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Who Takes the Cake? The Heterogeneous Effect of ECB Accommodative Monetary Policy Across Income Classes

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Who takes the cake? The heterogeneous effect of ECB accommodative monetary policy across income classes

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Abstract

This work provides evidence on the heterogeneous effects of ECB's monetary policy across income classes in the euro area. In particular, this investigation focuses on the macroeconomic channel and analyses how expansionary monetary policy affects income inequality through the labour market, that is, by stimulating economic activity which ultimately affects income classes differently. Based on European Union Statistics on Income and Living Conditions (EU-SILC) data, we compute specific unemployment rate and labour income metrics for each income class (lower, lower-middle, upper-middle, and upper) for the countries that originated the Economic and Monetary Union (EMU-11). These micro-derived indicators are combined with the usual macroeconomic metrics in this literature to compose a dataset that covers the period between 2006Q1 and 2019Q4. We then follow a dual empirical approach. On the one side, we estimate a series of country-specific structural Vector Autoregressive (SVAR) models at quarterly frequency to analyse the impact of an unexpected decline in the euro area shadow rate. On the other, we estimate panel local projections models with annual data using the exogenous monetary policy surprises. The results suggest that past monetary easing shocks helped decrease unemployment rates for lower- and middle-class households, to a larger extent for the former, while not affecting the employment status of those located at the rightmost side of the income distribution. The analysis also identifies a positive impact of expansionary monetary policy on real labour income, which, in this case, seems to have mostly benefitted those belonging to the upper class. Our analysis also uncovers some remarkable differences across countries. Overall, our results suggest that expansionary monetary policy have helped decrease income inequality via the labour market.

Key words: Monetary policy; income inequality; income class; structural vector autoregressive model; local projections; Eurozone.

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1. Introduction

In recent years, there is an overall concern about the situation of the middle class and its future prospects in economically advanced countries, which stems from the observation that inequality has increased, and the middle class has considerably lost ground in numerous countries (see, e.g., Cowen, 2013; Vaughan-Whitehead, 2016; Pew Research Center, 2017). This has located the question of income distribution at the core of the economic analysis (see Stiglitz, 2012; Deaton, 2013; Piketty, 2014; Atkinson, 2015; Galbraith, 2016; etc.). Moreover, the arising of theories supporting that advanced economies do not inevitable evolve toward more egalitarian societies, such as Piketty (2014), which opposes to the widely refuted traditional view based on Kuznets (1955), has further sparked this debate.

Many studies have recently investigated the drivers of income distribution in order to facilitate policymaking for the sake of equity. The deepening of globalization, skill-biased technological progress, demographic trends, changes in labour market institutions, financialisaton or the low ability of the tax-benefit systems to reduce market income are some of the major structural drivers addressed in the literature (see e.g. OECD, 2011 and 2015; Dabla-Norris et al., 2015; Bourguignon, 2018).

The increasing within-country inequality and the deterioration of the middle class is a long-term trend and primarily the result of deep and far-reaching structural changes. However, the unparalleled conventional and unconventional monetary measures implemented by most major central banks, including the European Central Bank (ECB), since the onset of the financial economic crisis in 2007/2008 have considerably sparked the debate about the potential distributive implications of monetary policy among academics and policy makers. In fact, although monetary policy is focused on price stability, monetary policy decisions are not neutral for income and wealth inequality.

From an academic perspective, the distributive effects of monetary policy are not a novelty and various theoretical channels through which monetary policy can affect income and wealth inequality have been argued in the literature by a number of authors (Coibion et al., 2017, Ampudia et al., 2018). Nevertheless, the distributive effects of monetary policy have also drawn the attention of central bankers, concerned by the potential distributive effects 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). Looking at advanced economies, the Bank of International Settlements (2022) observes an exponential increase in the share of central bank speeches mentioning inequality since 2014.

According to Bernanke (2015), monetary policy is not a key driver of the increase in 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. This traditional view proposing the neutrality of monetary policy over the business cycle is losing ground against the notion that cyclical and trend changes are hardly ever independent. The literature reveals cyclical increases in inequality during economic downturns are, in absolute magnitude, larger than the declines prompted by recovery phases. In this regard, by exerting a countercyclical effect, monetary policy might limit the deterioration of inequality during recessions thereby reducing subsequent long-lasting scars (see e.g., Pereira da Silva et al., 2022).

Amidst the recent shift in the macroeconomic environment initiated during the COVID-19 crisis and further exacerbated by the subsequent global supply chain disruptions and the effects of the war in Ukraine, central banks are reverting previous ultra-accommodative monetary policy stances to tame increasing inflation in advanced economies. The ongoing monetary tightening highlights the need to revise the impact on inequality past monetary easing tools had, so as to fully understand what might be at stake now and open the debate about whether and how other policy areas (mostly fiscal and structural policies) could help address potential upcoming changes in inequality.

This paper evaluates how monetary policy affects the different income classes by stimulating economic activity and employment for the set of countries that originated the Economic and Monetary Union (EMU-11). We distinguish between lower, lower-middle, upper-middle and upper classes and estimate country-specifics structural vector autoregressive (SVAR) and panel local projections (LP) models to assess possible impacts of monetary policy on the respective income classes over the period 2006Q1-2019Q4.

Our contribution is threefold. First, we are among the first researchers in this literature to exploit micro-level data so as to generate class-specific metrics, what provides a deeper analysis that goes

beyond aggregate measures of inequality. Second, our country-specific estimates allow us to uncover differences in the reaction of the various income classes across the euro area countries that compose our sample. Our findings point towards a non-homogeneous effect of monetary policy shocks across income classes. On the one hand, past accommodative monetary policy seems to have helped decrease unemployment rates for lower- and middle-income classes, while the impact on the upper-class appears to be not statistically significant. However, the estimated reduction in the employment rate appears to be much larger for lower-income households. On the other hand, we also identify a positive impact on real labour income, which, in this case, seems to affect mainly the upper-income class.

The remainder of the paper is structured as follows. Section 2 reviews the theoretical channels through which monetary policy affects income and wealth inequality and previous empirical evidence. Section 3 describes the data, while the empirical approach is elaborated throughout Section 4. Section 5 presents and discusses the results. Finally, some concluding remarks are offered in section 6.

2. Literature review

2.1. Theoretical framework

Although the distributive effects of inflation on economic inequality have been traditionally more considered by the literature 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). Most of the channels primarily affect wealth distribution, either via inflation, such as the saving redistribution channel or the portfolio channel, or via the transmission process of monetary impulses, such as the interest rate exposure channel or the financial segmentation channel. Nonetheless, two major channels operate affecting income distribution through transmission mechanisms of monetary policy: the income composition channel and the earnings heterogeneity channel.

The former focuses on the main sources of households' earnings and could be interpreted as the intensive margin. It underlines that an expansionary monetary policy shock may exert a heterogeneous pressure on the different sources of earnings, for example, increasing financial assets prices more than

labour wages. This way, its effect on income may be different for those agents who receive a large fraction of their income from wage earnings (often located in the leftmost part of the income distribution) 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 it is precisely most vulnerable households those who usually have higher odds of being or becoming unemployed. Therefore, monetary policy is expected to affect the employment situation of the different income groups heterogeneously. In particular, the employment status of households located at the leftmost part of the income distribution tends to be more sensitive to the economic cycle and therefore react more significantly to counter-cyclical monetary policy impulses. In this regard, an expansionary monetary policy shock able to support economic activity and employment might tend to benefit low- and middle-income classes disproportionately, thereby compressing income inequality. This channel could be understood as the extensive margin.

The relationship between monetary policy and inequality is bi-directional. While this investigation focuses on the potential effects of monetary policy on inequality, the literature is paying growing attention to how inequality might also affect the effectiveness of monetary policy. In this regard, greater income inequality is associated with deeper and longer recessions, while it also hampers the transmission of monetary policy (Pereira da Silva et al., 2022). The effect of monetary stimulus on the bottom part of the income distribution is crucial for the transmission of monetary policy, as its impact on aggregate consumption is largely driven by its effect on households with a larger marginal propensity to consume (i.e., "hand-to-mouth" households).

