and transmission channels. While loose monetary policy reduces income inequality in three core EMU economies (France, Belgium, the Netherlands) and two Southern European ones (Spain, Portugal), it exacerbates inequality in Germany, Austria, Finland, and Italy, and has no impact in Greece. These effects are persistent in a five-year horizon, but rather negligible in magnitude, accounting for 0.3-2.5% change in Gini.

The impact of channels is conditional on countries' economic and financial characteristics. The credit channel is the most evident one: an expansionary policy shock lowers credit growth. This can reduce income inequality when credit is allocated towards productive sectors that create jobs and wages for low- and middle-income households, but could worsen inequality if credit is used to boost profits of high-income earners. Asset prices play an important role, too. Loose monetary policy can reduce income inequality by boosting house and stock prices growth in countries where property ownership and equity holding is relatively high and distributed more evenly among the population, while it amplifies inequality when real estate and financial assets are concentrated among rich households. Moreover, monetary policy influences income inequality by stimulating GDP growth; the direction of its effect, as for credit, depends on who contributes more in different phases of the business cycle. We also find evidence for fiscal redistribution that impacts inequality and compliments monetary policy. The effects depend on the instrument used: fiscal revenues through progressive

taxes can reduce income inequality in highly unequal societies (e.g., Spain and Italy), while fiscal expenditures could lower inequality in countries with extensive social protection (e.g., Finland and Greece).

This research offers new insights into our understanding of factors driving income inequality. It suggests that monetary policy might have distributional effects in the euro area, although their size is negligible and direction – heterogenous. Given that the channels of distributional impact are also heterogenous across countries, future research could focus on a more in-depth examination of income and assets composition of households as a key to explaining changes in income inequality.

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Appendix

Table A.1: **Data description and sources**

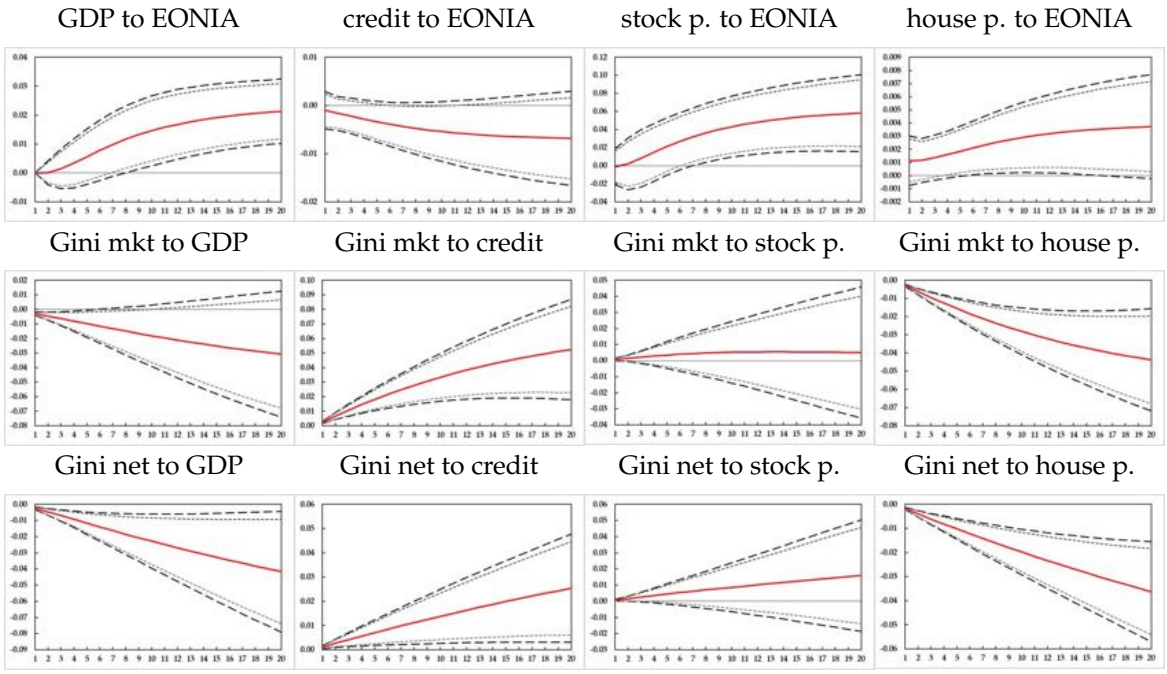
Variable	Description	Data sources
Real GDP	seasonally and calendar adj., chain linked volumes (2010), mln euro	Eurostat
Real GDP_{EMU}	seasonally and calendar adj., chain linked volumes (2010), mln euro; adjusted to EMU composition	Eurostat
Real consumption	final consumption expenditures; seasonally and calendar adj., chain linked volumes (2010), mln euro	Eurostat
Real households consumption	final consumption expenditures of households; seasonally and calendar adj., chain linked volumes (2010), mln euro	Eurostat
Real investment	gross fixed capital formation; seasonally and calendar adj., chain linked volumes (2010), mln euro	Eurostat
Real wage	seasonally adj., current prices, mln euro; deflated by HICP	OECD.Stat
HICP	HICP (2005=100)	Eurostat
$HICP_{EMU}$	$HICP_{EMU}$ (2005=100), adjusted to EMU composition	Eurostat
Interest rate	EONIA; shadow rate (1999Q1–2004Q2 use EONIA, 2004Q3–2013Q4 use shadow rate)	Datastream, Wu and Xia (2016)
Bank credit	Total bank credit to private sector, in mln euro	central banks' statistics
Stock price index	Share prices index 2010=100	OECD.Stat
House price index	Residential property prices, long series, 1995=100 (DE,NL,ES,BE,FI,FR,IT); regular series (GR,AT,PT)	BIS
Income inequality	Gini coefficient of market income, Gini of net income; 90/10 percentile ratio of income distribution	Solt (2016), EU-SILC
Fiscal policy	Fiscal expenditures/revenues as ratio to GDP	Eurostat

Table A.2: **Real estate ownership and equity holdings, % of households, 2013**

	DEU	NLD	FRA	BEL	AUT	FIN	ITA	GRE	ESP	PRT
Household main residence, all hhs	44.2	57.1	55.3	69.6	47.7	69.2	68.7	72.4	82.7	76.0
Bottom 20% of income distrib.	16.3	40.7	30.3	45.0	27.1	42.1	54.3	64.5	78.0	67.3
40-60% of income distrib.	43.2	53.5	53.1	71.9	47.8	69.6	67.4	72.0	82.4	76.8
Top 20% of income distrib.	72.2	77.3	79.8	89.0	69.5	92.2	82.8	82.7	89.3	86.8
Other real estate property, all hhs	17.8	6.1	24.7	16.4	13.4	30.0	24.9	37.9	36.2	29.1
Equity holdings (shares), all hhs	10.6	10.4	14.7	14.7	5.3	22.2	4.6	2.7	10.4	5.4
Bottom 20% of income distrib.	2.4	5.3	2.7	3.0	1.6	8.2	0.3	0.5	3.7	0.8
40-60% of income distrib.	8.2	9.7	11.0	14.0	4.4	20.4	3.2	2.0	6.5	2.9
Top 20% of income distrib.	25.4	16.1	36.3	28.3	11.2	43.9	13.4	7.6	26.0	18.4

