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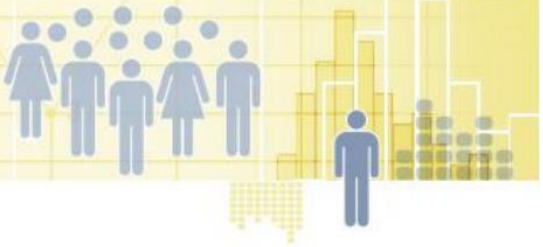

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Who takes the cake? Euro area monetary policy and income classes

Elena Bárcena Martín

Natalia Martín Fuentes

Salvador Pérez Moreno

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Elena Bárcena Martín [a]

Natalia Martín Fuentes [b]

Salvador Pérez Moreno [c]

Abstract

This paper provides evidence on the effects of monetary policy on the income class structure via stimulating economic activity and employment in Euro area countries over the decade after the financial crisis. Based on European Union Statistics on Income and Living Conditions data, we compute the share of the market income obtained by each income class (lower, lower-middle, upper-middle, and upper) for the states that originated the Economic and Monetary Union (EMU-11). We examine the impact of monetary policy impulses under a Bayesian Vector Autoregressive approach and find that a monetary easing shock involving a decrease in nominal interest rates tends to increase the market income share of middle classes at the expense of a smaller income share for the upper class, while the lower class is not significantly affected. Our findings highlight that the identified effects are mostly triggered by short-term interest rate cuts. In fact, these effects tend to vanish as the monetary policy proxy is located further in the yield curve, suggesting that the distributional impacts of monetary policy on market income distribution are to a larger extent driven by monetary policy decisions modifying short-term interest rates.

Key words: monetary policy; interest rates; distributional consequences; income classes; Bayesian Vector Autoregressive approach; Euro area

JEL codes: E52, D63

[a] University of Malaga, E-29071 Malaga, Spain. E-mail: barcenae@uma.es

[b] University of Malaga, E-29071 Malaga, Spain. E-mail: nmartinfuentes@uma.es

[c] Corresponding author. University of Malaga, E-29071 Malaga, Spain. Phone: +34-952131280. E-mail: sperezmoreno@uma.es

1. Introduction

Increasing within-country inequality and the deterioration of the middle class is a long-term trend resulting from deep and far-reaching structural changes over the last decades. The deepening of globalization, skill-biased technological progress, demographic trends, changes in labour market institutions, financialisation or the difficulty of the tax-benefit systems to reduce market income are some of the major drivers addressed in the literature (see e.g. OECD, 2011 and 2015; Dabla-Norris et al., 2015; Bourguignon, 2018).

Nevertheless, in the years following the Great Recession the concern about the situation of the middle class and its future prospects in economically advanced countries significantly rose as inequality exacerbated and the middle class lost considerable ground in numerous countries (see, e.g., Cowen, 2013; Vaughan-Whitehead, 2016; Pew Research Center, 2017). This placed the question of income distribution at the core of economic analysis (see Stiglitz, 2012; Deaton, 2013; Piketty, 2014; Atkinson, 2015; Galbraith, 2016; etc.). Moreover, the development of theories such as Piketty's (2014) supporting that advanced economies do not inevitably evolve toward more egalitarian societies, in opposition to the widely refuted traditional view based on Kuznets (1955), further sparked this debate. Recently, in addition, the COVID-19 pandemic has fuelled even further this concern and raised awareness of disparities between income classes.

Beyond the structural changes, after the financial crisis of 2007-2008, the unparalleled conventional and unconventional monetary measures implemented by most major central banks, including the European Central Bank (ECB), raised concerns about the distributional effects of monetary policy among academics and policy makers. In fact, although monetary policy focuses on price stability and distributional issues fall outside the mandate of central banks, monetary policy decisions are not neutral for income and wealth inequality. Therefore, distributional implications of monetary policies might have helped contain or contributed to the long-run trends that we can observe in the data (Panetta, 2015). From an academic perspective, the distributional effects of monetary policy are not a novelty as various conflicting theoretical channels through which monetary policy can affect income and wealth inequality have been widely tackled in the literature (Coibion et al., 2017, Ampudia

et al., 2018). Since the 2007 financial crisis, nevertheless, the distributional effects of monetary policy have also drawn the attention of central bankers, concerned by the potential consequences of their extraordinary monetary policy decisions, essentially via changes in asset prices and in the general macroeconomic environment (e.g. Bernanke, 2013, 2015; Yellen, 2014; Draghi, 2016; Constâncio, 2017; Powell, 2020). Likewise, in recent years, the debate around how income distribution shapes monetary policy transmission (Kaplan et al., 2018) and, subsequently, whether inequality should be considered while conducting monetary policy is beginning to take shape (Hansen et al., 2020).

According to Bernanke (2015), monetary policy is not a key driver of increased inequality, as "monetary policy is neutral or nearly so in the longer term, meaning that it has limited long term effects on *real* outcomes like the distribution of income and wealth". Nonetheless, given that monetary policy typically operates over a limited horizon, its influence on income distribution in the short- and medium-term should not be ignored. There are several complex theoretical channels through which monetary policy might affect both income and wealth inequality (see e.g. Coibion et al. 2019, and Colciago et al. 2019). These channels often apply opposing forces, thus increasing the difficulty of determining the net distributional effect of monetary policy interventions. Therefore, this is mainly an empirical issue, and the conclusions are contingent as they depend on economic and institutional characteristics (Panetta, 2015).

This paper provides empirical evidence on the effects of monetary policy on the market income distribution via stimulating economic activity and employment in Economic and Monetary Union countries (EMU11) over the 2007-20016 decade. In particular, we analyse income distribution through the study of the income share of the lower, lower-middle, upper-middle and upper classes and apply a Bayesian vector autoregressive (BVAR) and a recursive identification scheme to identify structural innovations of monetary policy. We assess the impacts of monetary policy shocks on the shares of market income obtained by the respective income classes over the period 2007Q3-2016Q1. Our findings suggest a non-homogeneous effect of monetary policy on income classes, which tends to strengthen middle classes more than the lower class, as monetary easing measures stimulate economic activity and employment in the short term.

The remainder of the paper is structured as follows. Section 2 briefly reviews the theoretical channels through which monetary policy affects income and wealth inequality and previous empirical evidence. Section 3 describes the data and the methodology. Section 4 presents and discusses the results. Finally, some concluding remarks are offered in Section 5.

2. Literature review

2.1. Theoretical framework

Although the literature has traditionally dealt more with the distributional effects of inflation on economic inequality than the impacts of monetary policy themselves (Galli and von der Hoeven, 2001; Albanesi, 2007), some specific channels through which monetary policy impacts income and wealth distribution have been clearly identified (see e.g. Coibion et al., 2017; Amaral, 2017; Colciago et al., 2019). Most of the channels primarily affect wealth distribution, either via inflation, such as the saving redistribution channel or portfolio channel, or via the transmission process of monetary impulses, such as the interest rate exposure channel or financial segmentation channel. Nonetheless, two major channels affect income distribution through monetary policy transmission mechanisms, namely income composition channel and earnings heterogeneity channel. The former focuses on the main source of households' earnings and underlines that an expansionary monetary policy might exert significant pressure on interest rates and financial assets prices. This way, its effect on income (and wealth) might be different for those agents who receive a large fraction of their income from wage earnings compared to those who receive a large part of their income from financial asset holdings and business gains, essentially upper-income households.