2.2. Empirical literature

From an empirical point of view, there is a significant amount of work concerning monetary policy and income inequality (see e.g., Colciago et al., 2019 and Kappes, 2023). Earlier studies focused on the impact of the inflation channel on income and wealth distribution despite 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 wages 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 redistributive effects of monetary policy shocks focus essentially 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 the employment status of high-income households is less likely to change throughout the business cycle. In this regard, Heathcote et al. (2010) suggests that earnings at the bottom of the distribution are mainly affected by changes in hours worked and the unemployment rate (i.e., the extensive margin), while earnings at the top are mostly affected by changes in hourly wages (i.e., the intensive margin). Furthermore, Lenza and Slacalek (2018) remark that the effect of monetary policy on income inequality is asymmetric, as tightening of policy raises inequality more than easing lowers it, with the ultimate impact also depending on the state of the business cycle.

Other studies, however, support that expansionary monetary policy is associated with higher income inequality or that its distributional effects may be negligible. For instance, for Japan, Inui et al. (2017) reveal that expansionary monetary policy may lead to higher income inequality due to labour market rigidities and nominal wage stickiness, as monetary policy might increase earnings inequality by dispersing wages. Looking at the distribution of wealth, O'Farrell et al. (2016) conclude that the distributional effects of expansionary monetary policy on average are negligible but differ considerably across OECD countries, so that they should be estimated on a case-by-case basis.

From a somewhat different perspective, 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 due to skilled workers being more complementary to capital than substitutable unskilled workers are. This way, in contrast to the arguments exposed above, a monetary easing may raise the relative income share of high-skilled workers, not favouring thus substantially individuals at lower income class. The sometimes-divergent results found in this literature reveal that the impact of monetary policy on inequality needs to be empirically addressed in each case, as socio-demographic and institutional dynamics affecting, e.g., the design of the labour market play an important role.

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 the income distribution, the empirical evidence is scarcer and mostly focused on the effects of quantitative easing (QE). Regarding the earnings heterogeneity channel, the literature finds evidence on QE reducing income inequality by stimulating the economic activity, job creation and wages growth in the U.S. (Bivens, 2015), Italy (Casiraghi et al., 2018) and the euro area (Guerello, 2018; Lenza and Slacarek, 2018). By contrast, concerning 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 the QE raises financial incomes of high-income households thereby exacerbating income inequality. Lenza and Slacalek (2018)[1] focuses on France, Germany, Italy and Spain and concluded QE substantially contributed to support vulnerable households since many households with lower incomes became employed, thus compressing the income distribution. They remark the stimulating effect of QE on aggregate consumption disproportionately boosts income in the lower part of the distribution. Therefore, given that there are two contrasting effects on income distribution, related to the earnings heterogeneity and income composition channels, the

[1] This investigation estimates the aggregate effects of monetary policy on key macroeconomic variables such as the unemployment rate and then distribute the aggregate impact across the different income classes using a Heckman model. Our study complements their results, as the use of microdata allows us to directly estimate class-specific results.

overall effect of unconventional policies seems to depend on the relative strength of both channels. In turn, this relates to the economic structure and the socio-demographic composition of each country.

Overall, most studies use annual inequality measures such as Gini index or metrics related to income of individuals at the top end of the distribution. Our proposal is among the first attempts in the literature (see also Corrado and Fantozzi, 2023, for the case of Italy) to empirically investigate the effects of monetary policy using household survey data. In this regard, EU-SILC micro-level data allows us to compute income class-specific labour market metrics so as to provide empirical evidence for the EMU-11 over the period of 2006Q1-2019Q4. This analysis seeks to improve our understanding of how both the earnings heterogeneity and the income composition channel actually work through the employment via.[2]

3. Data

3.1. Micro-level data from EU-SILC

To estimate class-specific labour market metrics we use household survey data from the European Statistics on Income and Living Conditions (EU-SILC), which has been carried out since 2004[3] and is 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. Focusing on 11 EMU countries, we use data from cross-sectional files for the years between 2006[4] and 2019, the latest available data at the moment of undertaking this analysis.

In order to examine the distributive 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;

[2] The aim of this investigation is to understand the effects that expansionary monetary policy applied since the onset of the global financial crisis (GFC) may have had in terms of boosting economic activity and thus employment. Therefore, other effects related to the income composition channel, such as the potential financial gains stemming from quantitative easing measures, are not address throughout this analysis.
[3] Missing data on gross employee cash or near cash income for various countries in our sample forces us to shorten the time dimension and consider the period that ranges between 2006 and 2019.
[4] Each wave contains income information related to the previous year, while the information on the employment status refers to the current year.

Atkinson and Brandolini, 2013): 75% and 125% of the median income. These cut-offs demarcate the lower-middle class as those '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) are considered lower class, whereas those at the top (above 200% of the median income) compose the upper class.

The concept of income used to compute the limit of the income classes is disposable household income, as usual in the delimitation of income classes. Disposable household income includes, by definition, all income from work (salaries of employees and income of self-employed workers), income from capital and property, and transfers between households, while taxes are excluded. The variable income is collected with reference to the previous calendar year (with the exception of Ireland, among the countries analysed).[5]

[5] 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 EU-SILC, the basic unit for collecting information is the household and this is usually taken as a unit of measure, since the level of life of an individual is influenced by her/his income and by the people with whom she/he lives. Although the unit of measurement is the household, we analyse the distribution of the income of the individuals, unit of analysis, whenever 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[6] and then we attach the equivalent household income to each member of the household. For each of the income classes mentioned above, we compute the class-specific unemployment rate and the labour income as a proxy for salaries[7]. The concept of labour income used is gross employee cash or near cash income, that is, before transfers and taxes. By looking at income before social transfers and taxes we try to exclude, to the extent possible, the significant redistributive effects of the tax and transfers system. Solely considering 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 drop from our sample those individuals with zero market income whose market income does differ from their disposable income. This way, we avoid analysing individuals whose disposable income comes only from transfer and benefit payments (see Annex 1).

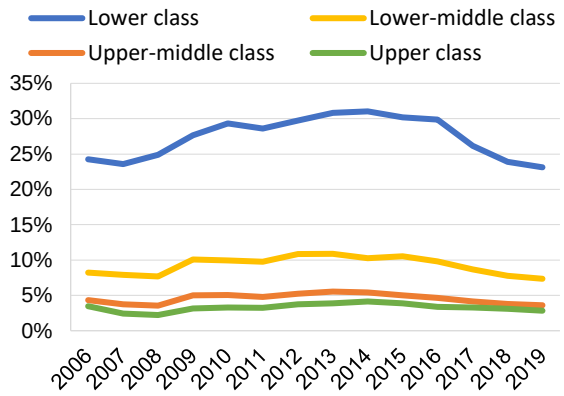
Looking at the evolution of unemployment rate by income class (Figure 1), we observe how the burden of unemployment falls disproportionately on the shoulders of the lower-class households, where unemployment rate has remained below but close to 30% for the period between 2006 and 2019. Interestingly enough, most vulnerable households seem to have been the first ones to exit the labour market when the recession starts: unemployment rate for the lower class starts increasing already in 2008, while the first year-on-year increase appears only in 2009 for the rest of the population. At the same time, these households seem to have been the last ones to re-enter the labour market during the recovery. In fact, while unemployment rate for the upper classes starts decreasing already in 2014-2015, the first decline is only observed in 2017 for the lower class (in 2016 for the lower-middle class). This "first-out, last-in" phenomenon present in the leftmost part of the income distribution, coupled with

[6]A value of 1 to the first adult in the household, 0.5 to each remaining adult, 0.3 to each member younger than 14.
[7] Nominal variables are deflated using the GDP deflator so as to be expressed in real terms (using 2015 prices).

their comparatively largest increase in unemployment rate, helps explain the cyclical increase of income inequality and its persistence.