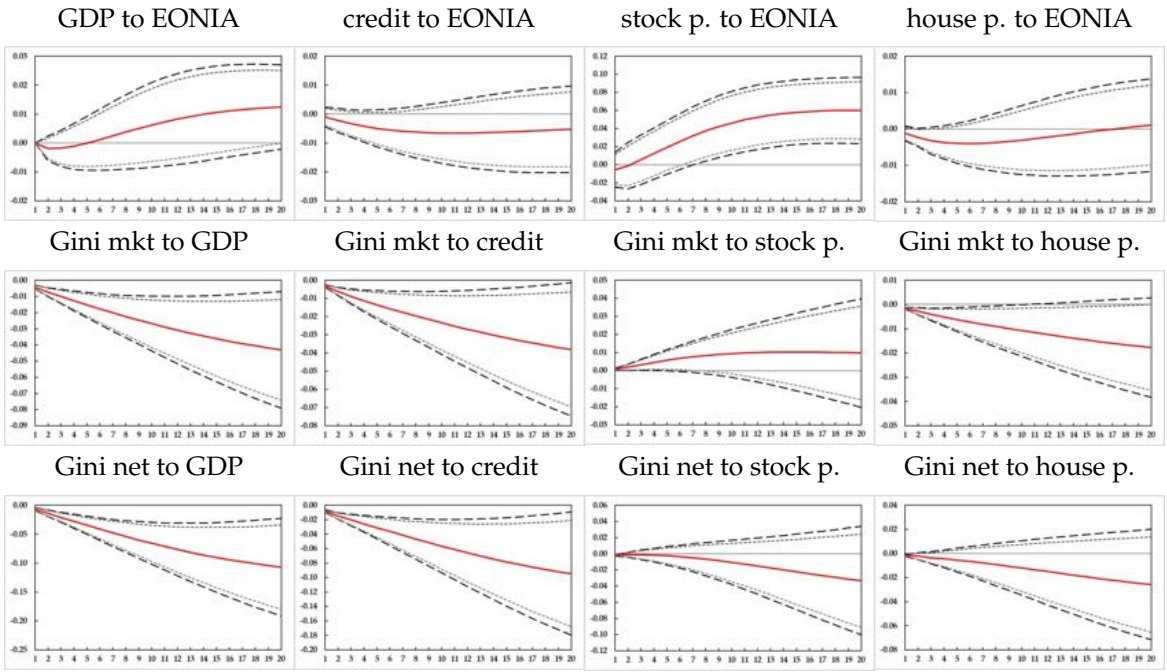
Source: HFCS, wave 1, different tables.

Figure A.1: Channels from a monetary policy shock to income inequality: Germany



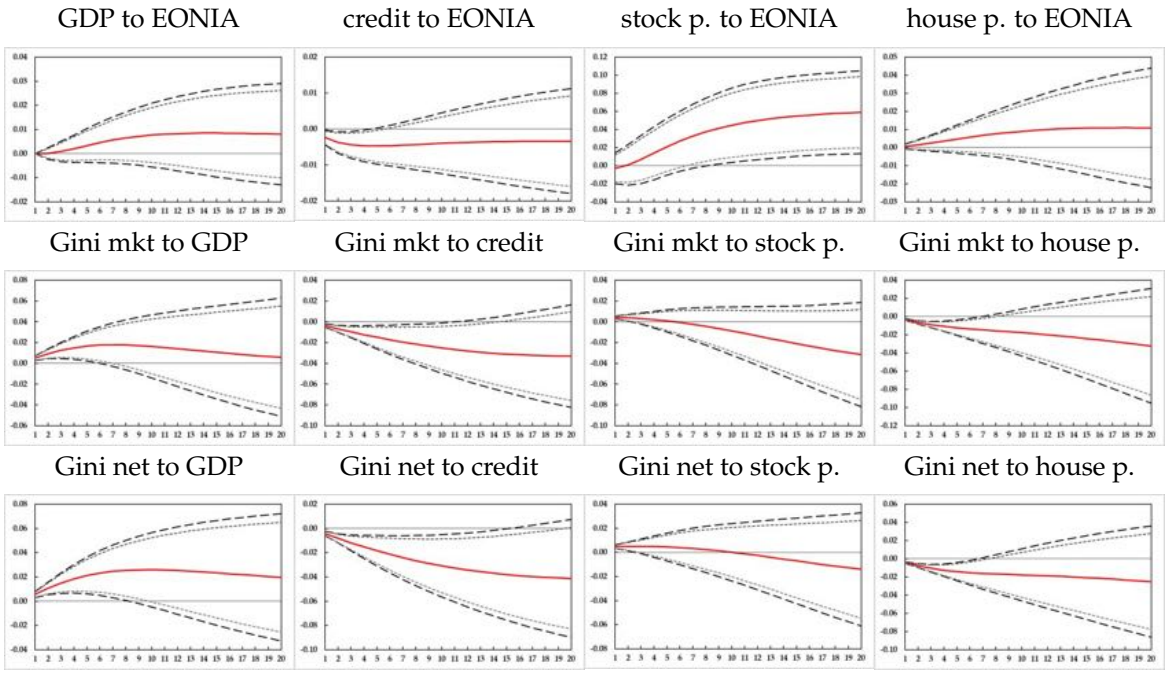
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.2: Channels from a monetary policy shock to income inequality: Netherlands



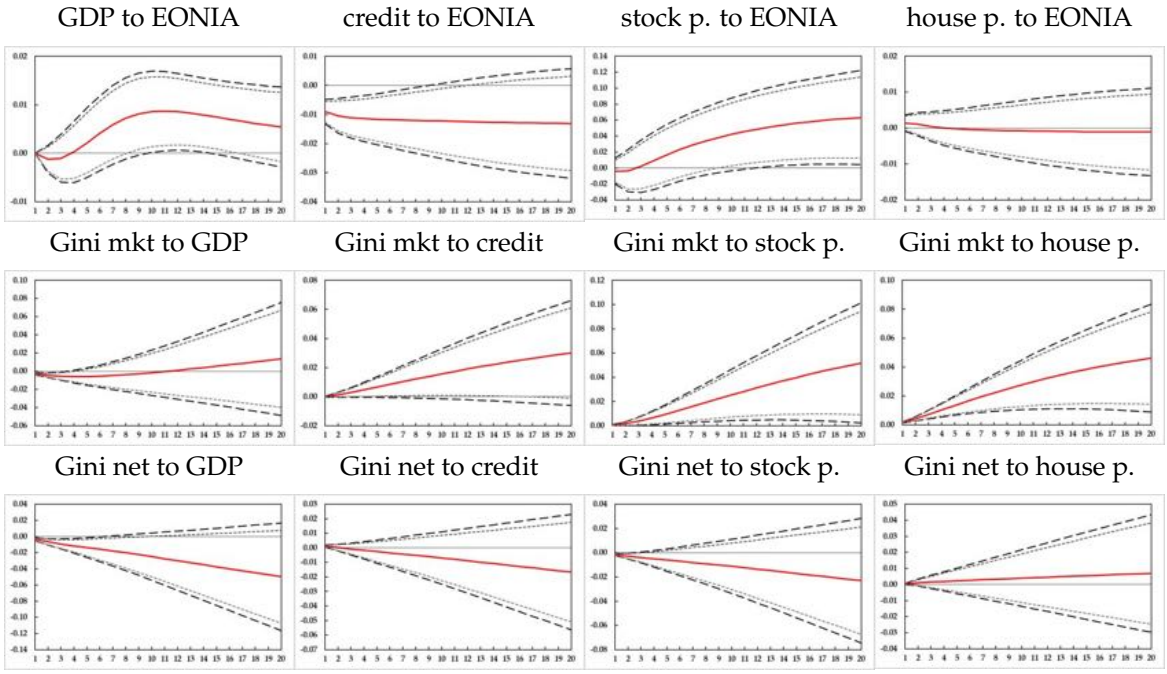
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.3: Channels from a monetary policy shock to income inequality: France



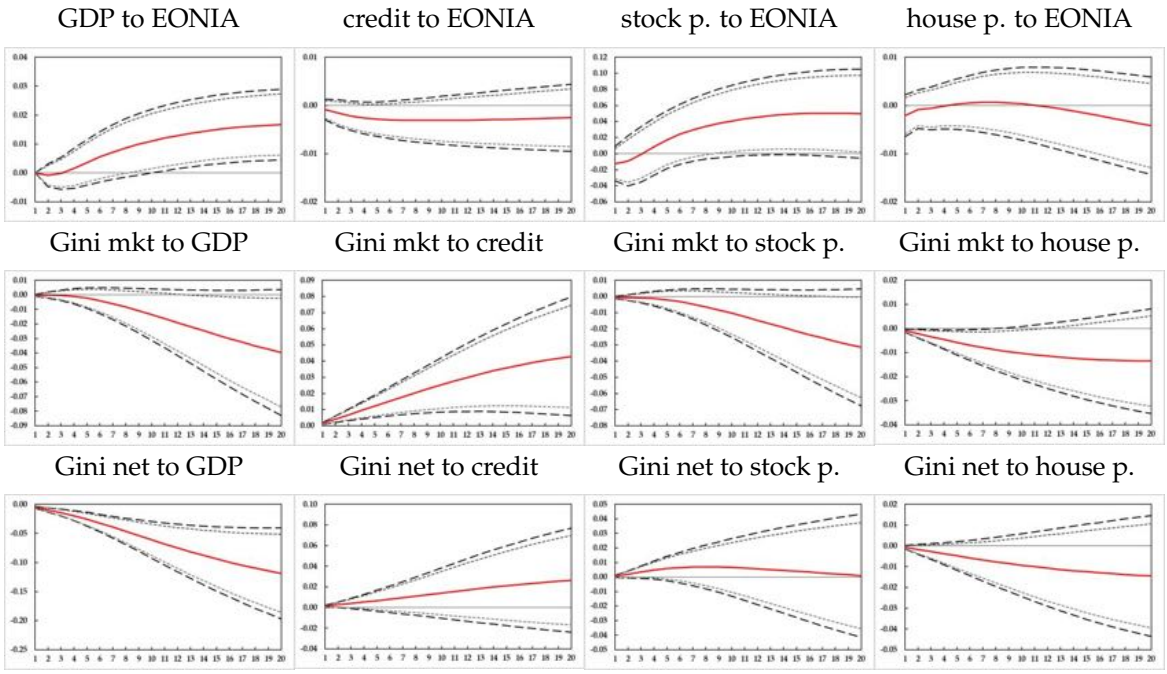
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.4: Channels from a monetary policy shock to income inequality: Belgium