Regarding the earnings heterogeneity channel, it points out that the risk of unemployment is distributed unequally across the population and households in the left part of the income distribution are precisely the ones that usually have higher odds of being or becoming unemployed. Therefore, bearing in mind that they rely considerably on labour earnings (as stated by the income composition channel), an expansionary monetary policy does not affect the employment situation of all income groups homogeneously. In this line, a better macroeconomic environment improving economic activity

and employment levels as a result of an expansionary monetary policy might tend to disproportionately and positively benefit low and low-middle classes, therefore compressing income inequality, since the employment status of households at the lower part of the income distribution is likely to react more significantly to monetary policy impulses. Among the many forms of heterogeneity across households that are conducive to the distributional implications of monetary policy, this channel focuses on the dispersion in the probability of being or becoming unemployed. In this vein, an aggregate decline in unemployment tends to disproportionately affect groups with a higher share of unemployment, frequently low- and low-middle income households. In fact, according to Heathcote et al. (2010) and Lenza and Slacalek (2018), earnings at the bottom of the distribution are mainly affected by changes in hours worked and the unemployment rate (extensive margin), while earnings at the top are mostly affected by changes in hourly wages (intensive margin). This might promote a more equal income distribution. Furthermore, the effect of monetary stimulus on the bottom part of the income distribution might also be substantially magnified due to a stronger impact on aggregate consumption via the larger marginal propensity to consume of these (constrained) households.

From an aggregate perspective, these potential distributional consequences of monetary policy stem from the mere fact that macroeconomic policies that help contain downturns and smooth out the business cycle tend to favour those whose income is more sensitive to economic fluctuations. Monetary policy interventions that success in reducing the frequency of recessions and the severity of falls in unemployment during recession stand the best chance of contributing to economic equity (Feiveson et al. 2020). This is particularly true in the case of longer-lasting expansions whereby gains tend to be shared more widely across income classes (Lenza and Slacalek, 2018; Powell, 2020). This is because the burden of recessions is shared unequally across income classes and vulnerable individuals tend to face adverse "first-out-last-in" labour dynamics: they are more likely to lose their employment, experience protracted recoveries, and thus suffer permanent scarring effects.

However, the interaction between monetary policy and domestic labour markets shapes how the aggregate decline in unemployment is distributed across individuals and to what extent macroeconomic stabilization benefits accrue to the more vulnerable. In this vein, Dolado et al. (2018) examine the earnings heterogeneity channel based on a New Keynesian model in which they study how capital-skill

complementarity interacts with monetary policy in affecting inequality between high- and low-skilled workers. They find that an unexpected expansionary monetary policy shock increases earnings inequality by lowering the labour share of income received by low-skilled workers and raising it for high-skilled workers, as the increase in capital demand amplifies this wage divergence as skilled workers are more complementary to capital than substitutable unskilled workers. This way, labour market specific dynamics, such as skill-biased employment growth, might hamper the materialisation of the potential positive effects of monetary policy in low-income household as not all economic expansions are equally conducive to more equal societies.

2.2. Empirical literature

From an empirical point of view, there is a significant amount of work concerning monetary policy and income inequality (see Colciago et al., 2019). Earlier studies focused on the impact of the inflation channel on income and wealth distribution, although its effects are mainly associated with wealth. On this basis, Easterly and Fischer (2001) find (an unexpected increase in) inflation significantly increases income inequality as it hurts poorest households who are more reliant on state-determined income that is not fully indexed to inflation, mostly due to real wage rigidities. Doepke and Schneider (2006) and Adam and Zhu (2016) evidence a significant redistribution from the rich and aged bondholders to relatively young and middle-class households with fixed-rate mortgage debts, although differences in nominal exposures across countries have to be born in mind.

Most recent empirical studies on the income distributional effects of monetary policy shocks essentially focus on the income composition channel and the earnings heterogeneity channel. Some papers highlight that expansionary monetary policy reduces income inequality in the U.S. (Coibion et al., 2017), the U.K. (Mumtaz and Theophilopoulou, 2017), the euro area (Guerello, 2018) and in advanced and emerging countries (Furceri et al., 2018). They argue that expansionary monetary policies tend to stimulate economic activity, employment and wages, favouring low-income households inasmuch as labour earnings constitute their main source of income, while high-income households are less likely to become unemployed and lose their labour income. As remarked by Lenza and Slacalek

(2018), the effect is asymmetric: tightening of policy raises inequality more than easing lowers it, and depends on the state of the business cycle.

Other studies, however, uphold that expansionary monetary policy is associated with higher income inequality or that its distributional effects might be negligible. For instance, Inui et al. (2017) reveal that in Japan expansionary monetary policy might lead to higher income inequality due to labour market rigidities and nominal wage stickiness, which increases earnings inequality by dispersing wages. Likewise, O'Farrell et al. (2016) conclude that the distributional effects of expansionary monetary policy on average are negligible but differ considerably across OECD countries. While an increase in house prices reduces wealth inequality, higher bonds and equity prices tend to exacerbate it, so that the effects of monetary policy easing on both income and wealth inequality are widely unequal across countries.

Regarding the effects of non-standard policy measures implemented since 2008 by most major central banks (forward guidance, low/negative interest rates, large-scale asset purchases, etc.) on income distribution, the empirical evidence is scarcer and mostly focused on the effects of quantitative easing (QE). Regarding the earnings heterogeneity channel, we find evidence of QE reducing income inequality by stimulating economic activity, job creation and wage growth in the U.S. (Bivens, 2015), Italy (Casiraghi et al., 2018) and the euro area (Guerello, 2018; Lenza and Slacarek, 2018). In contrast, in respect to the income composition channel, Saiki and Frost (2014) for Japan, Montecino and Epstein (2015) for the U.S. and Mumtaz and Theophilopoulou (2017) for the U.K. highlight that the increase in asset prices caused by QE raises the financial income of high-income households and thus exacerbates income inequality. Lenza and Slacalek (2018) focus on France, Germany, Italy and Spain and conclude that QE substantially contributes to support vulnerable households, since many households with lower income find jobs, thus compressing the income distribution. They remark that the stimulating effect of QE on aggregate consumption disproportionately boots income in the lower part of the distribution. Therefore, given that there are two contrasting effects on income distribution from the earnings heterogeneity and income composition channels, the overall effect of unconventional policies seems to depend on the relative strength of both channels, which is related, in turn, to each country's economic structure and socio-demographic composition.

Previous studies mostly use income inequality measures from national or international sources such as Gini index or measures related to the income of individuals at the top end of the distribution. To the best of our knowledge, this is the first attempt in the literature to research the effects of monetary policy on the market income shares across income classes. We consider the countries that originated the Economic and Monetary Union (EMU-11) and examine the effects of expansionary monetary policy applied since the onset of the financial crisis in terms of boosting economic activity and employment, leaving aside other effects related to the income composition channel, such as the potential financial gains from quantitative easing measures through assets purchase programs.

3. Data and methodology

3.1. Data

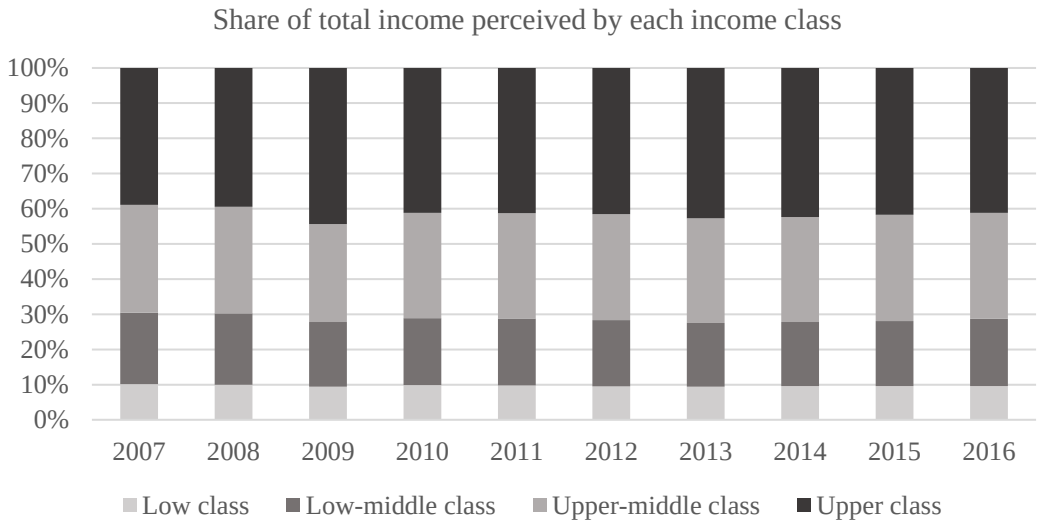
In order to examine the distributional effects of monetary policy on the income class structure, we adopt a relative definition of the income class that establishes thresholds in relation to percentages of the median income of the distribution. To delimit the lower-middle class, we consider the income limits that are conventionally accepted (see, e.g., Thurow, 1987; Birdsall et al., 2000; Ravallion, 2010; Atkinson and Brandolini, 2013), namely 75% and 125% of the median income. These cut-offs demarcate the lower-middle class as the group that is 'comfortably' clear of being at-risk-of-poverty (below 60% of the median). Similarly, we define the upper-middle class as the share of the population whose income is between 125% and 200% of the median income. Conveniently, the share of households belonging to the lower part of the income distribution (below 75% of the median income) is considered lower class, whereas those at the top (above 200% of the median income) comprise the upper class.

