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MONETARY POLICY AND LABOUR INCOME INEQUALITY: A REGIONAL APPROACH

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IES Working Paper 27/2025

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Bibliographic information:
Livorová B., Geršl A. (2025): " Monetary Policy and Labour Income Inequality: A Regional Approach " IES Working Papers 27/2025. IES FSV. Charles University.

Monetary Policy and Labour Income Inequality: A Regional Approach

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October 2025

Abstract:
This paper contributes to studying the impacts of monetary policy on labour income inequality in the euro area using subnational regional data on compensation per employee. The dataset covers 932 NUTS3 regions from 16 countries over the period 2000 – 2022 at a yearly frequency. Using sub-sample analysis combined with local projections, the results show that monetary policy rate changes have heterogeneous effects on the growth of real compensation per employee (deflated by the GDP deflator) at both the bottom and upper ends of the regional distribution within individual countries. From the whole euro area perspective, monetary policy tightening has a heterogeneous effect on labour incomes between regions - in times of monetary policy easing, shortening the gap between average low- and high-income regions.

JEL: E52, J31, R10
Keywords: Monetary Policy, Regional Inequality, Compensation of employees, Local Projections

Acknowledgement: This work is supported by the Grant Agency of the Czech Republic, Grant No. 24-12098S.

1 Introduction

Even though none of the central banks has "a decrease of (income) inequality" in their mandate, policymakers, as well as academia, are compelled by the public to pay attention to this topic. One of the other reasons why to care about inequality is that lower inequality is correlated with faster and more durable growth in the medium term (Ostry, 2014; Ostry, 2018), in other words, inequality can harm growth. Inequality can also increase the likelihood of a financial crisis (Bordo & Meissner, 2012; Rajan, 2010).

From a broad economic theory, looking more deeply at types of household incomes, labour income is usually more concentrated in the low-income percentiles of households and capital income is usually more concentrated in the high-income percentiles of households. Low-skilled households are also more likely to become unemployed during economic downturns than high-skilled households.

Our analysis aims to focus on the broader question of whether and how the development of labour income inequality is influenced by conventional monetary policy. This paper adds to ongoing research by investigating how changes in policy rates affect labour income inequality between individual regions in the euro area. Empirical evidence on the link between monetary policy and regional income inequality is sparse; it is ambiguous whether monetary policy tightening would increase or reduce differences between individual subnational regions. To find out possible heterogeneity in both monetary policy tightening and loosening transmission, we run sub-sample analysis using local projections (*Jordà, 2005; Jordà et al., 2015; Jordà and Taylor, 2016; Ramey and Zubairy, 2018; Jordà et al., 2020)* on subnational regional data for 932 NUTS3 regions in 16 countries over the period 2000 – 2022.[1] We look into the inequality within individual countries as well as within the whole euro area. The analysis is based on yearly data due to the data availability for the dependent and independent variables on a regional level. As the dependent variable, compensation per employee is used as a variable showing labour income in the National Accounts, a statistic widely collected across the EU.

Results of our analysis show that there is a significant negative effect of rise of policy rate on the growth of average compensation per employee at the mean, both in HICP-deflated and GDP-deflator-deflated terms. Heterogeneity is found of the effect of monetary policy on compensation per employee between the same country regions at the highest and lowest ends of the income distribution if we take into account price levels and their development in

[1] The panel is unbalanced as regions and countries enter the sample once they enter the euro area.

individual regions. Suggesting that monetary policy changes affect regional differences within individual countries in the euro area in compensation per employee. These results do not hold for the country-HICP-deflated specification. At the same time, between regions in the entire euro area, at the opposite ends of the income distribution, there is heterogeneity in the estimated effects of monetary policy. In the upper end of the distribution, during monetary policy loosening, the effect tends to be smaller, suggesting that monetary policy loosening mitigates regional differences within the whole euro area in compensation per employee.