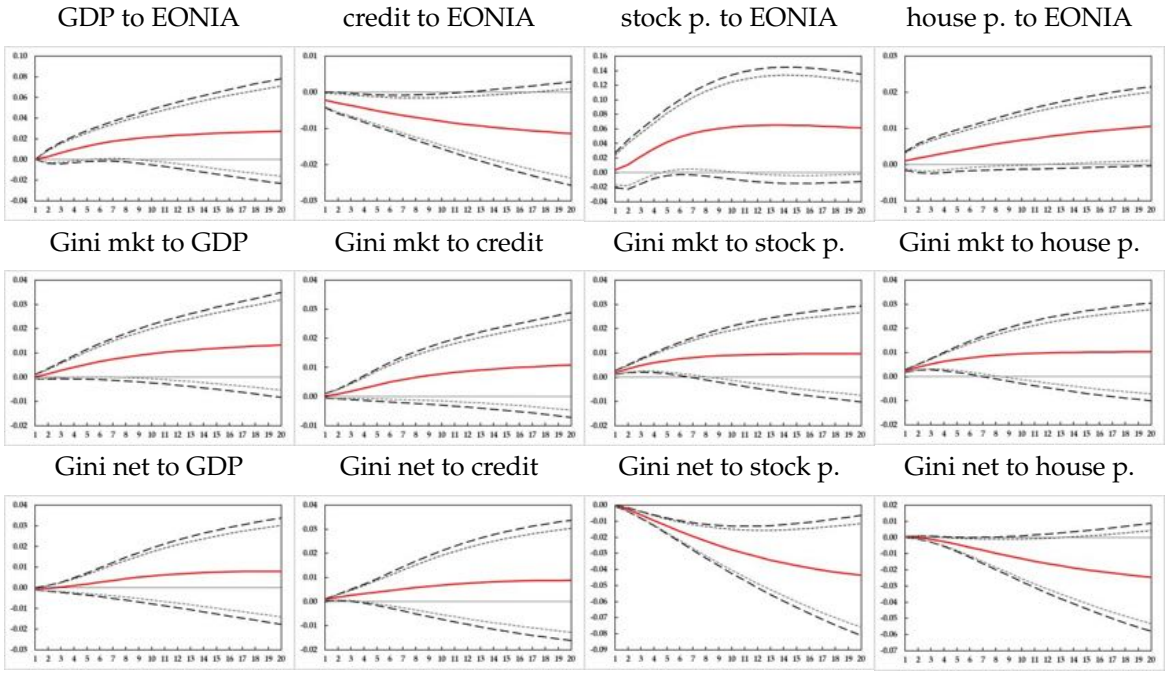
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.5: Channels from a monetary policy shock to income inequality: Austria



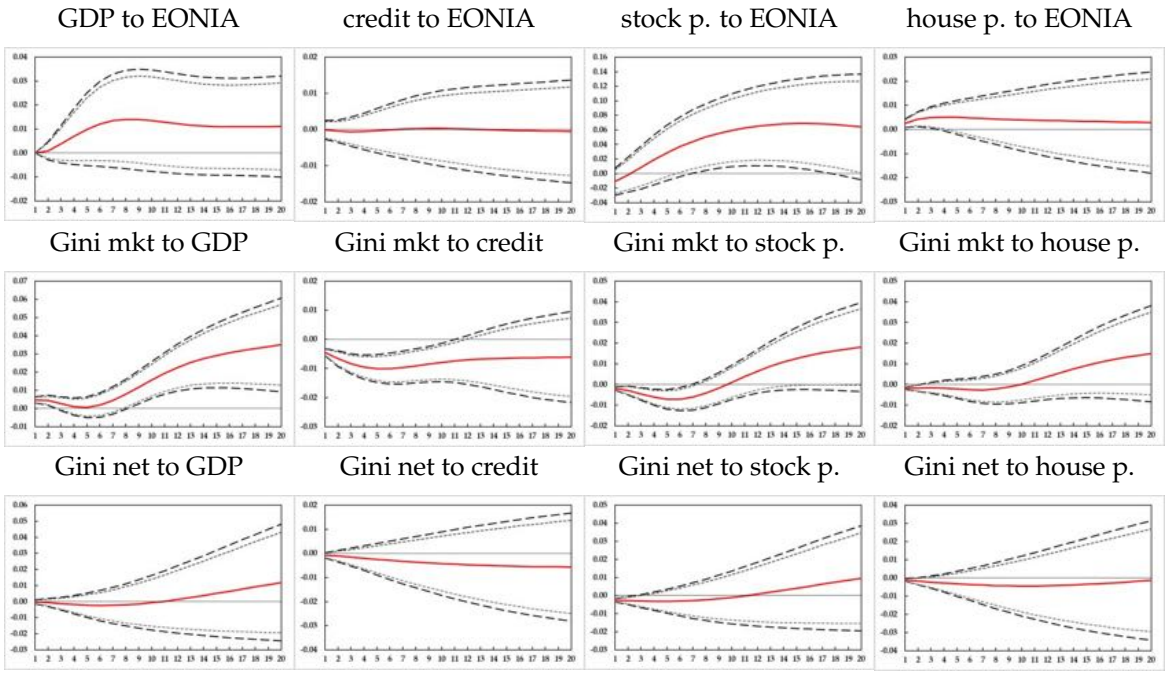
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.6: Channels from a monetary policy shock to income inequality: Finland



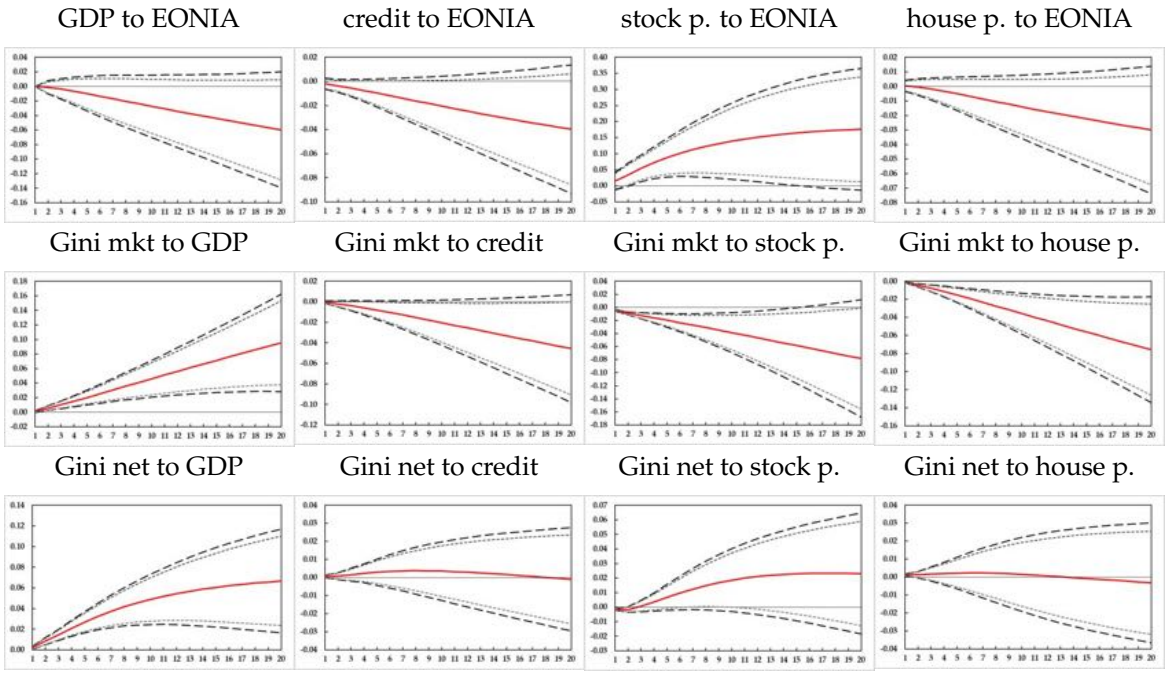
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.7: Channels from a monetary policy shock to income inequality: Italy