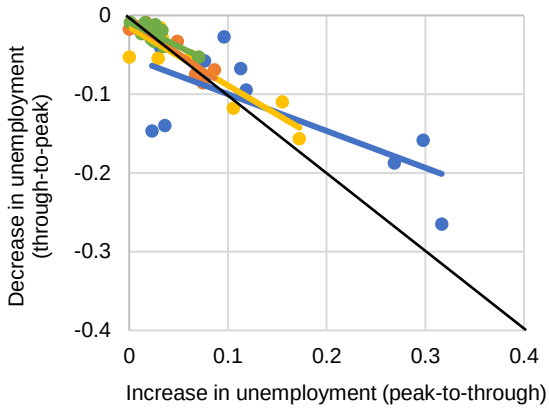
When looking at the entire business cycle, also including the full recovery up to 2019, we observe this cyclical disproportionate deterioration suffered by the lower class is not fully reversed. Instead, post-crisis unemployment rate remains above the pre-crisis figures, leading to a scarring or hysteresis effect. Visually, this is represented by the slope of the lower-class best-fit-line in Figure 2, which differs both from the "full recovery" -45º line as well as from the slope estimated for the rest of the population. This finding is aligned with Pereira da Silva et al. (2022), which uncovers the same dynamic also when looking at advanced economies outside the euro area.

Figure 1. Evolution of unemployment rate by income class (2006-2019, %)



Source: EU-SILC and authors' calculations. Note: Figure displays the weighted aggregate figures for the countries included in our sample (namely AT, BE, DE, ES, FI, FR, IT, LU, NL, PT) using active population as weights.

Figure 2. Scarring effect of unemployment rate by income class (2006-2019, pps)

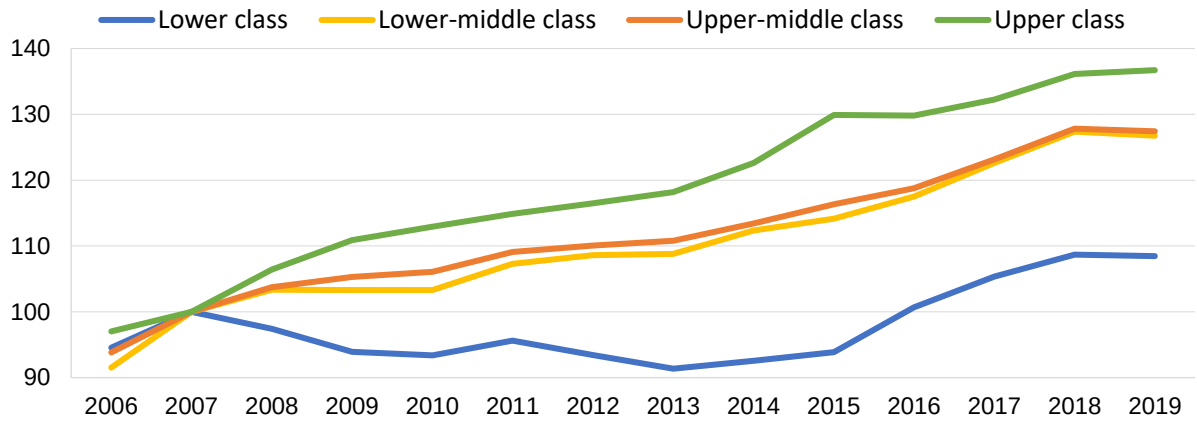


Source: EU-SILC and authors' calculations. Note: Dots in the figure represent each of the countries included in our sample (namely AT, BE, DE, ES, FI, FR, IT, LU, NL, PT). The increase in unemployment represented in the x-axis refers to the difference between the higher unemployment rate witnessed during the recession period (2008-2013) and the lower unemployment rate during the pre-crisis period (2006-2007). The y-axis represents the sharpest decline in unemployment rate during the post-crisis period (2014-2019), with respect to the largest value during the recession (2008-2013).

The evolution of real labour income vastly differs across income classes. Overall, labour income continued its upward trend throughout the recession period, albeit the growth rate was below that of the post-crisis years (Figure 3). When compared to the other income classes, the different behaviour displayed by the real labour income accrued by the lower class stands out, as wage growth stagnates for a long time. In particular, it remains around 3-5% below pre-crisis levels for seven years in a row and only starts recovering in 2016, thereby suffering a long-lasting scarring effect. This finding is aligned

with Cockx and Ghirelli (2016) and Rothstein (2020), which document that the earnings of the low-skilled workers and new entrants remain below pre-crisis levels more than ten years after the end of the recession. By 2018, the cumulative growth rate with respect to 2007 amounts to around 30% for the middle and upper classes, while it was below 10% for the lower-class households. These dynamic highlights that wage inequality widened notably throughout the recession period and remained elevated even after the recovery phase.

Figure 3. Evolution of real labour income by income class (2006-2019; index: 2007=100)



Source: EU-SILC and authors' calculations. Note: Figure displays the weighted aggregate figures for the countries included in our sample (namely AT, BE, DE, ES, FI, FR, IT, LU, NL, PT) using active population as weights. Nominal values are deflated using the country-specific GDP deflator (2015 prices).

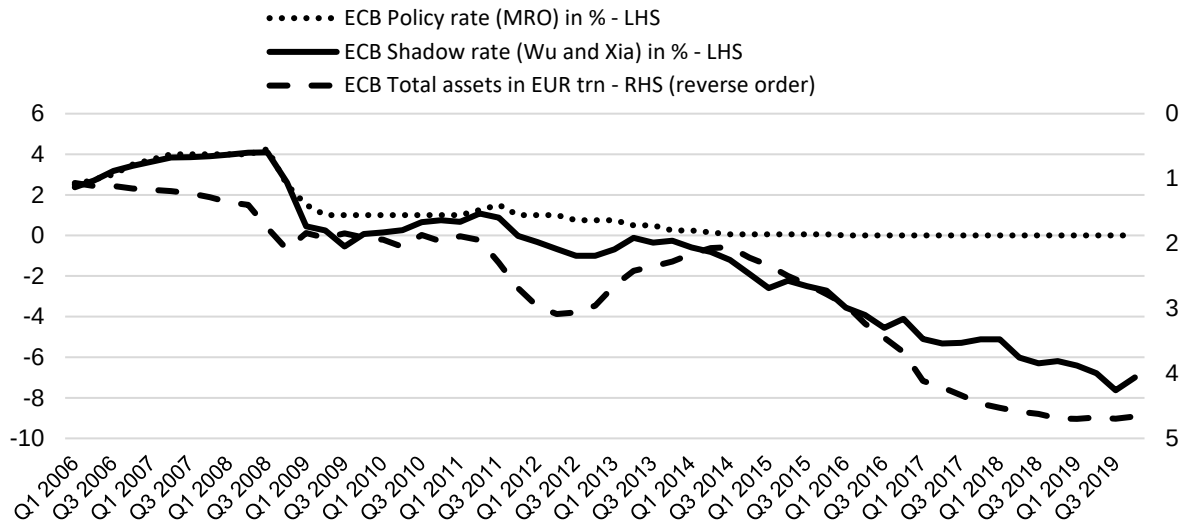
3.2. Macro-level data from various sources

In accordance with the literature (see, for example, Peersman, 2011 and Coibion et al., 2017), apart from the indicators derived from the EU-SILC microdata, we include a series of macroeconomic variables as controls in our various models. In particular, we employ real gross domestic product, GDP_{it}, and also consider the evolution of prices by including the deflator of gross domestic product (referring to 2015 prices), $GDPdef_{it}$. In order to factor in the dynamics present in the financial markets, we also include in our models the Eurostoxx 600 prices, $StockPrices_{it}$ and the term spread between the euro area 10-year Government Benchmark bond yield and its 2-year counterpart, $TermSpread_{it}$.

Concerning monetary policy, it is commonly proxied either by short-term or policy interest rates (e.g., 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), particularly when intending to examine specifically unconventional monetary policy. In order to capture as far as possible, the overall effects of the wide variety of monetary policy decisions adopted by the ECB since the onset of the financial crisis, including both conventional and unconventional monetary policy tools, we use the shadow rate from Wu and Xia (2020), $ShadowRate_{it}$. As reflected in Figure 4, while at the beginning of our sample period the shadow rate perfectly co-moves with the conventional monetary policy rate applied to main refinancing operations, it also reflects the expansion of the ECB's balance sheet over the Quantitative Easing (QE) period, where the shadow rate falls below zero.