We estimate the proportion of the total income earned by each income class using data from the European Statistics on Income and Living Conditions (EU-SILC), which have been published since 2004 and are the reference source for comparative statistics on the distribution of income in Europe. The EU-SILC has the advantage of collecting detailed information on individual and household income,

and data is comparable across the participating European countries. We use data from cross-sectional files for the waves 2008[1] to 2017 for the 11 EMU countries.

The concept of income used to compute the limit of the income classes is that of household market income, that is, income before transfers and taxes, in order to exclude, as far as possible, the significant redistribute effects of the tax and transfer system. It includes: all income from work (salaries of employees and income of self-employed workers), income from capital and property, transfers between households, as well as income from private pension plans. The variable income is collected with reference to the previous calendar year (with the exception of Ireland among the countries analysed).[2] Solely taking into account market income implies that households that live on transfer payments such as retirees cannot be included in the analysis, as their market income is close to zero in most cases. For this reason, we exclude from our sample those households with zero market income whose market income differs from their disposable income. This way, we avoid analysing households whose disposable income comes only from transfer payments.

Figure 1. Evolution of the income share in average terms of the EMU-11



Source: Prepared by authors based on EU-SILC.

[1] Note that each wave contains information on income of the previous year.

[2] As argued by Böheim and Jenkins (2006), the differences in income reference periods are unlikely to be a major source of non-comparability across countries.

In the EU-SILC the basic unit for collecting information is the household, which is usually taken as a unit of measure since an individual's standard of living is influenced by his income and by the people with whom he/she lives. Although the unit of measurement is the household, we analyse the distribution of the individuals' income given that we try to examine the economic position of the people. To adjust household income according to its size, we use the modified OECD equivalence scale[3] and then we assign the equivalent household income to each member of the household.

We work with a panel of 11 countries (EMU-11) for the period between 2007Q3, the beginning of the financial crisis, and 2016Q1. We compute the proportion of the total income obtained by the income classes for each year and interpolate it into a quarterly frequency. In addition, all the variables are both seasonally and calendar adjusted data. In accordance with the literature (see, for example, Peersman, 2011 and Coibion et al., 2017), apart from income shares as a way of measuring income distribution, the following macroeconomic variables are included in our models: short-term nominal interest rates (ECB Statistical Data Warehouse, 2019) as a proxy variable for the monetary policy (and longer-term interest rates as robustness analysis); real gross domestic product growth (Eurostat, 2019a); inflation rate measured as the percentage change of the gross domestic product deflator (Eurostat, 2019b); private sector consolidated credit flow, measured as the net amount of liabilities which non-financial corporations, households and non-profit institutions serving households have incurred along the year, as a percentage of the gross domestic product (Eurostat, 2019c); unemployment rate, as the percentage of the labour force (persons aged 15 to 74) who were without work during the reference period, currently available for work and actively seeking work (Eurostat, 2019d), and in-work at-risk-of-poverty, which measures the share of working people who have an equivalised disposable income below 60% of the national median equivalised disposable income (Eurostat, 2019e).

This study aims to provide empirical evidence of the general impact of ECB's monetary policy at an EMU1999-level, and hence abstracts from analysing country-specific dynamics that might shape the transmission of monetary policy. This research strategy allows condensing a complex phenomenon

[3]A value of 1 for the first adult in the household, 0.5 to each remaining adult, and 0.3 to each member younger than 14.

and makes it tractable from an empirical approach. This way, we estimate a panel model[4] considering cross-sectional homogeneity in the transmission mechanism of monetary policy in order to cover the general distributional consequences for the set of countries considered[5].

In respect to monetary policy shocks, they are commonly extracted from innovations to either short-term or policy interest rates (Furceri et al., 2018; Mumtaz and Theophilopolou, 2017; Coibion et al., 2017), central bank assets (Saiki and Frost, 2014; Guerello, 2018) or government bond spreads (Baumeister and Benati, 2010; Ampudia et al. 2018; Lenza and Slacalek, 2018). In this research, we initially take the short-term nominal interest rates as a proxy variable of monetary policy and enrich our analysis by using longer-term interest rates[6]. In particular, in our baseline model we use the 3-month Euribor from the European Central Bank Statistical Data Warehouse (2019), and in annexes 2, 3 and 4 we include robustness checks considering longer interest rates as proxy variables of monetary policy, namely 1-year Euribor, and Euro area 5-year and 10-year government benchmark bond yield. Since some unconventional monetary policy tools sought to step down the yield curve by lowering longer-term interest rates[7], the use of a range of interest rates could provide some insights on how different monetary decisions focusing especially on either short- or long-term interest rates might end up affecting income shares to a larger or lesser extent. The descriptive statistics of the variables used in the main model and the robustness check analyses are shown in Table 1.

[4] The relatively short period covered by our panel dataset would make drawing comparisons from single unit estimation of the parameters difficult and even uninformative, since estimates may be biased and estimation uncertainty would be large (Canova, 2007).

[5] It should be borne in mind that certain individual characteristics might be responsible for country-specific differences that fall outside the scope of our analysis.

[6] During the unconventional monetary policy period, the short-term interest rates have displayed a rather low volatility around the effective lower bound. Monetary easing measures have sought to affect especially interest rates with longer maturities.

[7] For example, via purchases of long-term maturity securities under the APP or directly affecting the expectations on future interest rates using forward guidance.

Table 1. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
3-months Euribor	385[a]	1.292	1.608	-0.186	4.982
1-year Euribor	385[a]	1.647	1.575	0.007	5.367
5-years EA benchmark government	385[a]	2.519	1.468	0.050	5.786
10-years EA benchmark government	385[a]	3.233	1.148	0.931	4.809
Real GDP growth	385	0.175	1.587	-6.800	22.600
GDP deflator (percentage change)	385	0.317	0.736	-3.300	6.900
Private credit	385	4.804	8.833	-22.500	70.300
Unemployment rate	385	9.271	4.833	3.600	26.200
In-work at-risk-of-poverty	385	7.770	2.723	-3.100	13.100
Lower class income share	385	9.636	1.017	5.249	12.033
Lower-middle class income share	385	18.853	2.439	-8.449	24.457
Upper-middle class income share	385	29.764	4.985	7.452	40.530
Upper class size income share	385	41.747	6.925	27.320	78.849

[a] These data are the same for all countries in a year
Source: Prepared by authors based on EU-SILC, Eurostat and ECB Statistical Data Warehouse.

3.2. Methodology

Macroeconomic analyses and policy evaluations increasingly require taking into account existing interdependencies among the different economic variables in order to assess the impacts from a global perspective. Monetary policy effects are distributed through numerous transmission mechanisms, giving rise to both direct and indirect impacts of a different nature. The existence of interactions between the variables analysed is the main reason why a simultaneous equation system appears to be the most accurate approach for our analysis, bearing in mind the endogeneity of the variables. Initially developed by Sims (1980), the vector autoregression approach considers each variable as endogenous, and they are included in the system as functions of lagged values of all endogenous variables; thus tackling the endogeneity issue allows us to study their interrelations. A priori, the vector autoregressive (VAR) methodology is thought to be minimalist in the sense that economic theory is barely used in the inferential process, as it does not require a strong theory to support the model.