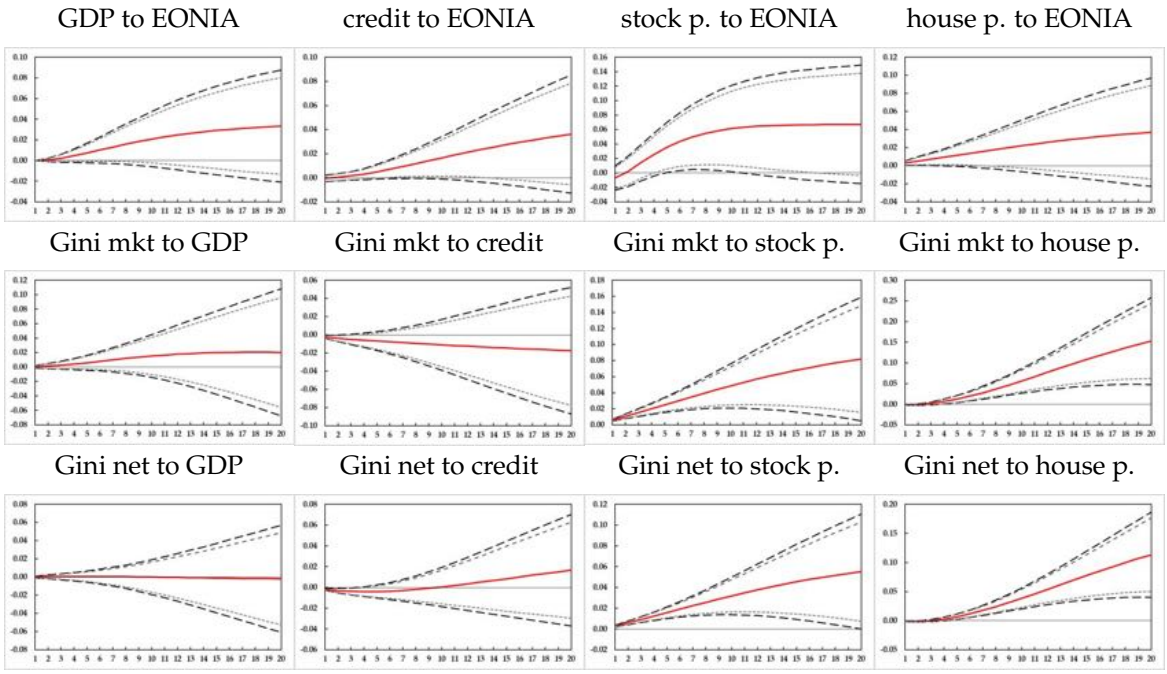
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.8: Channels from a monetary policy shock to income inequality: Greece



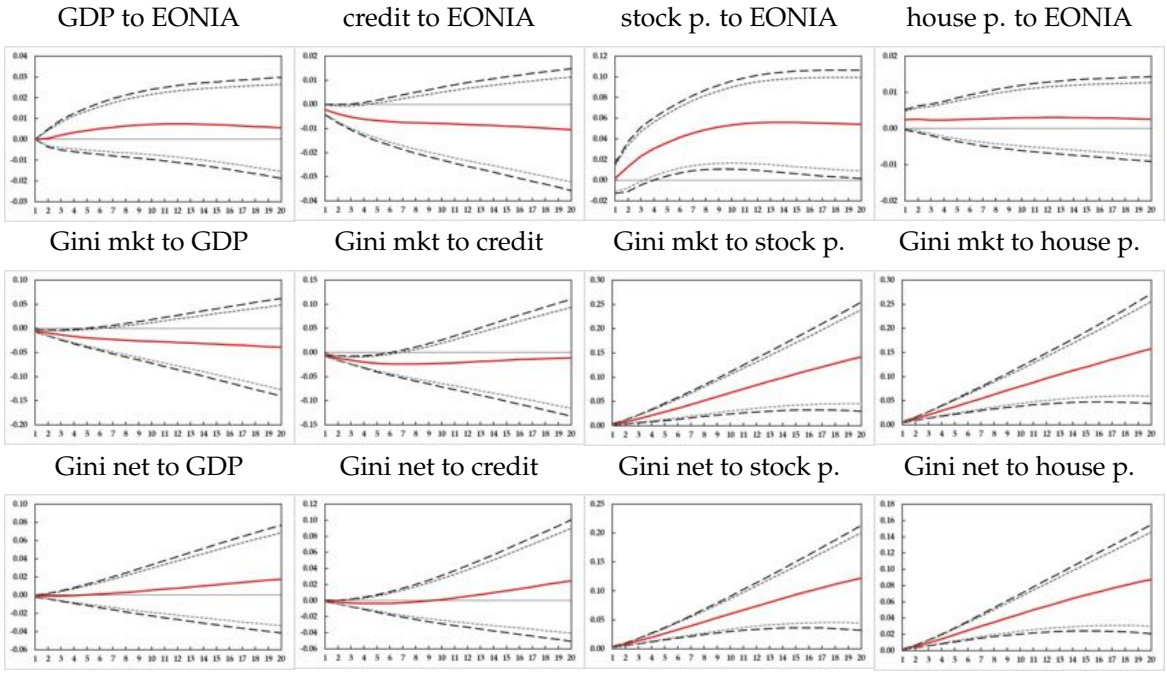
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.9: Channels from a monetary policy shock to income inequality: Spain



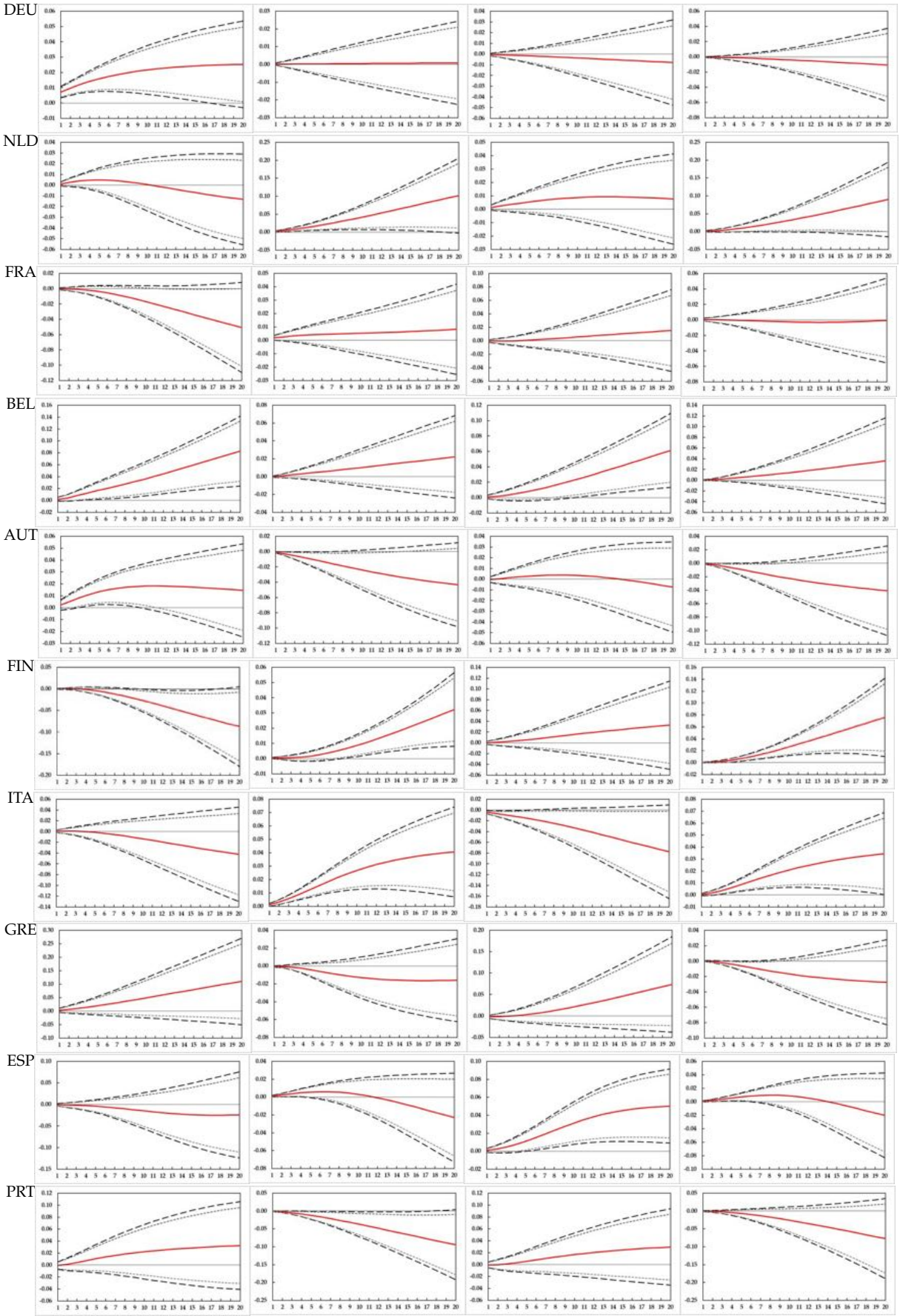
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.10: Channels from a monetary policy shock to income inequality: Portugal