Figure 4. Evolution of various monetary policy indicators (2006Q1-2019Q4)



Source: ECB Statistical Data Warehouse (SDW) and Wu and Xia (2020).

4. Empirical approach

4.1. Country-specific structural Vector Autoregressive (SVAR) models with quarterly frequency

Macroeconomic analyses and policies evaluations require considering the interdependencies among the different economic variables, with the purpose of assessing the impacts from a global perspective. Monetary policies effects are distributed through numerous transmission mechanisms, giving rise to both direct and indirect impacts of different nature. The existence of interactions between the analysed variables constitutes the main reason why a simultaneous equation system appears to be the most accurate way to approach our analysis, bearing in mind their endogeneity. 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. This is the first empirical approach we use to address our research question.

The dynamic interactions among the set of macroeconomic endogenous variables[8] collected in the vector Y_{it}, $(g \times 1)$, is governed by the following system of autoregressive simultaneous equations in reduced form:

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

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

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

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 = 56, the quarters from 2006Q1 to 2019Q4. Here C denotes a $(g \times 1)$ vector of constants, and A_j are $(g \times g)$ matrices of coefficients on the p lags of the variables, where p = 8. ε_{it} is an error process which is assumed to be white noise with zero mean and have a time invariant covariance matrix, Σ. The vector Y_{it} includes the 7 following endogenous variables: $Y_{it} = (GDP_{it}, GDPdef_{it}, StockPrices_{it}, TermSpread_{it}, ShadowRate_{it}, UnempRate_{it}, LabourIncome_{it})'$, therefore g is equal to 7 for each of the four models corresponding to each of the four income classes.

While the macroeconomic and financial variables are available at a quarterly frequency, this is not the case for the household survey data from EU-SILC we use to estimate the class-specific unemployment rate and real labour income. To solve this mixed-frequency problem, we perform a regression-based temporal disaggregation so as to convert the low frequency data (annual data) into a higher-frequency data (quarterly data). In particular, we use quarterly data on GDP growth rate and aggregate unemployment rate (at country-level) to disaggregate the class-specific metric on unemployment rate. For real labour income, we follow the same approach using as regressors the real

[8] For each of the variables included in our models, the source and the transformation can be found in Annex 3.

GDP per capita and the aggregate compensation by employee (at country-level). The underlying implicit assumption is that the annual relationship between the variables also holds intra-annually. This disaggregation approach is also used to extend the data on real labour income for the period 2019Q1-2019Q4, as it is only available in EU-SILC until 2018.

The reduced-form VAR system above (equations 1 to 3) does not account for direct contemporaneous relationship among the variables, as 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 tends to have non-zero off-diagonal elements), and thus does not have a clear economic interpretation. In order to identify the structural model so as to recover the impulse-response functions associated to an orthogonal shock to the shadow rate, we follow two different identification strategies: triangular factorization (also known as Cholesky decomposition) and sign restrictions. The associated restrictions can be found in Annex 2.

4.2. Panel Local Projections (LP) models with annual frequency

To complement the analysis based on SVAR models, we also estimate a series of models following the local projections approach à la Jordà (2005). In this case, we use the original frequency of the microdata and estimate panel models with annual frequency. Under a local projection set-up, the orthogonal shocks are not internally estimated in the system but instead are exogenous variables that are included directly in the regression. In our case, we use the euro area shocks estimated by Jarociński and Karadi (2020), aggregated annually.

Based on equation (4) below, we estimate a sequence of regressions of the variable of interest (including control variables) on a structural orthogonal shock for different horizons so as to derive the coefficients of the impulse response functions (IRFs) directly. When compared to the VAR approach, the local projections methodology does not impose any underlying dynamics on the variables in the system, does not suffer from the curse of dimensionality and can accommodate non-linearities. Unlike in a VAR set up, the fact that the response is computed at each horizon makes potential misspecification errors not to be compounded over time.

$$Y_{it+h} - Y_{it} = C^h + A_1^h Y_{it-1} + \beta^h MP_t + \partial^h MP_{t-1} + FE_i^k + \varepsilon_{it+h} \quad (4)$$

$$\varepsilon_{it+h} \sim N(0, \Sigma_\varepsilon^h) \quad (5)$$

This equation is estimated for each of our variables of interest. Therefore, Y_{it+h} includes individually each of the endogenous variables mentioned in the previous section (GDP deflator, real GDP, stock prices, term spread, shadow rate, and both unemployment rate and real labour income for each of our four income classes), at different horizons *h*. Y_{it-1} includes the first lag of the endogenous variables, which are included in the model as control. The estimates are robust to the inclusion of two lags as controls. ε_{it+h} represents the error term. The exogenous shock, MP_t, is directly included in the model both contemporaneously and in first lag form, in order to control for potential first-order autocorrelation. FE are country fixed effects which are included in order to control for unobserved country-specific factors. Equation (4) is estimated for h = 1, 2, 3, 4, 5, 6, and therefore allows us to retrieve the response of the variable of interest to a monetary policy shock up to six years after the shock. Impulse-response functions are computed using the coefficients estimated, β^h, and the associated estimates for the standard errors.

5. Results

First, country specific SVAR models are estimated for each of the income classes, both using sign restrictions and triangular factorisation. The results are presented throughout Figures 5, 6, and 7 and Tables 1 and 2. Looking at Figure 5, results show that an expansionary monetary policy shock equal to minus one percentage point in the shadow rate results in a long-lasting effect on inflation, in particular, the deflator of gross domestic product increases around 0.10-0.15%. The term spread also reacts to the shock, displaying the negative peak impact between -0.1 and -0.3 percentage points around three quarters after the shock. Stock prices seem to increase around 3% during the first year after the shock takes place. Regarding real gross domestic product, it remains 0.3-0.5% above its pre-shock level at least during the sixteen quarters after the shock.

Looking at Figure 6, our results highlight that the response of unemployment rate to monetary easing is largely heterogeneous across income classes. In particular, the lower class displays the largest reaction in size, as seven to ten quarters after the shock it remains around -0.3 to -0.6 percentage points

below the initial value. The magnitude of the response decreases as we go up through the income strata, with the unemployment rate reacting between -0.15 and -0.25 for the lower-middle class, and between -0.1 and -0.15 for the upper-middle class. Regarding the upper class, its unemployment rate does not seem to be significantly affected by monetary policy shocks. This reveals that the greater economic activity promoted by expansionary monetary policies, materialized in more employment opportunities, which seem to have been unevenly distributed among the different income classes. In fact, it has particularly favoured households located in the lower income class as they seem to have captured most of the generated employment. These results suggest that, over the past economic cycle, monetary easing might have helped contain income inequality via the extensive margin of the labour market. However, the positive contribution to the unemployment rate of the lower class seems to have been largely heterogeneous across countries, being particularly sizeable for Ireland, Luxembourg, and Spain, in stark contrast with countries like the Netherlands, Germany and Finland, which display more moderate impacts. These disparities relate to the differences in labour market dynamics across countries. In particular, countries that suffered larger relative increases in the unemployment rate during the recession are those for which our analysis identifies larger impacts (see Table 1).

Figure 7 displays the estimated impulse-response functions for the case of real labour income. First and foremost, this analysis highlights that the labour income perceived by the lower class has not been significantly affected by monetary shocks. For the rest of the income classes the results paint a mixed picture both in terms of magnitude and time evolution. On the one hand, the middle classes (both lower- and upper-middle classes) seem to derive a positive effect on their wages. However, this impact appear to be slow-moving and only becomes significant in the long run, namely around eight to twelve quarters after the shock. On its peak, this impact appears to be as high as 0.15-0.25%. This contrasts with the pattern displayed by the IRF related to the upper class, as labour income for these households already reacts during the first three to eight quarters after the shock, when wages seem to be around 0.3-0.5% above what they would be otherwise. Upper classes in France, Ireland, Italy, Luxembourg, and Spain seem to have particularly benefitted. Overall, these results suggest expansionary monetary policy might have exacerbated income inequality via the intensive margin of the labour market, as the higher income classes seem to have enjoyed a larger positive effect which also tended to materialise sooner in

time. On their side, wages accrued by most vulnerable households seem to have been rather unresponsive to expansionary monetary policy shocks.