The dynamic interactions among the set of macroeconomic endogenous variables collected in the vector (gx1) of endogenous variables, Y_{it}, is governed by the following system of autoregressive simultaneous equations in reduced form:

$$Y_{it} = C + A_1 Y_{it-1} + A_2 Y_{it-2} + \cdots + A_p Y_{it-p} + \varepsilon_{it} \quad (1)$$

$$Y_{it} = C + \sum_{j=1}^{p} A_j Y_{it-j} + \varepsilon_{it} \quad (2)$$

$$\varepsilon_{it} \sim N(0, \Sigma) \quad (3)$$

where $i = 1..., N$ indicates countries. In our case N=11, corresponding to the 11 countries of the European Monetary Union in 1999. Time is $t = 1..., T$, with T= 35, the quarters from 2007Q3 to 2016Q1. Here c denotes a (gx1) vector of constants, and $A_j$are (gxg) matrices of coefficients on the p lags of the variables. Σ is the covariance distribution of the VAR errors. In particular, the vector Y_{it}, is composed of the variables in the following order: real gross domestic product growth, GDP deflator, domestic credit to private sector, unemployment rate, short-term nominal interest, in-work at-risk-of-poverty rate and the share of total income obtained by each income-class.

We apply a Bayesian Vector Autoregressive (BVAR)[8] methodology with traditional normal-Wishart identification strategy for the sake of extracting the valuable information from the sample while controlling for overfitting (De Mol and Giannone, 2008; Banbura et al., 2010).[9] Our analysis implements a pooled estimator that considers that country-specific variables are only affected by themselves and not by those of other countries, and a single VAR is estimated for a whole set of units.[10] This implies that the variance covariance matrix of residuals is both time invariant and common to all

[8]This empirical analysis is performed using the Bayesian estimation, analysis and regression (BEAR 4.2.) toolbox developed by Dieppe et al. (2016), from the External Developments Division of the European Central Bank. We accept the End User Licence Agreement (EULA) and acknowledge we have no rights in or to the software other than the licence to use it in accordance with the terms of the EULA.

[9] The large number of parameters to be estimated relative to the available sample implies a potential "curse of dimensionality"; that is, classical techniques would very likely result in large estimation uncertainty and data overfitting. These authors showed that since most macroeconomic variables tend to co-move, Bayesian reduces the estimation uncertainty without biasing the estimates by imposing priors that push the model's parameter values toward those of naïve representations.

[10]The BEAR 4.2 toolbox used to estimate the model does not handle unbalanced datasets. Therefore, the missing information related to Ireland's income class structure between 2015Q2 and 2016Q1 has been replaced by its forecast based on past values.

cross-sectional units. The informative priors for the autoregressive coefficients follow (conditional on Σ) a multivariate normal, while the prior for Σ is inverse Wishart; both are assumed to be unknown. The normal-Wishart variance-covariance matrix of the autoregressive parameters is a special case of the Minnesota variance-covariance matrix where Σ is diagonal and the cross-variable weighting parameter is constrained to take a value of $1(\lambda_2)$. This implies a lack of extra shrinkage, i.e. tighter priors cannot be imposed on cross-variable parameters, and thus it is advisable to set the overall tightness parameter (λ_1) between 0.01 and 0.1. For the remaining hyperparameters, values assumed by the Minnesota prior could be attributed; therefore the lag decay (λ_3) may be given values of 1 or 2 and the exogenous variable tightness (λ_4) amounts to 100 (Dieppe et al., 2016). As stated by Dieppe et al. (2016), in the presence of co-movement the information contained in the data "conjures" against the prior and allows the parameters to reflect sample information even if very tight prior beliefs are enforced.

The reduced-form VAR above does not account for a direct contemporaneous relationship among the variables, since there are no time endogenous variables on the right-hand side. In fact, the error terms in the reduced form are typically correlated (matrix Σ) and can and indeed tend to have non-zero off-diagonal elements, thus lacking a clear economic interpretation. Impulse-response functions are meant to measure the change in a shock *ceteris paribus*; so if the shocks are correlated one cannot hold other shocks constant when a shock occurs. To solve this problem, we use the estimated reduced-form model from which we recover the structural model, which cannot be directly estimated (it is unobservable and relies on the interpretation of historical data). The structural VAR considers that the correlations between shocks arise due to contemporaneous correlations between variables, and thus includes their contemporaneous interdependence. If the model successfully captures the contemporaneous effects, the errors in the structural equations will be uncorrelated.

The reduced-form VAR is the result of pre-multiplying the structural VAR by ${D_0}^{-1}$, so that the reduced-form coefficients are $A_m = {D_0}^{-1} D_m$.To be more specific, the resulting structural-form (SVAR) system of order p will be:

$$D_0 Y_{it} = \eta + D_1 Y_{it-1} + D_2 Y_{it-2} + \cdots + D_p Y_{it-p} + u_{it} \quad (4)$$

$$D_0 Y_{it} = \eta + \sum_{j=1}^{p} D_J Y_{it-j} + u_{it} \quad (5)$$

Where D_0 is a (gxg) contemporaneous coefficient matrix, this is the structural matrix that permits to recover structural innovations from the reduced-VAR form residuals. Now the structural shocks $u_{it} \sim N(0, \Gamma)$ are taken to be uncorrelated, i.e. E (u_{it}) = 0, and the variance-covariance matrix is a diagonal matrix (all the elements off the main diagonal are zero). Therefore, by assuming the shocks in u_{it} are mutually orthogonal we can overcome the shock correlation issue. In fact, the reduced form (VAR) errors are linear combinations of the structural errors: they are indeed the result of pre-multiplying the SVAR by ${D_0}^{-1}$, so that $\varepsilon_{it} = {D_0}^{-1} u_{it}$.

Once the structural model has been identified, we formally test that the model does in fact satisfy the stability condition and is invertible.Therefore, there exists an infinite lag VAR representation as specified above, also known as Wold (1954) representation.

$$Y_{it} = A(L)^{-1} {D_0}^{-1} C + \psi_0 u_{it} + \psi_1 u_{it-1} + \cdots \quad (6)$$

$$Y_{it} = A(L)^{-1} {D_0}^{-1} C + \sum_{q=0}^{\infty} \psi_q u_{it-q} \quad (7)$$

where $\psi_0 u_{it} = {D_0}^{-1} D_0 \varepsilon_{it}$ and $\psi_q u_{it-q} = \overline{\psi_q} {D_0}^{-1} D_0 \varepsilon_{it-q}$. Then $\psi_0 = {D_0}^{-1}$ and $\psi_q = \overline{\psi_q} {D_0}^{-1}$, for i = 1, 2, 3, …The existence of a Wold representation for our process allows us to trace the effects of structural shocks on the endogenous variables; that is, to elaborate impulse-response functions from coefficients ψ_q. The series ${D_0}^{-1}$, ψ_1, ψ_2,… represents the response of the VAR variables to structural innovations, and results from independent shocks (meaningful economic interpretation) as long as Γ is diagonal.