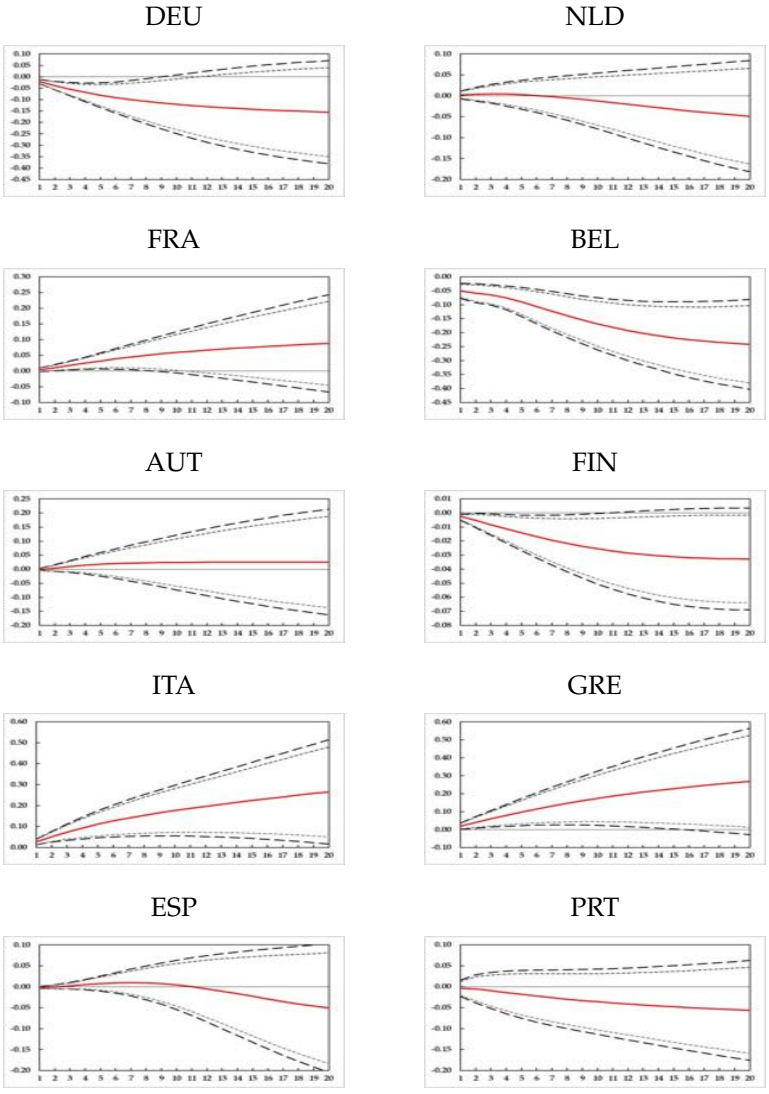
Notes: The figure plots cumulative impulse responses of GDP and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.11: Impact of fiscal policy on net income inequality



Notes: The figure plots cumulative impulse responses of fiscal expenditures and revenues to one st.dev. expansionary monetary policy shock; and responses of Gini net to one st.dev. decrease in fiscal variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.12: Responses of 90/10 percentile ratio of net income distribution to an expansionary monetary policy shock



Notes: The figure plots cumulative impulse responses of 90/10 percentile ratio of disposable income distribution to one st.dev. expansionary monetary policy shock. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.13: Impact of monetary policy on inequality, 1999Q1–2007Q3: Germany

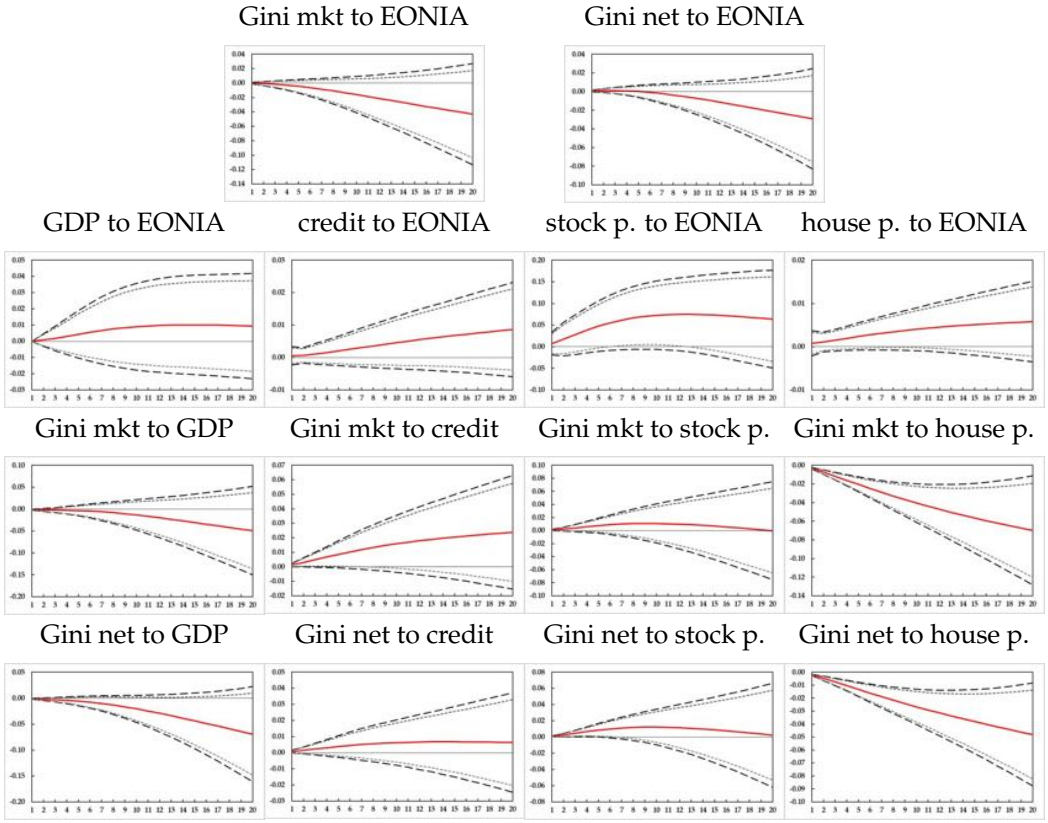
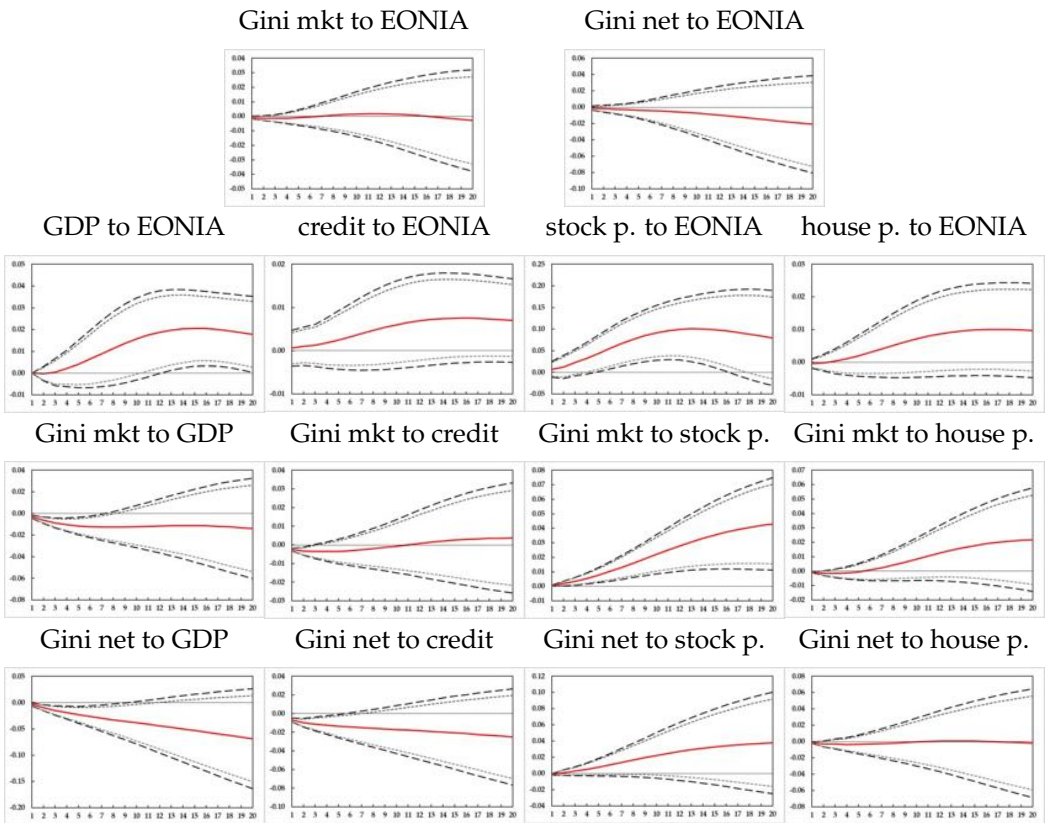