We now turn to the results associated with the panel Local Projections methodology, which are displayed in Figures 8, 9, and 10. The reaction of the macroeconomic variables to a negative percentage point impact on the euro area monetary policy shock estimated by Jarociński and Karadi (2020) are displayed in Figure 8. In line with the SVAR methodology, both the GDP deflator and real GDP display a long-lived positive reaction that lasts for around four years. Stock prices also react strongly, being the bulk of the impact concentrated in the first two years. In line with previous estimates, the immediate response of the term spread is negative.

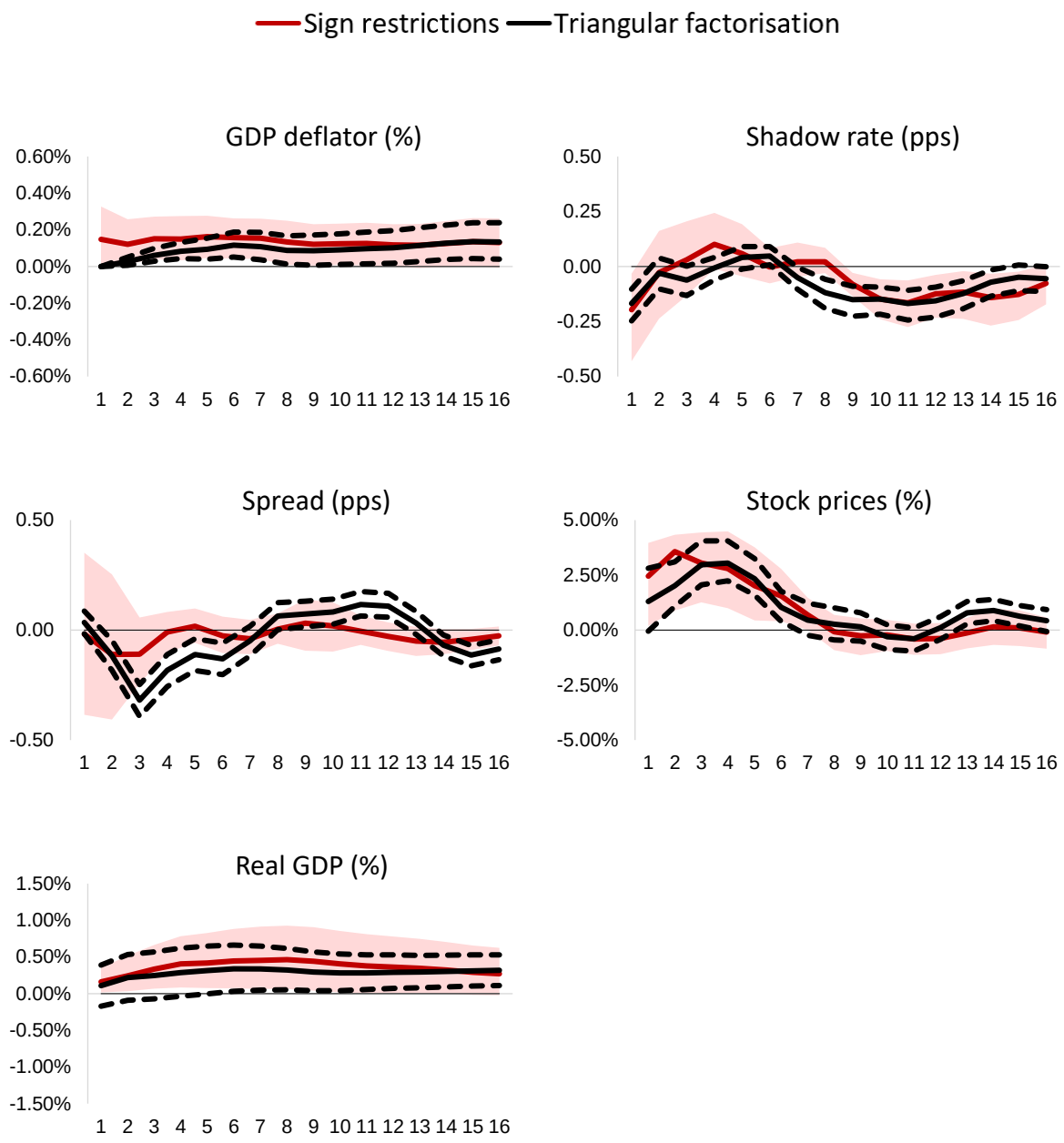
In line with the previous set of results, Figure 9 highlights that monetary easing shocks have helped decrease unemployment rate, being the impact heterogeneous across income classes and particularly larger for the lower class. For these households, unemployment rate seems to have remained around -0.3 to -0.5 during the first two years after the shock. In comparison, the peak impact stood around -0.25 and -0.15 for the lower-middle and upper-middle class, respectively. Regarding the upper class, unemployment rate does not seem to react to the monetary policy shock in a statistically significant manner.

Turning to the reaction of real labour income, Figure 10 reveals the differing patterns across income classes. In particular, wages received by lower- and lower-middle classes only seem to react to the easing shock in the long run. In comparison, the reaction of upper-middle and upper classes appears earlier in time, as their labour income appears to be already around 0.2-0.5% above pre-shock values during the first two years after the shock. The earlier reaction of the salaries of the upper-middle and upper classes is aligned with the findings in the previous section. In a similar fashion to the country-specific estimates for the case of the unemployment rate, the estimated impact for real salaries also present difference across countries. Explorations to the data suggest that countries where salaries fluctuated the most (e.g., Ireland and Luxembourg) are those for which the estimated impact appears to be more sizeable (see Table 2). Aspects related to labour market flexibility are also expected to shape how wages react to countercyclical policies.

Overall, this both analyses (SVAR and LP methodologies) confirm that expansionary monetary policy seems to have decreased income inequality via the extensive margin (i.e., unemployment rate) of the labour market, while increasing disparities across income classes via the intensive margin (i.e., salaries). The last step in our analysis is to compute the total effect on labour income by income classes, decomposing the impact into the extensive and intensive margin. Using the country-specific peak impacts estimated in the SVAR set up (see Tables 1 and 2), we observe that a negative shock to the shadow rate equal to a percentage point leads to an increase in the mean annual labour income of around 1% for the lower class (Figure 11). This impact is almost entirely driven by the reaction of the unemployment rate (i.e., the extensive margin). In comparison, the total impact for the rest of the income classes is much lower and stays between 0.4% and 0.55%. The role played by the increase in salaries (i.e., the intensive margin) increases as we move towards the rightmost side of the income distribution. In particular, the bulk of the positive effect on the labour income for the upper class is derived via wages. When considering the overall implications for all income classes, and in line with Lenza and Slacalek (2018), our results suggest that expansionary monetary policy seems to have helped decrease income inequality via the labour market.