For the structural identification of the shocks, ${D_0}^{-1}$ comprises g^2 elements to identify and Γ comprises $g(g+1)/2$, making a total of $(g/2)(3g+1)$ elements to identify. Since the known elements of $\Sigma = {D_0}^{-1} \Gamma {D_0}^{-1'}$ provide $g(g+1)/2$ restrictions on ${D_0}^{-1}$ and Γ, g^2 additional restrictions have to be implemented to fully identify ${D_0}^{-1}$. To do this we use what is known as triangular factorization, under

the assumptions that Γ is a triangular but not an identity matrix[11] and ${D_0}^{-1}$ is lower triangular and its main diagonal is made of ones[12], which imposes a unit contemporaneous response of variables to their own shocks. In practice, this identification arises from the result in Hamilton (1994), according to which any positive definite symmetric gxg matrix Σ has a unique representation $\Sigma = {D_0}^{-1}\Gamma{D_0}^{-1'}$ where ${D_0}^{-1}$ is a lower triangular matrix with ones along the principal diagonal and Γ is a diagonal matrix. The uniqueness of the decomposition permits its integration into the Gibbs sampling process. The fact that ${D_0}^{-1}$ is a lower triangular matrix entails the implicit order in which our endogenous variables in vector Y_{it} affects the contemporaneous relationships among them, i.e. whether a variable reacts or not to a specific shock in another variable within a quarter. Therefore, the vector of endogenous variables is specified as follows: $Y_{it} = (GDP_{it}, DEF_{it}, CRED_{it}, UNEM_{it}, INT_{it}, POV_{it}, IS_{it})'$, g being equal to 7 for each of the four models corresponding to each income class.[13] This recursive identification scheme accounts for the fact that monetary policy contemporaneously reacts, and makes decisions based on developments in gross domestic product and unemployment. Furthermore, the assumption that prices display a delayed reaction after unexpected monetary policy shocks is empirically documented by Bernanke et al. (1999), and supports the ordering of the deflator before short-term interest rate.. The ordering also accounts for the two pillar monetary policy strategy followed by the ECB, whereby not only economic but also monetary analysis (the second pillar) is crucial for the calibration exercise, thus monetary policy is set to react to credit developments in the same quarter. On the other end of the spectrum, the variables related to the income class structure and at-risk-of-poverty working population are perceived as the most exogenous, since they do not affect monetary policy. Therefore, each variable's contemporaneous shock has an effect on that variable and all the variables that come afterward in the vector specified above. The ordering that we apply is thus in line with the theoretical

[11] Zeros below the diagonal impose the additional $g(g-1)/2$ restrictions required for a complete identification of ${D_0}^{-1}$ and Γ.

[12] Zeros above the main diagonal combined with the diagonal of ones generate another $g(g+1)/2$ constraint.

[13] For the purpose of controlling for the unusual value that most variables show in 2009 due to the economic recession's worst peak, a dummy variable for these four quarters is included.

hypothesis being tested, this is, the direct and indirect transmission mechanisms from monetary policy to the income share perceived by each income classes through labour market.

4. Results

Results from the estimated panel VAR are the average responses of the endogenous variables, for all the countries considered and the period covered by our sample, to unexpected innovations in the short-term nominal interest rates (as a proxy variable for monetary policy) after controlling for each country's time-invariant characteristics.[14] Four different models are estimated; each one includes Y_7 as the income share of the lower class, lower-middle class, upper-middle class and upper class, respectively. Testing shows that no root lies outside the unit circle, so the VAR model satisfies the stability condition; likewise, residuals prove to be not serially correlated and tend to be normally distributed. All the specified models agree on the model selection criteria, namely that four lags are the optimum to be included, and the results concerning the common variables in the four models (each one for an income class) are robust.

The extent to which the impulse-response functions are reliable depends on the causal effect between two variables. In other words, the related coefficients of the regressors' matrices have to be significantly different from zero, confirming the existence of Granger causality among each pair of variables. This occurs when the impulse-response credibility intervals are above or below the zero axis in Figure 2. This figure shows the response to a unit structural shock impulse in the short-term nominal interest rates.

Figure 2 shows that the most immediate response to an expansionary monetary policy is displayed by the real gross domestic product growth rate. Specifically, one percentage point cut on the short-term nominal interest rates is unambiguously reflected in the gross domestic product growth rate. It reaches the maximum in the third quarter after the shock, showing a peak at around 0.5 percentage points above the growth rate trend. The effect persists over two periods and then fades away. This

[14] As stated by Canova (2007), it is rare and cumbersome to report estimated VAR coefficients, since they are poorly estimated (except for the first own lag, they are all insignificant), and the displayed impulse-response functions of these VAR coefficients summarise information better.

monetary easing leads to an intense and persistent decrease in unemployment that does not fade away until the 12th quarter. This decrease of the unemployment rate achieves its lower peak around five quarters after the shock, when it seems to amount to a rate 0.3 percentage points below its trend. Impulse-response functions related to in-work at-risk-of-poverty rate are negligible and non-significant.

Nevertheless, while a negative shock on short-term nominal interest rates seems to have a clear impact on economic activity and employment, it shows no impact on the inflation rate; the almost non-existent inflationary pressures during the period analysed might back this finding. Similarly, lower interest rates could have also caused a diluted increase in private credit, even though this effect is slightly not significant.

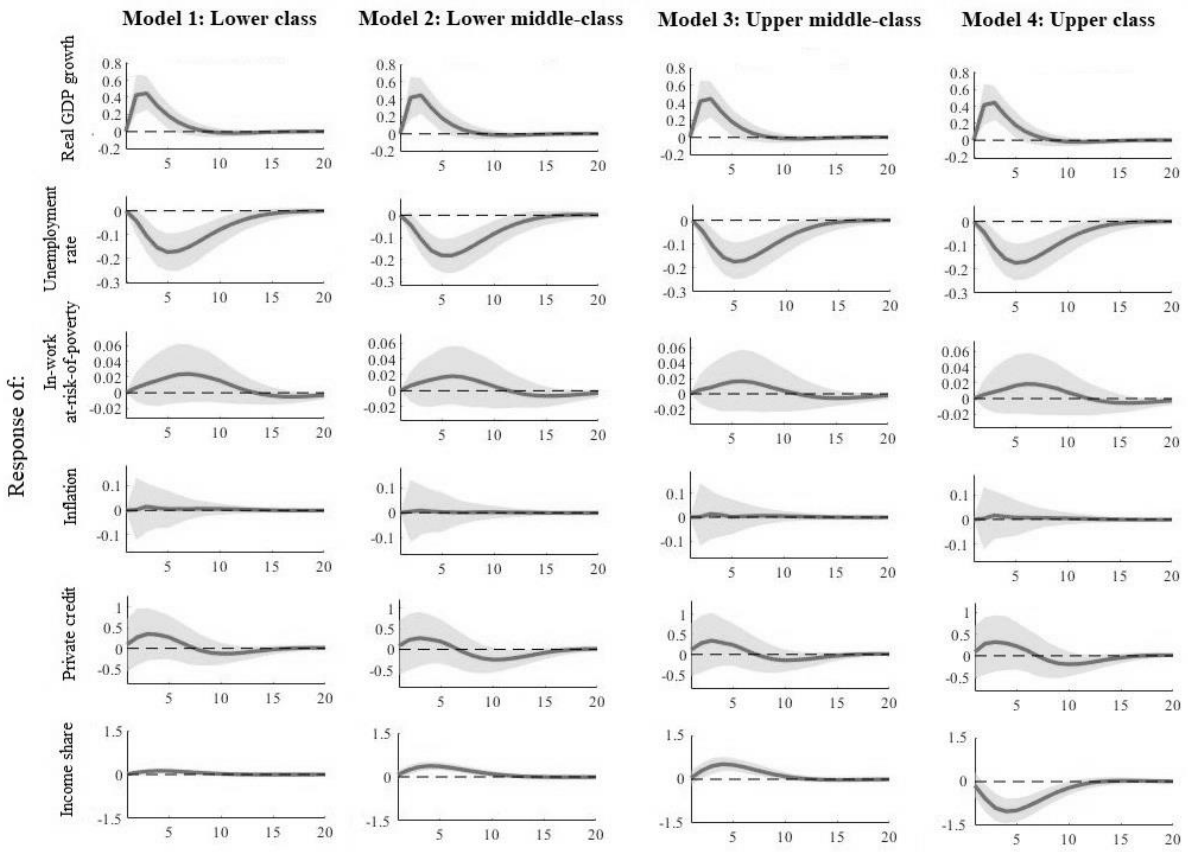
If we focus on the income-class structure, we perceive that a cut in the short-term nominal interest rates leads to heterogeneous impacts on the income share obtained by the different classes. Expansionary monetary policy seems to have left the lower class almost untouched, which stays still in terms of the share of the total income it acquires. Both the lower-middle and upper-middle class display a hump-shaped response, even though the latter seems to have achieved the greatest increase in its income share from short-term interest rate cuts. Around five quarters after the shock, the income share of the lower middle-class peaks at about 0.33 percentage points above its trend, while this increment amounts to around 0.52 percentage points for the upper-middle class. These impacts disappear in the 11th quarter after the shock. The effect on the share of total income of the upper class is the opposite, falling more than one percentage point below its trend.