Figure A.14: Impact of monetary policy on inequality, 1999Q1–2007Q3: Netherlands



Notes: The figures plot cumulative impulse responses of inequality, GDP, and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.15: Impact of monetary policy on inequality, 1999Q1–2007Q3: France

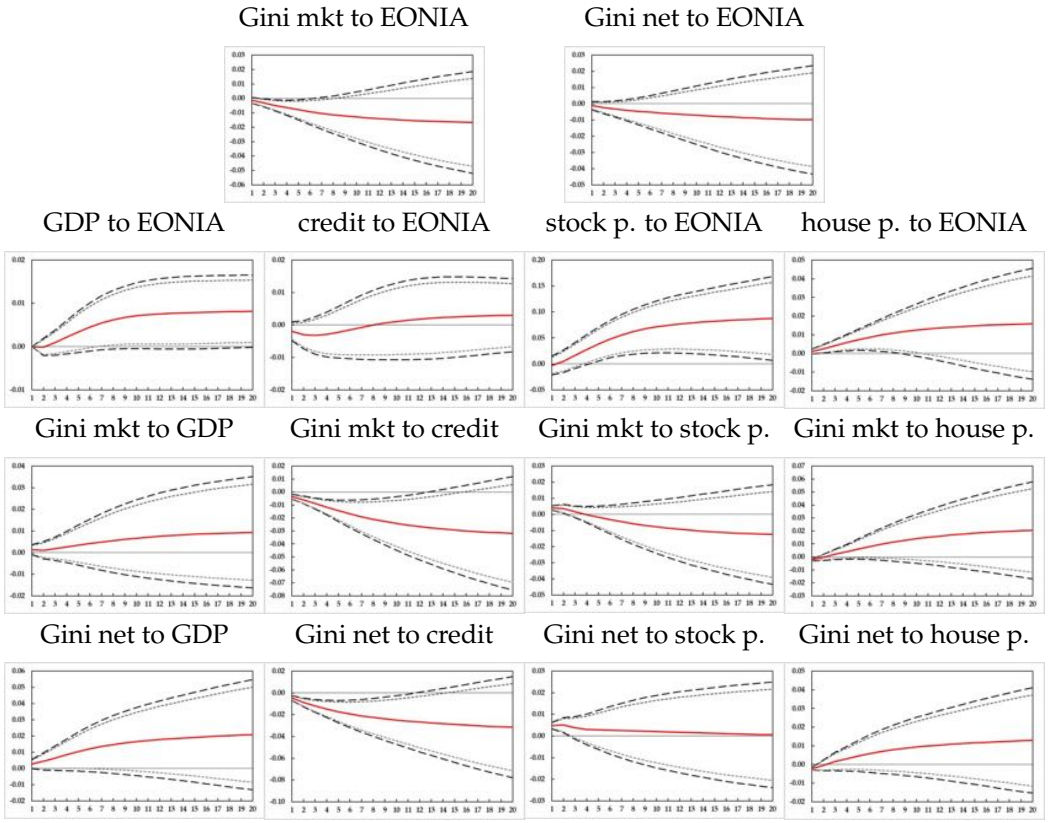
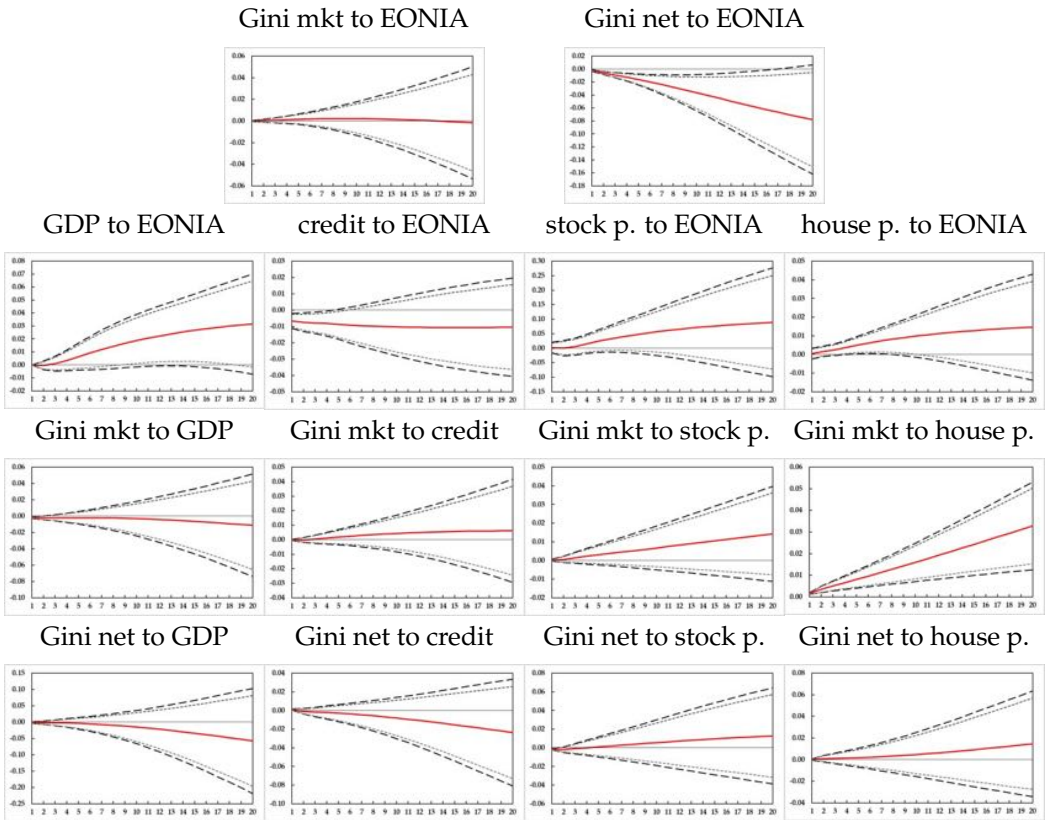


Figure A.16: Impact of monetary policy on inequality, 1999Q1–2007Q3: Belgium



Notes: The figures plot cumulative impulse responses of inequality, GDP, and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.17: Impact of monetary policy on inequality, 1999Q1–2007Q3: Austria