Figure 5. SVAR – Estimated IRFs to an expansionary monetary policy shock (I)

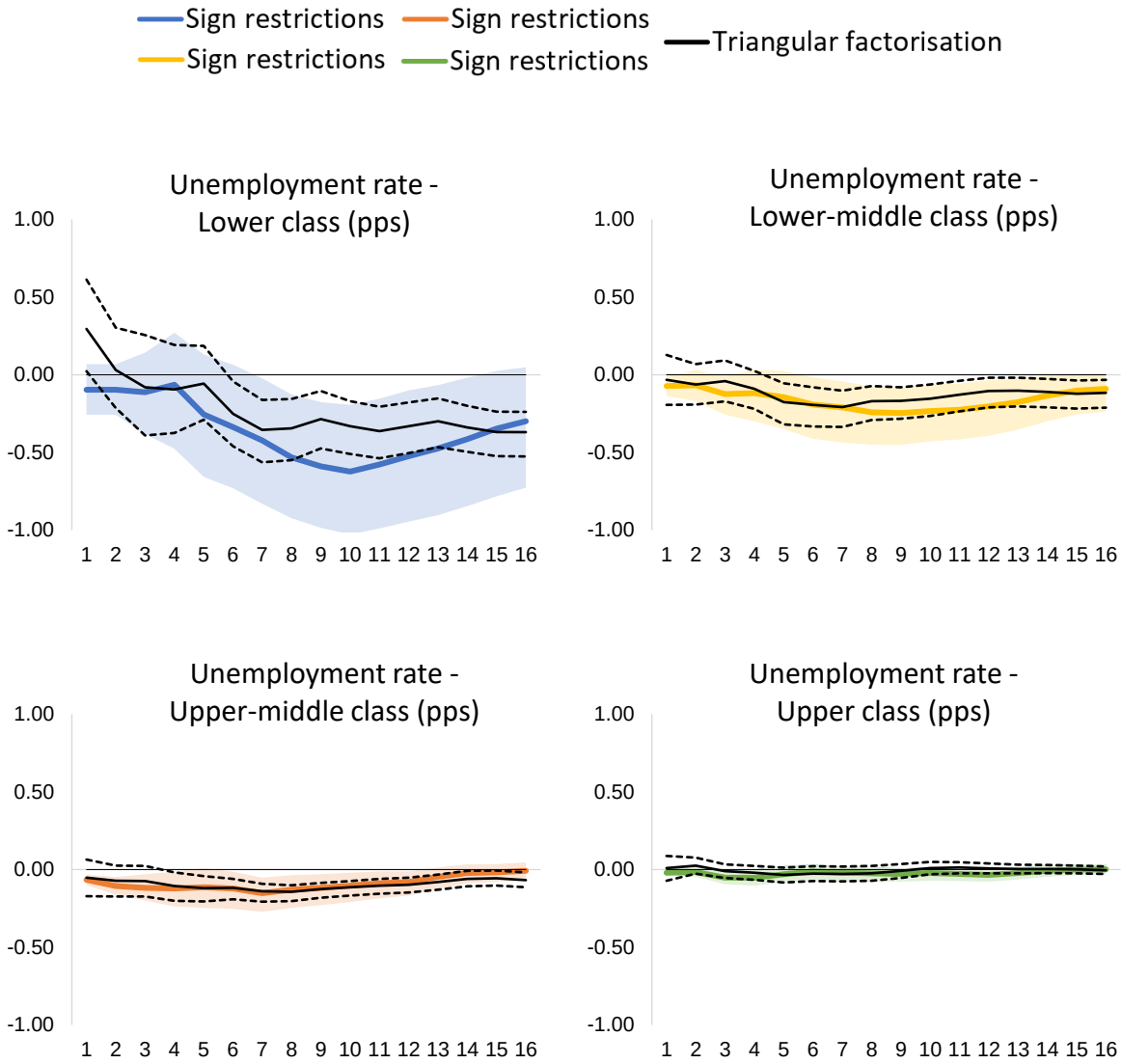
(-1 percentage point shock to an orthogonal deviation in the shadow rate)



Notes: Shaded areas and dotted lines refer to 90% confidence bands. X-axis refers to the number of quarters after the shock.

Figure 6. SVAR – Estimated IRFs to an expansionary monetary policy shock (II)

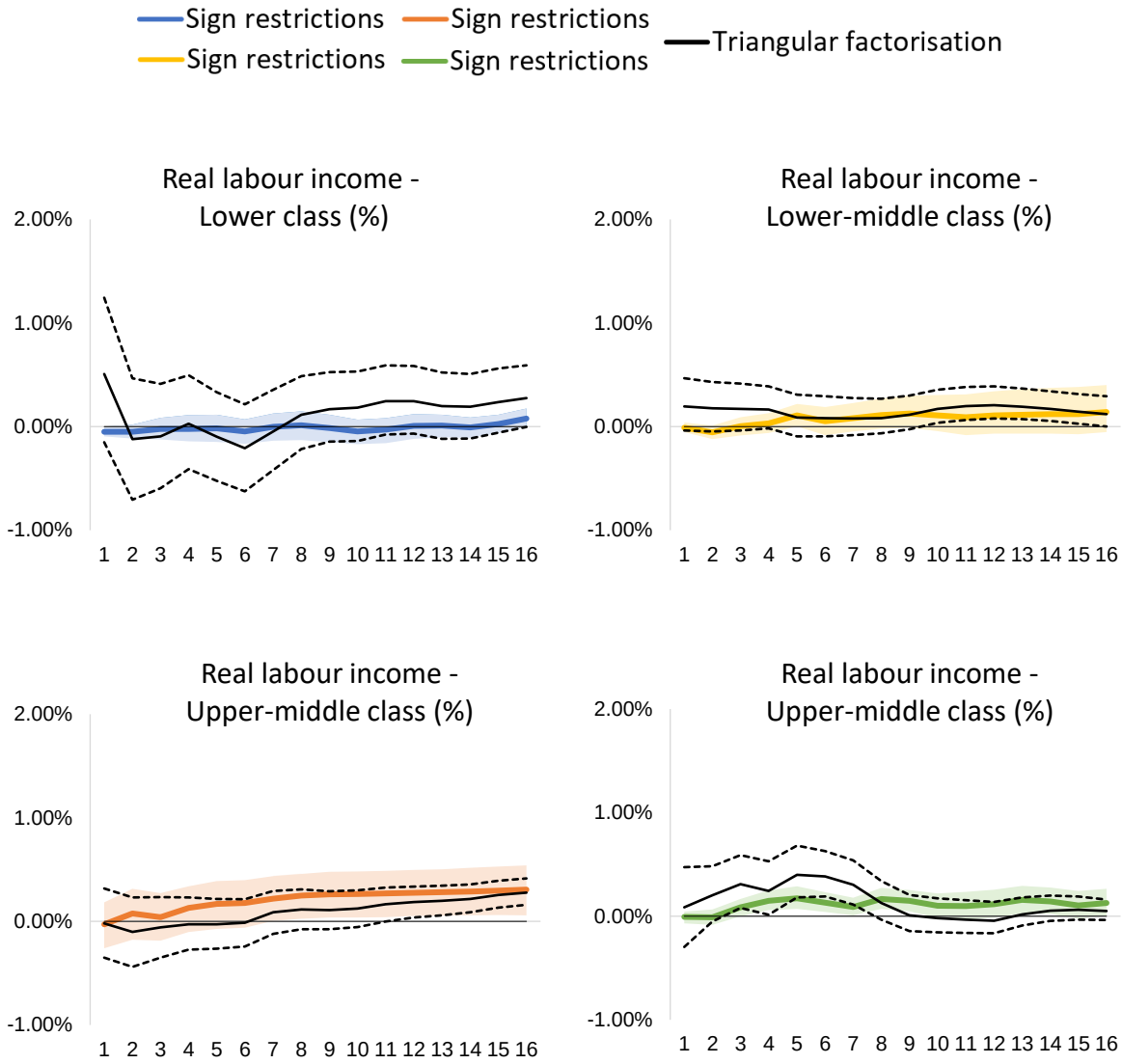
(-1 percentage point shock to an orthogonal deviation in the shadow rate)



Notes: Shaded areas and dotted lines refer to 90% confidence bands. X-axis refers to the number of quarters after the shock.

Figure 7. SVAR - Estimated IRFs to an expansionary monetary policy shock (III)

(-1 percentage point shock to an orthogonal deviation in the shadow rate)



Note: Shaded areas and dotted lines refer to 90% confidence bands. X-axis refer to the number of quarters after the shock.