This reveals that the greater economic activity promoted by expansionary monetary policies, materialised in more employment opportunities, has been unevenly distributed among the different income classes. In fact, it has particularly favoured the lower-middle and upper-middle classes as they seem to have captured most of the generated income, thus contributing to a stronger middle class. It is striking that the lower-class income share seems to have been left unaffected, showing no significant changes in terms of income share despite the upturn in employment levels. This is consistent with Dolado et al. (2018), when examining how capital-skill complementarity interacts with monetary policy in affecting inequality between high- and low-skilled workers. In this sense, monetary easing might

raise the relative income share of high-skilled workers rather than that of low-skilled workers, thus not substantially favouring individuals of the lower income class.

In order to test the robustness of our analysis, we replicate the models using longer-term interest rates as proxy variables of monetary policy. The general guidelines and conclusions remain to a large degree the same, proving that our results are robust and providing further evidence on the real effects of monetary decisions. In particular, the effects of interest rate cuts are ineffective to enhance economic activity and employment as long as we consider longer-term interest rates as proxy variables of monetary policy, so that the effects tend to completely disappear while examining the 10-years EA government benchmark bond yield. This suggests that those monetary decisions that lead to a reduction of long-term interest rates are less effective in terms of market income distribution in the short run than other monetary measures focusing on short-term interest rates.

Figure 2. Impulse-response functions of a negative unit shock in the short-term nominal interest rate[15]



Source: Prepared by authors based on EU-SILC, Eurostat and ECB Statistical Data Warehouse.

[15] The charts plot median responses and 95% credible intervals, i.e. the central portion of the posterior distribution that contains 95% of the values.

5. Conclusions

This study analyses the impact of the monetary policy over the income shares across income classes in the countries composing the EMU-11 for the period between 2007Q1 and 2016Q4. Based on household market income, that is, income before transfers and taxes, provided by EU-SILC, we compute the share of the market income obtained by each income class and examine the earnings heterogeneity channel through which monetary policy affects income classes.

Our Bayesian vector autoregressive (BVAR) approach follows a recursive identification scheme and highlights significant effects of a negative shock in the short-term nominal interest rates (due to an expansionary monetary policy) on real GDP growth and the labour market, contributing to a decrease in the unemployment rate. Nevertheless, although precariousness in the labour market is a reality in numerous Euro countries, the almost non-existent response of the in-work at-risk-of-poverty rate to monetary policy shocks suggests this is utterly structurally driven and is not exacerbated by monetary policy decisions. In distributional terms, easing monetary policies result in a broader income share of the lower-middle and upper-middle classes, so that the middle-class gains ground in terms of income shares to the detriment of the upper class while the lower class seems to be unaffected. The lack of income share increase for the lower part of the income distribution is noteworthy, so that the improvement gained by the middle class is not extended to the lower class. This suggests the existence of labour market performances in which lower classes, more prone to be low-skilled, are unable to take advantage of new labour opportunities related to changes that arise in labour demand. Furthermore, it also seems to bring up the unemployment hysteresis debate embodying the idea that the persistence of unemployment, even in times of economic recovery, is essentially materialised in individuals in the lower part of the income distribution.

The results also reveal that the identified positive effects of monetary policy are mainly caused by cuts in short-term (3-months and 1-year Euribor) interest rates, and do not appear when the monetary policy proxy is located further in the yield curve. This seems to imply that those unconventional tools that tend to mainly alter longer-term interest rates, such as purchases of long-term securities (up to 30 years), have a smaller influence on the real economy, at least in the short run. In this sense, it is worth noting that mortgages and other longer terms contracts are linked to the Euribor instead of longer

interest rates. Our findings, therefore, seem to be consistent with the idea that monetary easing measures reduce income inequality in the short-term by stimulating economic activity and employment, even though monetary policy tends to be neutral or nearly neutral in the long run. Nevertheless, our results go beyond these findings and highlight that monetary stimuli could accrue differentially to households in different parts of the income distribution.

Our findings thus point out the relevance of exploring the distributional effects of monetary policy by examining separately the different strata of the distribution instead of focusing on overall measures of income distribution. This way, as the economic crisis resulting from the COVID-19 pandemic is forcing the main central banks to take unprecedented expansive monetary measures, it seems essential to evaluate how these extraordinary policy decisions might end up affecting each stratum of the income distribution in a post-pandemic world characterized by high inequalities and low growth and inflation expectations. While equity is not a goal of monetary policy, a profound understanding of these side effects will remain an important topic. In this context, our empirical analysis covers the global financial crisis and the subsequent recession and recovery years, which could provide valuable case study evidence for navigating the years ahead.

References

Adam, K. and J. Zhu (2016): "Price-Level Changes and the Redistribution of Nominal Wealth across the Euro Area", *Journal of the European Economic Association*, 14(4), 871-906.

Albanesi, S. (2007): "Inflation and inequality", *Journal of Monetary Economics*, 54(4), 1088-1114.

Amaral, P. (2017): "Monetary policy and inequality", *Federal Reserve Bank of Cleveland*, Economic Commentary, 2017-01.

Ampudia, M., D. Georgarakos, J. Slacalek, O. Tristani, P. Vermeulen and G. L. Violante (2018): "Monetary policy and household inequality", *European Central Bank,* Working Paper Series, No.2170.

Atkinson, A. B. (2015): *Inequality.* Ed. Harvard University Press.

Atkinson, A. B. and A. Brandolini (2013): "On the Identification of the Middle Class", *Society for the Study of Economic Inequality*, Working paper, 2011-217.

Banbura, M., D. Giannone, and L. Reichlin (2010): "Large Bayesian VARs", *Journal of Applied Econometrics*, 25(1).

Baumeister, C. and L. Benati (2010): "Unconventional Monetary Policy and the Great Recession. Estimating the impact of a compression in the yield spread at the zero-lower bound", *European Central Bank,* Working Paper Series, No.1258.

Bernanke, B (1999): *Inflation Targeting: Lessons from the International Experience*, Princeton University Press.

Bernanke, B. (2013): *Chairman Bernanke's Press Conference*, The Federal Open Market Committee, United States of America.

Bernanke, B. (2015): "Monetary policy and inequality", *http://www.brookings.edu/.*

Birdsall, N., C. Graham and S. Pettinato (2000): "Stuck in The Tunnel: Is Globalization Muddling the Middle Class?", *Center on Social and Economic Dynamics*, Working Paper 14.

Bivens, J. (2015): "Gauging the impact of the Fed on inequality during the Great Recession", *Hutchins Center on Fiscal & Monetary Policy*, Working Paper 12.

Bourguignon, F. (2018): "World changes in inequality: an overview of facts, causes, consequences and policies", *CESifo Economic Studies*, 64(3), 345-370.

Canova, F. (2007): Methods for Applied Macroeconomic Research, ed. Princeton University Press.

Casiraghi, M., E. Gaiotti, L. Rodano and A. Secchi (2018): "A "reverse Robin Hood"? The distributional implications of non-standard monetary policy for Italian households", *Journal of International Money and Finance,* 85, 215-235.

Coibion, O., Y. Gorodnichenko, L. Kueng and J. Silvia (2017): "Innocent bystanders? Monetary policy and inequality", *Journal of Monetary Economics,* 88, 70-88.

Colciago, A., A. Samarina and J. de Haan (2019): "Central Bank Policies and Income and Wealth Inequality: A Survey", *Journal of Economic Surveys,* 33(4), 1199-1231.

Constâncio, V. (2017): "Inequality and macroeconomic policies", *Annual Congress of the European Economic Association,* Lisboa.

Cowen, T. (2013): *Average Is Over: Powering America beyond the Age of the Great Stagnation,* Ed. New York: Penguin.