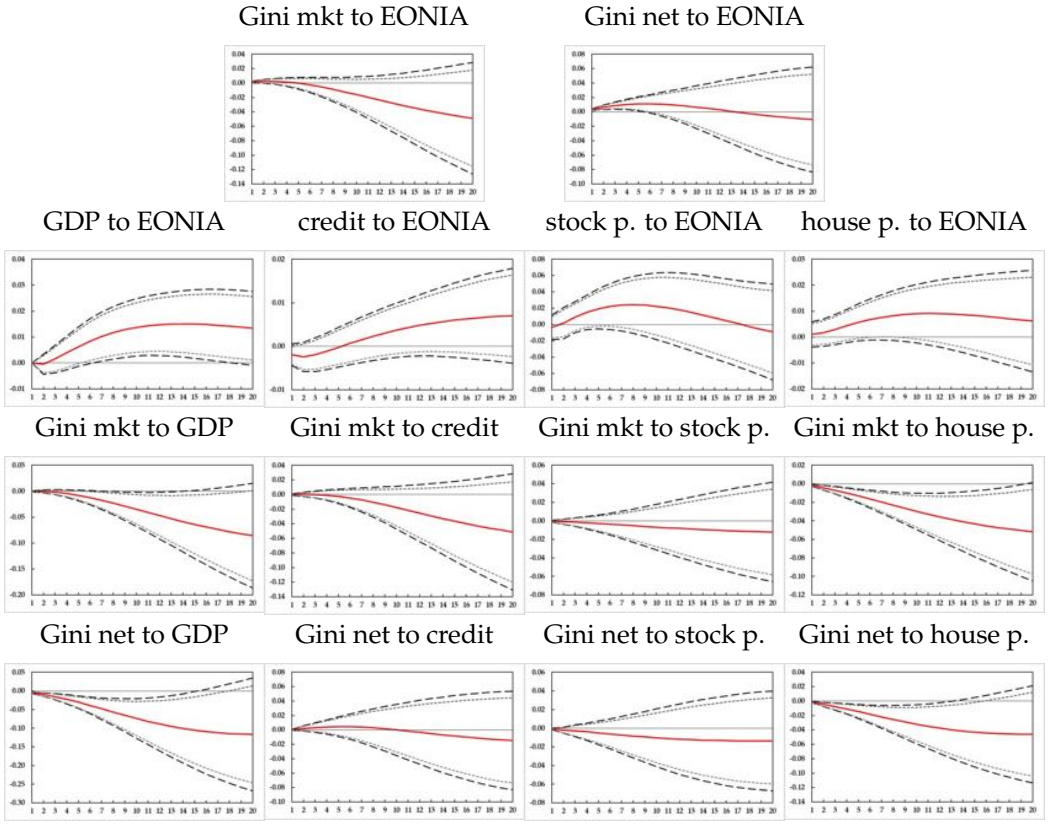
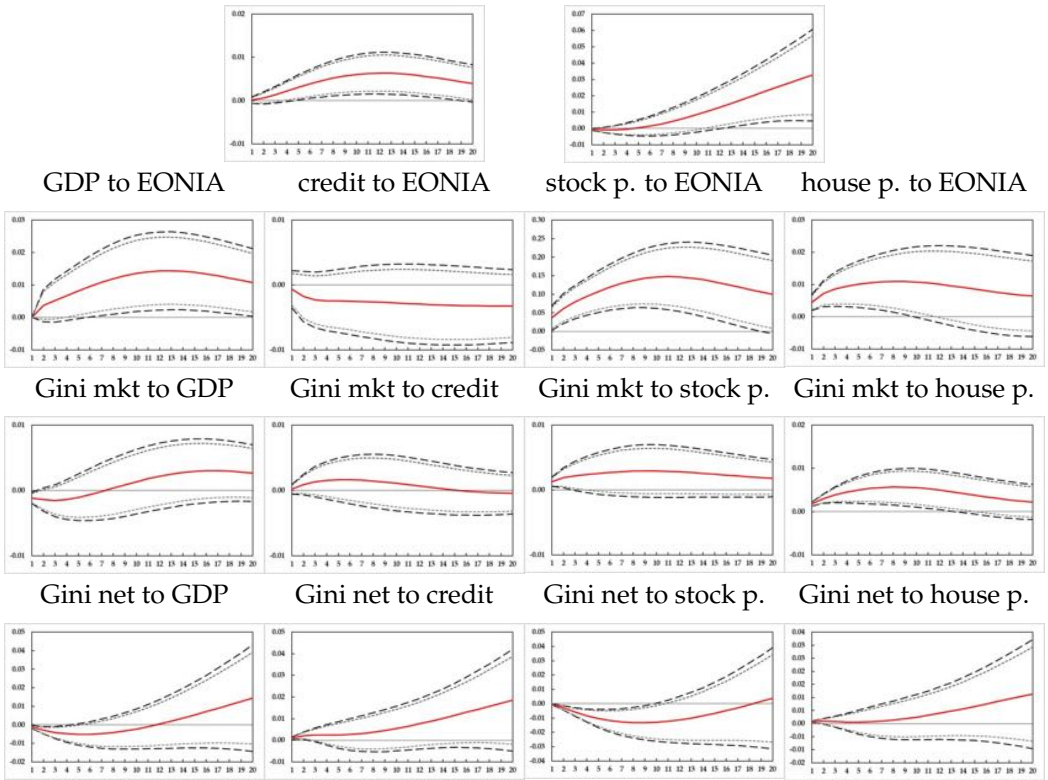


Figure A.18: Impact of monetary policy on inequality, 1999Q1–2007Q3: Finland



Notes: The figures plot cumulative impulse responses of inequality, GDP, and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.19: Impact of monetary policy on inequality, 1999Q1–2007Q3: Italy

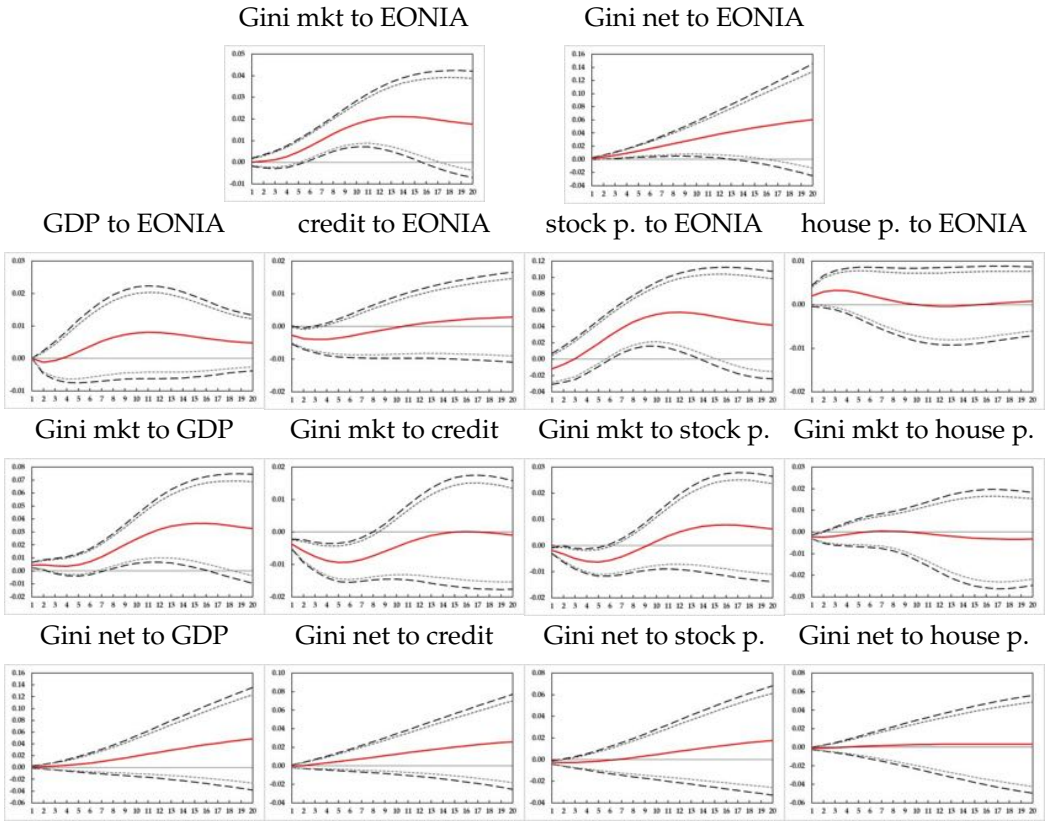
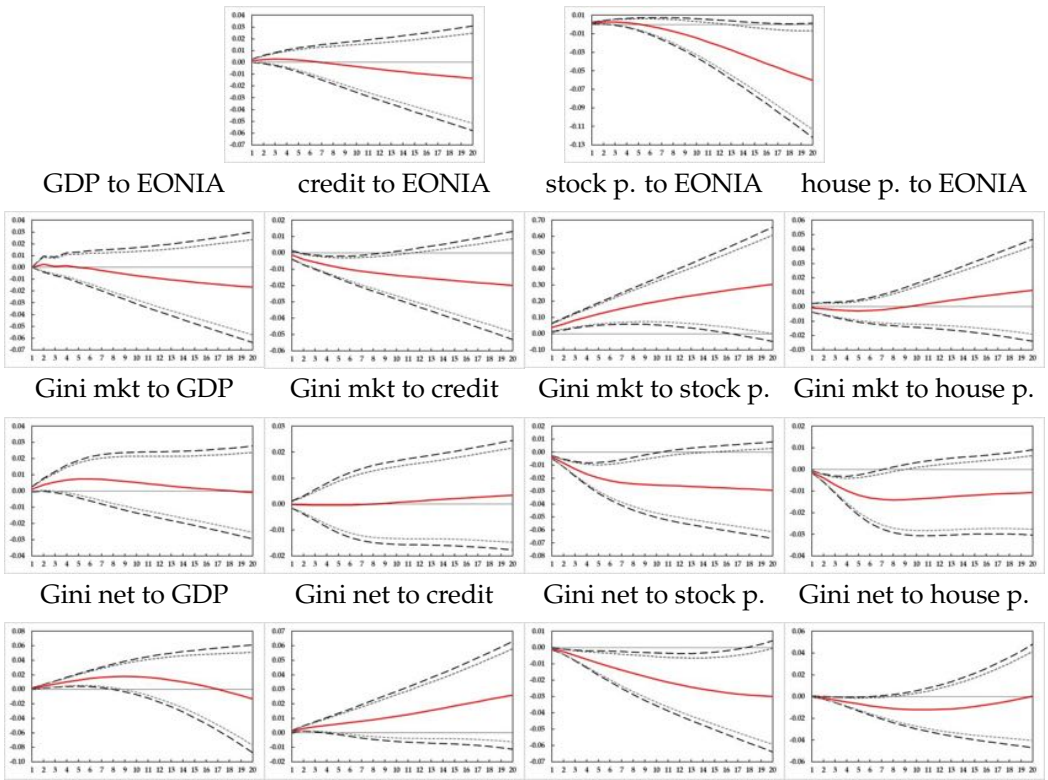