Table 1. SVAR – Country-specific peak response of unemployment rate (by income classes)

(-1 percentage point shock to an orthogonal deviation in the shadow rate)

		AT	BE	DE	ES	FI	FR	IE	IT	LU	NL	PT	EMU-11
Sign restrictions	Lower-class	-0.53	-0.56	-0.36	-0.93	-0.41	-0.72	-2.36	-0.70	-0.98	-0.24	-0.59	-0.62
	Lower-middle class	-0.24	-0.23	-0.17	-0.19	-0.31	-0.18	-1.55	-0.21	-0.51	0.00	-0.30	-0.21
	Upper-middle class	-0.19	-0.15	-0.11	-0.15	-0.27	-0.11	-1.07	-0.14	-0.39	-0.08	-0.23	-0.15
	Upper class	-0.05	-0.05	-0.05	-0.06	-0.09	-0.03	-0.31	-0.05	-0.11	-0.05	-0.10	-0.05
Triangular factorisation	Lower-class	-0.19	-0.17	-0.18	-0.65	-0.18	-0.35	-2.20	-0.34	-0.58	-0.18	-0.22	-0.34
	Lower-middle class	-0.19	-0.26	-0.19	-0.13	-0.15	-0.20	-0.71	-0.16	-0.15	-0.16	-0.13	-0.19
	Upper-middle class	-0.08	-0.09	-0.10	-0.07	-0.07	-0.08	-1.16	-0.09	-0.09	-0.05	-0.08	-0.11
	Upper class	-0.01	-0.02	-0.04	-0.05	0.00	-0.01	-0.05	-0.01	-0.02	0.00	0.03	-0.02

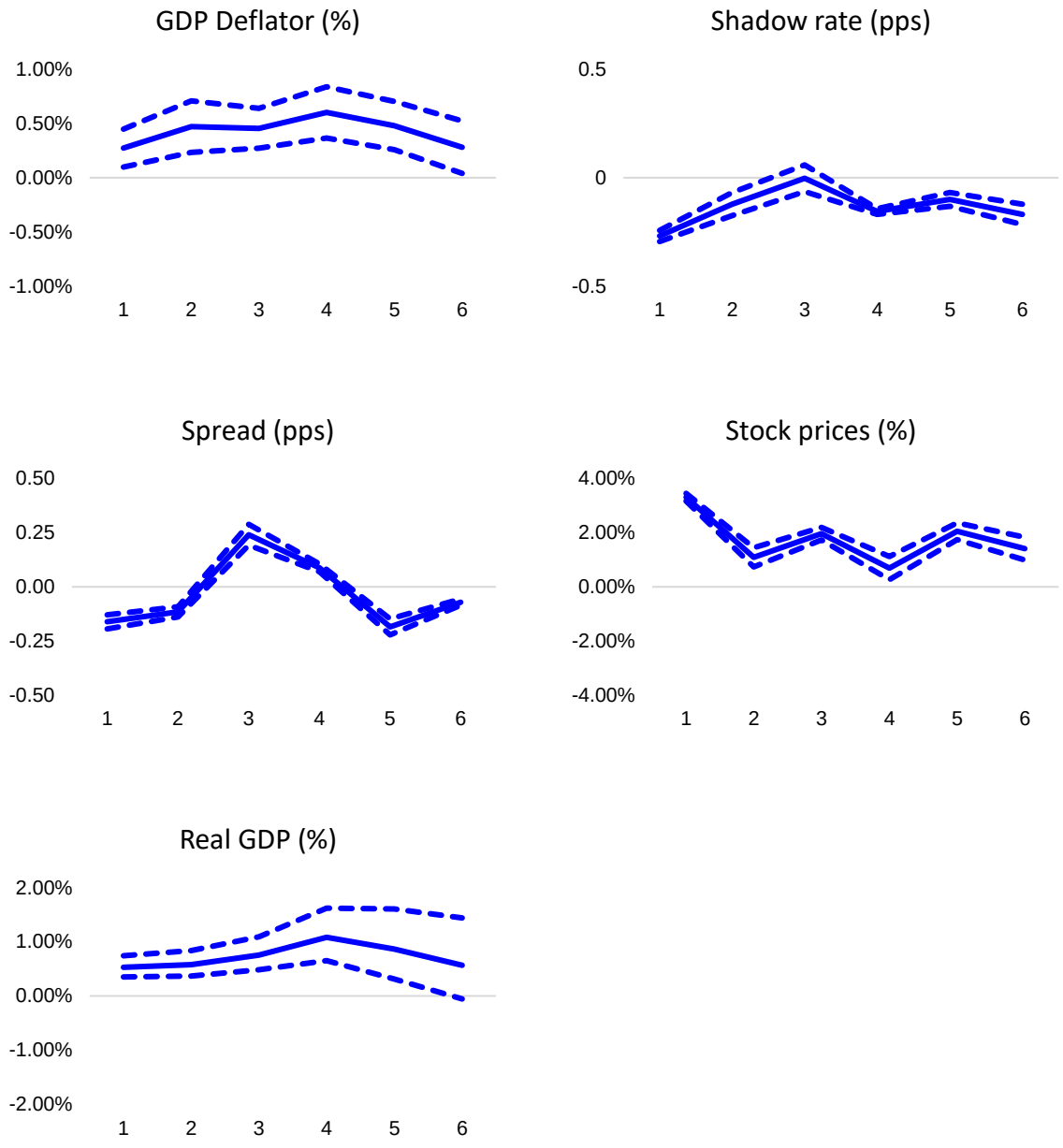
Table 2. SVAR – Country-specific peak response of real labour income (by income classes)

(-1 percentage point shock to an orthogonal deviation in the shadow rate)

		AT	BE	DE	ES	FI	FR	IE	IT	LU	NL	PT	EMU-11
Sign restrictions	Lower-class	0.02%	0.03%	0.03%	0.00%	0.02%	0.02%	0.05%	0.00%	0.03%	0.02%	0.01%	0.02%
	Lower-middle class	0.10%	0.07%	0.12%	0.09%	0.09%	0.09%	0.00%	0.11%	0.10%	0.07%	0.13%	0.10%
	Upper-middle class	0.22%	0.16%	0.15%	0.17%	0.22%	0.13%	0.76%	0.16%	0.32%	0.11%	0.21%	0.17%
	Upper class	0.26%	0.23%	0.20%	0.31%	0.29%	0.38%	0.41%	0.32%	0.41%	0.14%	0.23%	0.28%
Triangular factorisation	Lower-class	0.06%	-0.16%	0.07%	0.02%	0.05%	0.04%	0.08%	-0.02%	0.07%	0.05%	0.03%	0.03%
	Lower-middle class	0.16%	-0.01%	0.20%	0.10%	0.10%	0.21%	0.61%	0.08%	0.08%	0.17%	0.30%	0.17%
	Upper-middle class	0.10%	0.02%	0.33%	0.27%	0.12%	0.16%	0.19%	0.14%	-0.07%	0.12%	0.19%	0.21%
	Upper class	0.15%	0.10%	0.34%	0.76%	0.27%	0.60%	0.42%	0.70%	0.36%	0.16%	0.27%	0.47%

Figure 8. LP – Estimated IRFs to an expansionary monetary policy shock (I)

(-1 percentage point shock to an orthogonal deviation in the shadow rate)



Note: Shaded areas and dotted lines refer to 90% confidence bands. X-axis refer to the number of years after the shock.

Figure 9. LP – Estimated IRFs to an expansionary monetary policy shock (II)

(-1 percentage point shock to an orthogonal deviation in the shadow rate)

Note: Shaded areas and dotted lines refer to 90% confidence bands. X-axis refer to the number of years. After the shock.