Dabla-Norris, E., K. Kochhar, N, Suphaphiphat, F. Ricka and E. Tsounta (2015): "Causes and consequences of income inequality: A global perspective", *International Monetary Found SDN/15/13.*

Deaton, A. (2013): *The Great Escape. Health, Wealth and the Origins of Inequalitie*s. Ed. Princeton University Press.

De Mol, C. and D. Giannone (2008): "Forecasting using a large number of predictors: Is Bayesian shrinkage a valid alternative to principal components?", *Journal of Econometrics,* 146(2), 318-328.

Dieppe, A., R. Legrand and B. van Roye (2016): "The BEAR Toolbox", European Central Bank, Working Paper Series, No. 1934.

Doepke, M. and M. Schneider (2006): "Aggregate Implications of Wealth Redistribution: The Case of Inflation", Journal of the European Economic Association, 4(2-3), 493-502.

Dolado, J., G. Motyovszki and E. Pappa (2018): "Monetary policy and inequality under labor market frictions and capital-skill complementarity", *IZA Discussion Paper Series*, 11494.

Draghi, M. (2016): "Stability, equity and monetary policy", *German Institute for Economic Research*, 2nd DIW Europe Lecture, Berlin.

Easterly, W. and S. Fischer (2001): "Inflation and the poor", *Journal of Money, Credit and Banking*, 33(2), 160-178.

ECB Statistical Data Warehouse (2019): *Euribor 3-months*, https://sdw.ecb.europa.eu/quickview.do;jsessionid=CCF92627D7CDAC5A0BB3BB12B4C1EFD5?SERIES_KEY=143.FM.M.U2.EUR.RT.MM.EURIBOR3MD_.HSTA *[accessed on 17.05.2019]*.

Eurostat (2019a): *Real gross domestic product growth*, http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do *[accessed on 17.05.2019]*.

Eurostat (2019b). *Gross domestic product deflator*, http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do *[accessed on 17.05.2019]*.

Eurostat (2019c): *Private sector consolidated credit flow*, https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tipspc20&plugin=1 *[accessed on 17.05.2019]*.

Eurostat (2019d): Unemployment rate, http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do *[accessed on 17.05.2019]*.

Eurostat (2019e): In-work at-risk-of-poverty, https://ec.europa.eu/eurostat/web/products-datasets/product?code=tespm070 *[accessed on 17.05.2019]*.

EU-SILC (2019): *Longitudinal UDB*, 2005-2017, *version of 2019-03*, European Union Statistics on Income and Living Conditions.

Feiveson, L., N. Goernemann, J. Hotchkiss, K. Mertens, and J. Sim (2020): "Distributional Considerations for Monetary Policy Strategy", Finance and Economics Discussion Series, 2020-073, Washington: Board of Governors of the Federal Reserve System.

Furceri, D., P. Loungani and A. Zdzienicka (2018): "The Effects of Monetary Policy Shocks on Inequality", *Journal of International Money and Finance,* 85(C), 168-186.

Galbraith, J. K. (2016): *Inequality: what everyone needs to know*, ed. Oxford University Press.

Galli, R. and R. von der Hoeven (2001): "Is inflation bad for income inequality: The importance of the initial rate of inflation", *International Labour Organization*, ILO Employment Paper 2001/29, Geneva.

Guerello, C. (2018): "Conventional and unconventional monetary policy vs. household's income distribution: An empirical analysis for the Euro Area", *Journal of International Money and Finance,* 85, 187-214.

Hamilton, J. D. (1994): *Time series analysis.* Ed. Princeton University Press.

Hansen, N. H., A. Lin, and R. C. Mano (2020): "Should Inequality Factor into Central Banks' Decisions?", *IMF Working Paper*, WP/20/196.

Heathcote, J., F. Perri and G. Violante (2010): "Unequal we stand: An empirical analysis of economic inequality in the United States 1967-2006", *Review of Economic Dynamics,* 13(1), 15–51.

Inui, M., N. Sudo, and T. Yamada (2017): "Effects of monetary policy shocks on inequality in Japan", *Bank of Japan Working Paper Series* 17-E-3, Bank of Japan, Tokyo.

Kaplan, G., B. Moll, and G. L. Violante (2018): "Monetary Policy According to HANK", *American Economic Review,* 108(3), 697-743.

Kuznets, S. (1955): "Economic Growth and Income Inequality", *The American Economic Review*, 45, 1-28.

Lenza, M. and J. Slacalek (2018): "How does monetary policy affect income and wealth inequality? Evidence from the Euro Area", European Central Bank Working Paper Series, No. 2190.

Montecino, J. A. and G. Epstein (2015): "Did Quantitative Easing increase income inequality?", Working Paper 28, *Institute for New Economic Thinking*, New York.

Mumtaz, H. and A. Theophilopoulou (2017): "The impact of monetary policy on inequality in the UK. An empirical analysis", *European Economic Review,* 98, 410-423.

OECD (2011): *Divided We Stand: Why Inequality Keeps Rising*, ed. OECD Publishing.

OECD (2015): *In It Together: Why Less Inequality Benefits all*, ed. OECD Publishing.

O'Farrell, R., L. Rawdanowicz and K. I. Inaba (2016). "Monetary policy and inequality", *OECD Economics Department*, Working Papers No. 1281.

Panetta, F. (2015): "The distributional consequences of monetary policy", Remarks by Mr. Fabio Panetta, Deputy governor of the Bank of Italy, at the Netherlands Bank, Amsterdam, 20 November 2015.

Peersman, G. (2011): "Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area", *European Central Bank*, Working Paper No. 1397.

Pew Research Center (2017): *Middle Class Fortunes in Western Europe, https://www.pewresearch.org/global/2017/04/24/middle-class-fortunes-in-western-europe/.*

Piketty, T. (2014): *Capital in the Twenty-First Century*, ed. Harvard University Press.

Powell, J. H. (2020): *New Economic Challenges and the Fed's Monetary Policy Review,* Jackson Hole Symposium, Federal Reserve Bank of Kansas City, Wyoming, 27 August 2020.

Ravallion, M. (2010): "The Developing World's Bulging (but Vulnerable) Middle Class", *World Development*, 38(4), 445-454.

Saiki, A. and J. Frost (2014): "Does unconventional monetary policy affect inequality? Evidence from Japan", *Applied Economics,* 46(36), 4445–4454.

Sims, C. A. (1980): “Macroeconomic and reality”, *Econometrica,* 48, 1-48.

Stiglitz, J. E. (2012): *The price of inequality: How today's divided society endangers our future*, ed. WW Norton & Company.

Thurow, L. (1987): “A surge in Inequality”, *Scientific American*, 256, 30-37.

Vaughan-Whitehead, D. (2016): *Europe’s disappearing middle class? Evidence from the world of work*, Edward Elgar Publishing, International Labour Organization (Geneva).