Figure A.20: Impact of monetary policy on inequality, 1999Q1–2007Q3: Greece



Notes: The figures plot cumulative impulse responses of inequality, GDP, and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.

Figure A.21: Impact of monetary policy on inequality, 1999Q1–2007Q3: Spain

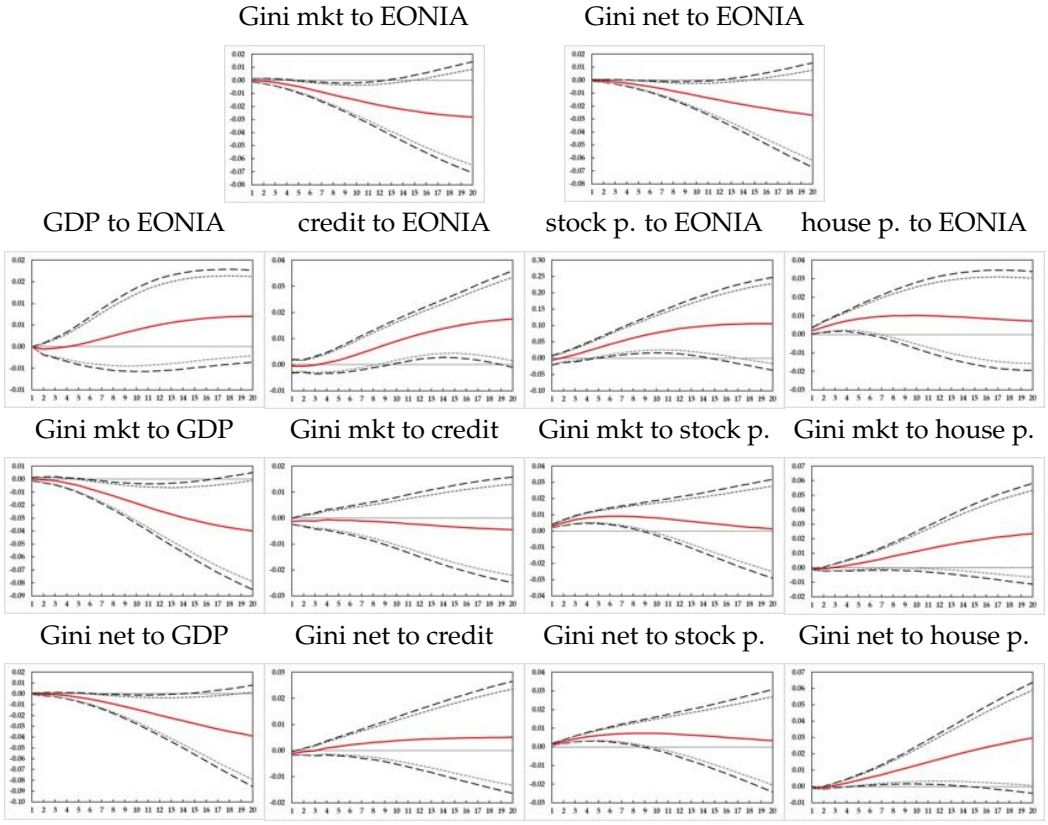
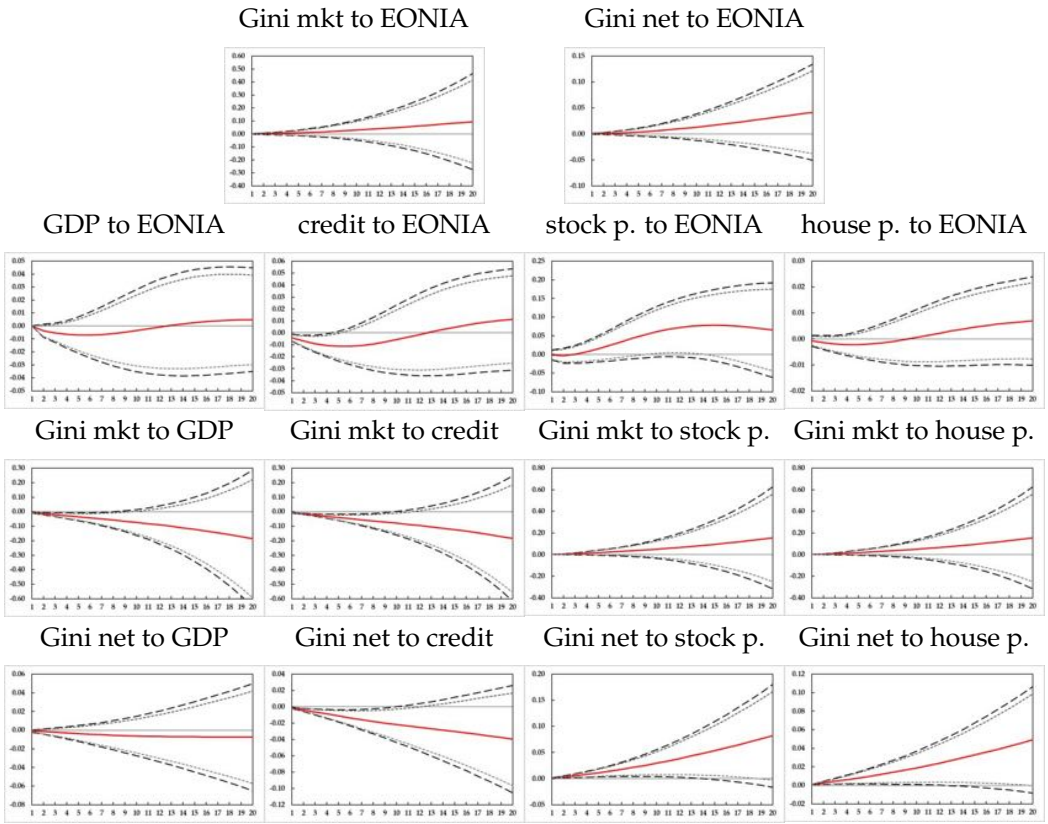


Figure A.22: Impact of monetary policy on inequality, 1999Q1–2007Q3: Portugal



Notes: The figures plot cumulative impulse responses of inequality, GDP, and financial variables to one st.dev. expansionary monetary policy shock; and cumulative impulse responses of inequality to one st.dev. decrease in GDP and financial variables. The solid line shows the point estimate, the dashed and dotted lines are 95% and 90% confidence intervals, respectively.