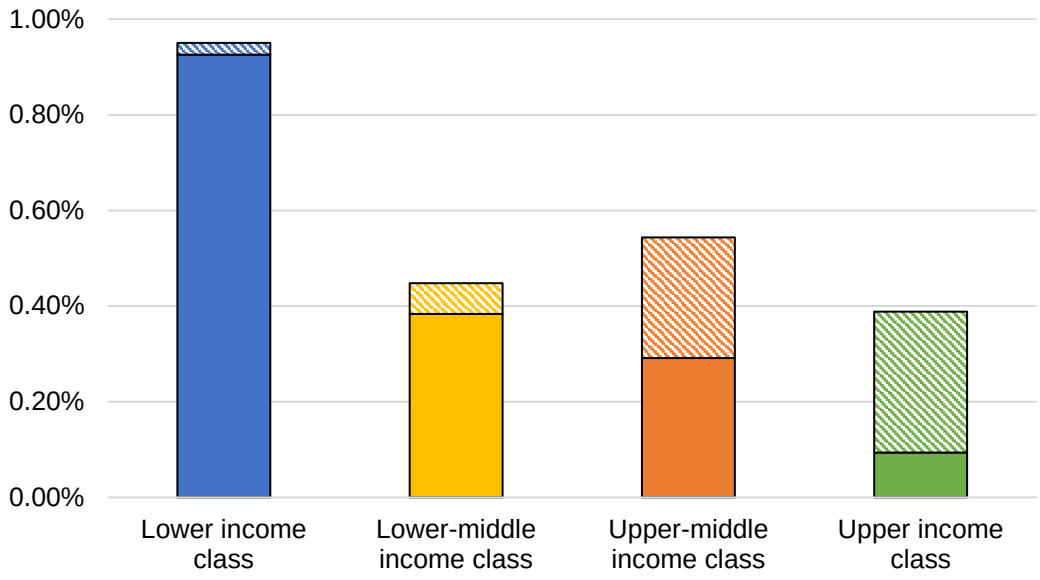
Figure 10. LP – Estimated IRFs to an expansionary monetary policy shock (III)

(-1 percentage point shock to an orthogonal deviation in the shadow rate)

Note: Shaded areas and dotted lines refer to 90% confidence bands. X-axis refer to the number of years after the shock.

Figure 11. Decomposition of the overall impact on mean labour income (in real terms) into the extensive and the intensive margins by income class

(-1 percentage point shock to an orthogonal deviation in the shadow rate)



Note: Figures displays the total effect for all countries (EMU-11) composing our sample. Impacts used for the computation are the peak impacts estimated via the SVAR set up with sign restrictions.

6. Conclusions

This study analyses the impact of ECB's monetary policy across income classes in the countries composing the EMU-11. Looking at the period between 2006Q1 and 2019Q4 and using household survey microdata on employment status and labour income provided by EU-SILC, we compute class-specific unemployment rate and labour income metrics. This allows us to directly estimate the effect of monetary policy on the different income classes, hence complementing the literature up to date, which tends to focus on aggregate inequality metrics such as the Gini index.

We use a dual empirical approach and combine a set of country-specific structural vector autoregressive (SVAR) models estimated at quarterly frequency with models estimated via panel local projections (LP) using data at annual frequency. According to the earnings heterogeneity and income composition channels, we assess the extent to which the reaction of the extensive margin (i.e., unemployment rate) and the intensive margin (i.e., real labour income) to monetary policy shocks have been heterogeneous across income classes.

Our analyses reveal that an expansionary monetary policy shock boosts real gross domestic product and contributes to decrease the unemployment rate while also increases salaries. However, the reaction is highly heterogeneous across income classes. Essentially, looking at the employment status, a monetary easing shock seems to particularly support employment for those at the leftmost part of the income distribution, especially in Ireland, Luxembourg and Spain. The magnitude of the decline in unemployment rate prompted by expansionary monetary policy is comparatively more modest for the lower-middle and upper-middle households, while the unemployment rate of the upper class seems to be largely unaffected.

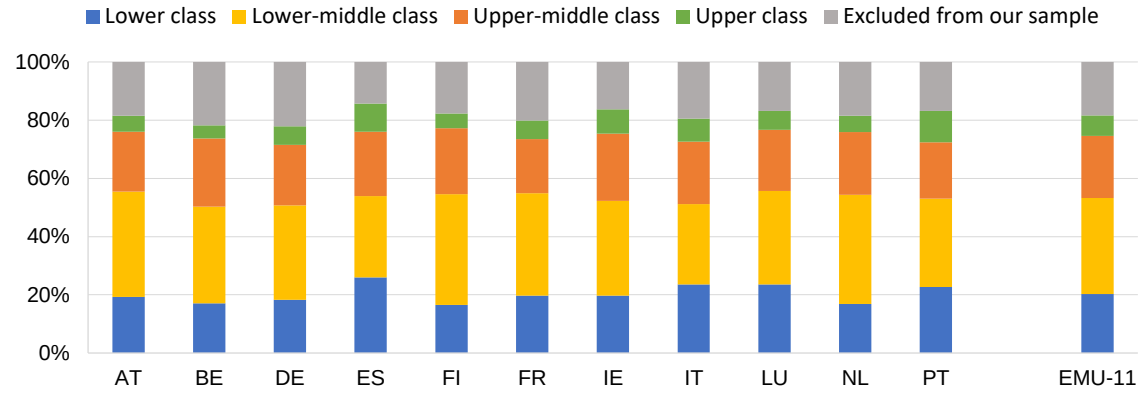
Regarding real salaries, we observe, first, that most vulnerable households do not seem to enjoy an increase in their wages after a monetary easing shock. Second, the impact of monetary policy on middle classes' labour income only becomes significant in the medium to long run, while it materialises earlier in time for the upper class and with more emphasis in countries such as Ireland, Luxembourg, Spain, France and Italy. The fact that employee compensation accrued by the low-income class has remained rather irresponsive to countercyclical monetary policy helps partially understand a stylised fact we document in the text: the increase in wage dispersion during the recession was not fully reversed

in the recovery phase. In this regard, our results reveal that the past expansionary monetary policy might have exacerbated income inequality via the intensive margin.

Overall, when considering the joint impact via both the extensive (i.e., unemployment rate) and the intensive margin (i.e., salaries), we observe expansionary monetary policy seems to have helped decrease income inequality. This is due to the fact that its positive effect on economic activity seems to have particularly boosted employment for most vulnerable households. This positive effect dominates and more than compensates for the increase in income inequality expansionary shocks seem to have prompted via salaries. While these findings qualitatively hold for all countries that compose our sample, our analyses uncover significant differences across countries, highlighting differing labour market dynamics across countries. In particular, countries where unemployment rate and real wages fluctuated the most during the economic cycle are those for which the largest impacts are estimated (see e.g., Ireland, Luxembourg, Spain and Portugal). Aspects related to labour market flexibility also shape how wages react to countercyclical monetary policy.

Our findings are broadly in line with the official standpoint of most central bankers, for whom, even though monetary policy may be neutral or nearly in the long run, in the short-term monetary easing measures are thought to reduce income inequality by stimulating the economic activity and employment. Nevertheless, our results go further as they evidence that monetary stimulus may accrue differentially to households in different parts of the income distribution, with different implications in terms of unemployment and salaries for the different income classes.

Annex 1. Percentage of population represented by each income class



Source: EU-SILC and authors' calculations.

Annex 2. Identification of the SVAR models

Table A. Triangular factorisation – Contemporaneous restrictions

Shock:	GDP deflator	Shadow rate	Term spread	Stock prices	Real GDP	Unemp. rate	Labour income
Response:							
GDP deflator		0	0	0	0	0	0
Shadow rate			0	0	0	0	0
Term spread				0	0	0	0
Stock prices					0	0	0
Real GDP						0	0
Unemp. rate							0
Labour income							

Table B. Sign restrictions – Contemporaneous and one-period ahead restrictions

Shock:	Demand	Supply	Monetary policy
Response:			
GDP deflator	+	-	-
Shadow rate			+
Term spread	+	+	+
Stock prices	+	+	-
Real GDP	+	+	
Unemp. rate	-	-	
Labour income			

Annex 3. Database

Variable	Source	Transformation
Gross domestic product (GDP)	Eurostat	Log-levels
Deflator of GDP (2015 prices)	Eurostat	Log-levels
Eurostoxx 600	ECB Statistical Data Warehouse	Log-levels
Term spread (10y vs. 2y)	ECB Statistical Data Warehouse	Levels (percentage points)
Shadow rate	Wu and Xia (2020)	Levels (percentage points)
Unemployment rate (by income class)	EU-SILC	Levels (percentage points)
Labour market (by income class)	EU-SILC	Log-levels

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