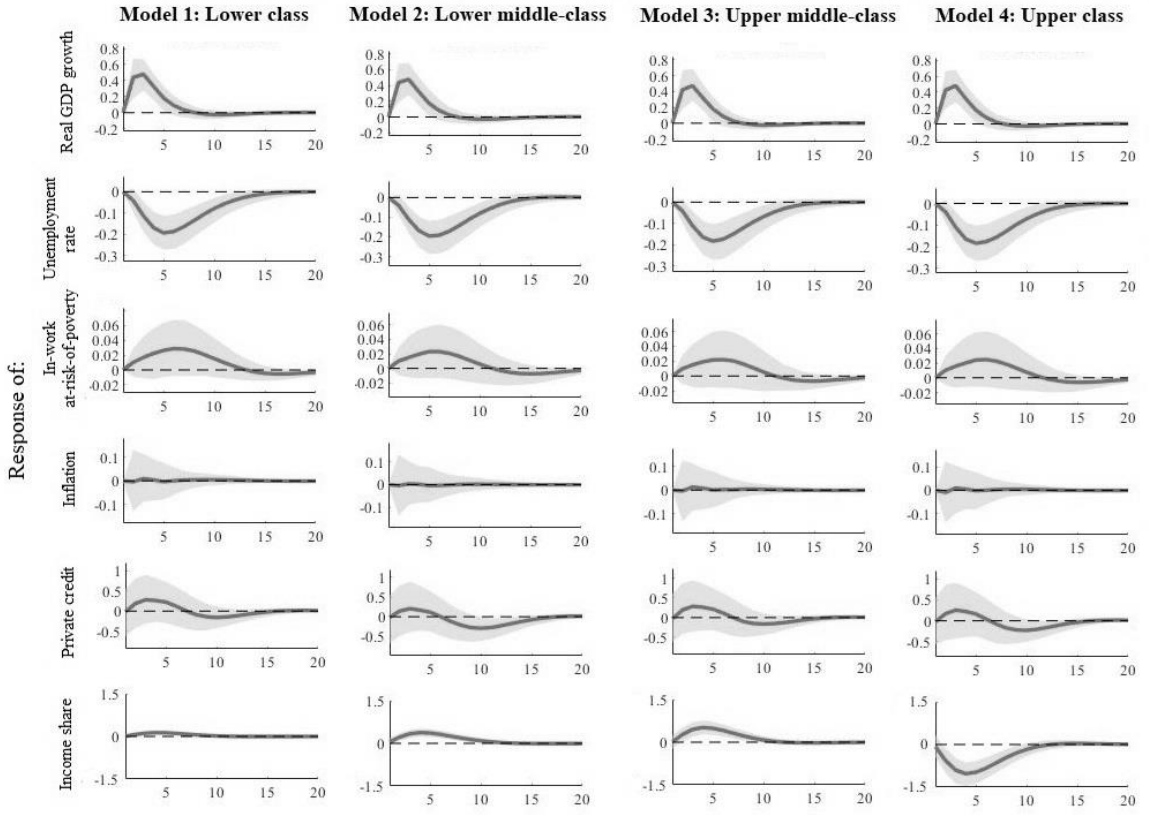
Watkins, J. P. (2014): “Quantitative Easing as a Means of Reducing Unemployment: A New Version of Trickle-Down Economics”, 2014 Annual Meeting of the Association of Evolutionary Economics.

Wold, H. (1954): “A Study in the Analysis of Stationary Time Series”, *Journal of the Royal Statistical Society*, 102(2), 295-298.

Yellen, J. L. (2014): “Perspectives on Inequality and Opportunity from the Survey of Consumer Finances”, *Conference on Economic Opportunity and Inequality*, Federal Reserve Bank of Boston, Massachusetts.

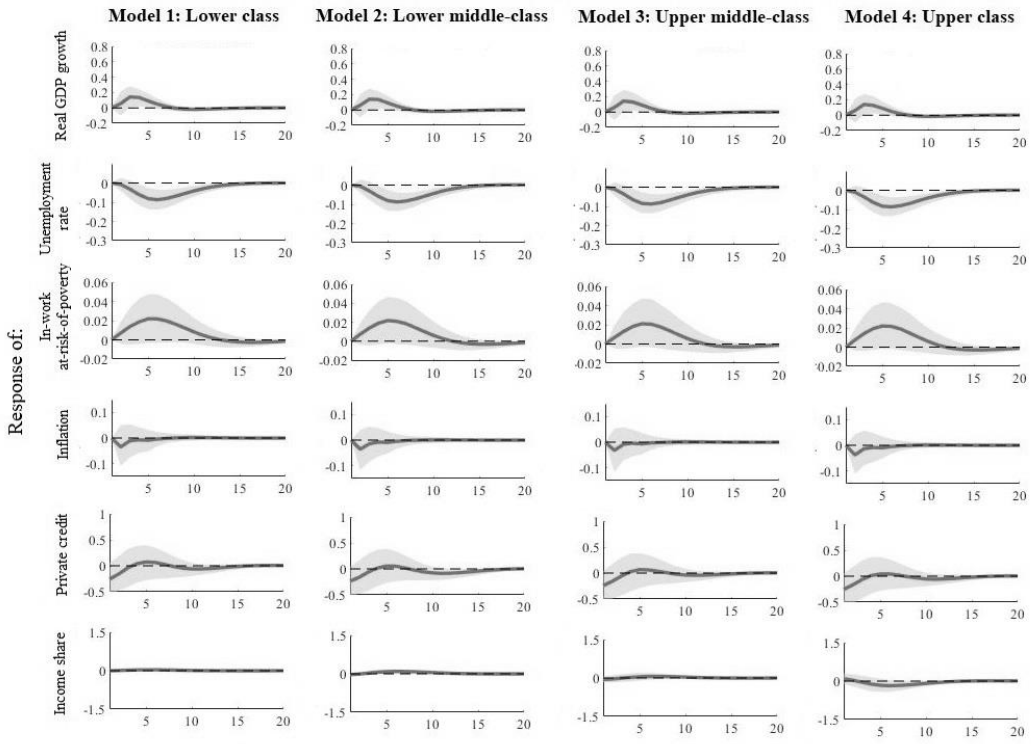
Appendix: Robustness analyses

A.1. Impulse-response functions of a negative unit shock in the 1-year Euribor rate



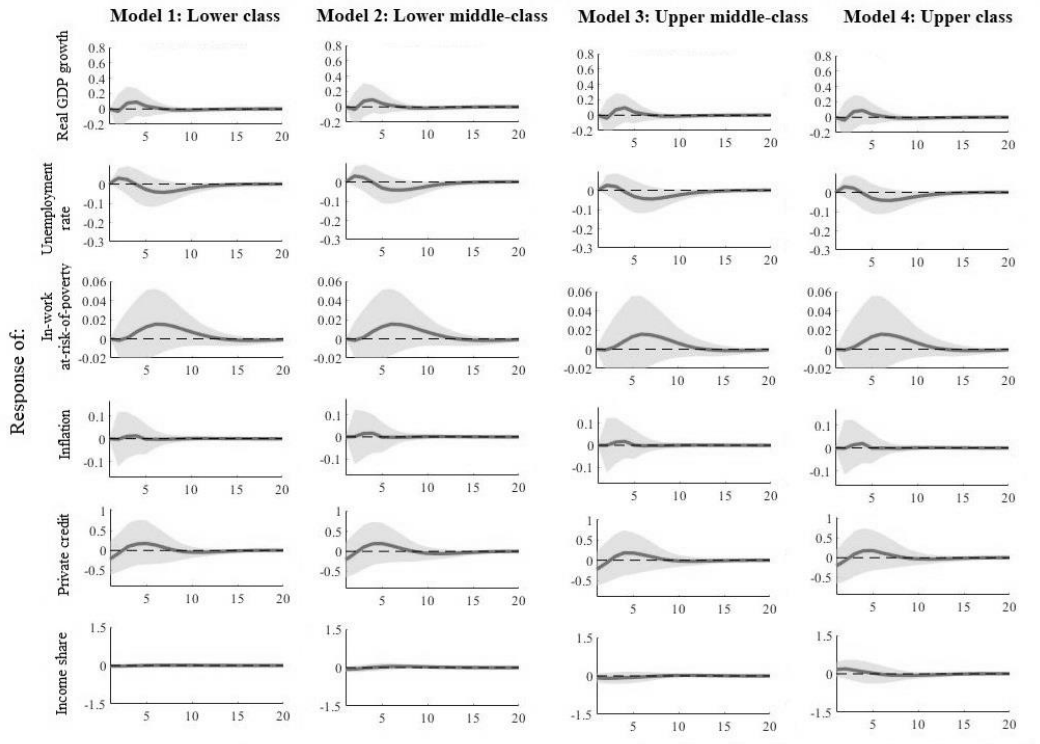
Source: Prepared by authors based on EU-SILC, Eurostat and ECB Statistical Data Warehouse.

A.2. Impulse-response functions of a negative unit shock in the EA 5-year government benchmark bond yield



Source: Prepared by authors based on EU-SILC, Eurostat and ECB Statistical Data Warehouse.

A.3. Impulse-response functions of a negative unit shock in the EA 10-years government benchmark bond yield



Source: Prepared by authors based on EU-SILC, Eurostat and ECB Statistical Data Warehouse.