Existing literature focuses on economic agents at the ends and in the middle of the income distribution, showing that the effects differ between these parts of the distribution. If these agents tend to cluster geographically, these differences may translate into various responses in highly prosperous and less prosperous subnational regions to monetary policy tightening. This paper contributes to the ongoing research on how monetary policy is transmitted into the economy, as policymakers typically do not adopt the policy in response to specific regional developments.

The rest of the paper is organized as follows. Section 2 provides an overview of the existing literature on how monetary policy impacts income inequality. Section 3 describes data and highlights some facts regarding labour income at the regional level in Europe. Section 4 provides a description of the methodology used, and Section 5 shows the baseline results. Section 6 presents robustness checks, and last but not least, Section 6 concludes.

2 Literature review

Existing literature provides somewhat mixed evidence, as while *Coibion et al. (2017), Mumtaz & Theophilopoulou (2017), Furceri et al. (2018)* and *Guerello (2018)* provide evidence that tightened monetary policy increase income inequality, other paper like *Inui et al. (2017)* or *Cloyne et al. (2020)* show that tightened monetary policy does not have a significant effect on income inequality. Regarding unconventional monetary policy, loosened monetary policy reduced income inequality in some euro area countries (*Ampudia et al. (2018)*, *Casiraghi et al. (2018), Guerello (2018)*, *Lenza & Slacalek (2018)*, *Samarina & Nguyen (2024*)) while in Japan, the UK and the U.S. quantitative easing led to increased inequality (*Saiki & Frost (2020), Montecino & Epstein (2015)*, *Mumtaz & Theophilopoulou (2017)*). Other paper on Japan, *Inui et al. (2017)*, shows insignificant effects of QE on inequality. *Saiki & Frost (2020)* argues that labour market rigidity and the large share of the older population lead to lower impacts of monetary policy through the labour market channel in Japan. *Evgenidis & Fasianos (2023)* underpin the significance of taking into account

specifics of the COVID-19 pandemic when estimating the effects of monetary policy and show that expansionary monetary policy in the U.S. lowers income inequality.

Part of the literature on the effects of monetary policy on inequality is based on various consumption surveys and individual data. *Lenza & Slacalek (2018)* finds mixed effects of unconventional monetary policy (QE) on income (suppressive effects) and wealth (negligible effects) of households in four euro area countries. *Coibion et al. (2017)* show that monetary policy has increased inequality in the earnings and spending of households in the U.S. since 1980. Analysis based on the micro-data from the UK shows the effects of monetary policy on increasing inequality and fluctuations of earnings and consumption by having a larger impact on low-income than high-income households (*Mumtaz & Theophilopoulou, 2017)*. Based on individual data from Sweden, an analysis of *Amberg et al. (2021)* showed that the effects of monetary policy shocks on the income distribution are U-shaped, i.e. the effects are stronger on high- and low-income than on middle-income individuals. Moreover, the transmission path of monetary policy effects differs between those with low-income (via labour-income channel) and high-income (via capital-income channel). Analysis based on this type of data from Denmark showed that softer monetary policy increases labour income of individuals with low income and is a result of higher employment of people at this end of distribution. However, at the same time, a softer monetary policy has even higher impact on non-labour income, i.e. overall increases income inequality (*Andersen et al., 2022*). Asset Purchase Program of the ECB led to large drop of unemployment of low-income households (*Ampudia et al., 2018*).

Other stream of literature is based on aggregated panel data. The impact of monetary policy on regional GDP in the euro area is that tightening worsens regional inequality (*Hauptmeier et al., 2020*). Expansionary monetary policy leads to rise in wages and employment, thus reducing income inequality in 10 euro area countries (*Samarina & Nguyen, 2024*). An analysis of *El Herradi & Leroy (2021)* focuses on the top income shares, showing that the effects of monetary policy shocks are probably propagated via real asset returns channel and that the inequality decreasing effects hold for those with very high income; however, they do not hold for the whole income distribution. *Hajek & Horvath (2018)* find that unconventional monetary policy tightening by the ECB has some international spillover-decreasing effects on economic activity in European countries that are not part of the euro area. Moreover, their analysis shows that the international spillover effects of unconventional monetary policies are somewhat weaker than those of conventional monetary policies.

As was mentioned before, existing literature shows various effects of monetary policy on income inequality and on wealth inequality. *Albert et al. (2020)* show that expansionary monetary policy shock has a significant effect only on wealth inequality, an effect on income inequality is found to be insignificant in the U.S. An analysis of micro-data from Denmark (*Andersen et al., 2022*) shows that loosened monetary policy increases income inequality mainly via non-labour channels, where these monetary policy conditions create larger gains to higher-income-households from disposable income, asset values, net wealth and durable consumption. *Ma (2023)* shows that loosened monetary policy decreases inequality via increasing employment at the lower part of the household income distribution. Research has also been done on the topic of effects on racial inequality – *Bartsher et al. (2021)* show that monetary policy shocks increase differences in wealth between black and white households.

3 Data description and descriptive analysis

3.1 Data description and sources

Our analysis is based on a dataset of both economic and demographic indicators at the level of subnational provinces and regions in Europe. We use data for so-called NUTS3 regions, these regions and provinces are determined by Eurostat's Nomenclature of Territorial Units for Statistics (NUTS), a hierarchical system that divides the territory of the EU, EFTA and candidate EU states into four levels, going from NUTS0 as the nation-state level to NUTS3 representing cities or counties. In our analysis, we focus on NUTS3 regions; these regions have, on average, a population size between 150 thousand and 800 thousand.

Our main data source is the Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy (ARDECO), which is maintained and updated by the Joint Research Centre. Data on the national level are taken from the Annual Macro-Economic Database of the European Commission's Directorate General for Economic and Financial Affairs (AMECO).

Main regional variables used in our analysis are compensation per employee,[2] real gross domestic product, and average hours worked per employee. At the country level, variables for real GDP and inflation were obtained from the AMECO database. At the euro area level, monetary policy shocks, real gross domestic product and inflation were obtained from the AMECO database. Policy rates of the ECB are used as the interest rate. The sample

[2] Compensation of employees is defined as the total remuneration, in cash or in kind, payable by an employer to an employee in return for work done by the latter during an accounting period. (ESA 2010, paragraph 4.02, by Eurostat, 2013). Compensation per employee is computed as the ratio between compensation of employees and number of wage and salary earners (employees).

covers 932 NUTS3 regions[3] from 16 countries (Table 3) over the period 2000 – 2022. The starting point of the sample is chosen based on data availability, and the endpoint corresponds to the last year for which the data are currently available.

An issue connected with showing inequality in income between individual regions is that price level indicators are usually available only on the country level and not on the regional level (only a limited number of statistical offices provide official regional data on price levels). Omitting differences in price levels within countries and the euro area may lead to erroneous inferences regarding impacts on households (like limitation of the purchasing power). A recently published study by *Šedivý and Jánský (2025)* contains a databases of 23 countries of regional price levels, that unfortunately does not cover our full sample and is inefficiently detailed. To address the issue, we tried to deflate the nominal values by regional GDP deflators, thus, including the regional differences in prices. We show the results also for nominal values deflated by country HICP for showing the effects of monetary policy on labour income. However, we consider the regional GDP deflator to be a better indicator to capture labour income inequality and its implications for the purchasing power.

3.2 Descriptive analysis

In the descriptive analysis, we will focus on the dependent variable, more specifically on the heterogeneity in compensation per employee within the euro area. Starting from a nominal point of view, in our sample, one can observe heterogeneity in nominal compensation per employee, where the average nominal compensation per employee per year in 2022 was lowest in Greece (20,187 EUR) and highest in Belgium (64,458 EUR). In the same year, average nominal compensation per employee in individual regions in our sample ranged from 15,761 EUR per year in *Ioannina* region in Greece to 250,524 EUR in *Lozère* region in France. In real terms (in prices of 2022), the real compensation per employee (deflated by HICP) ranged from 17,317 EUR2022 (Latvia) to 52,864 EUR2022 (Belgium) on a country level and from 14,172 EUR2022 to 219,681 EUR2022 on a regional level (Table 1). Similarly, the real compensation per employee (deflated by GDP deflator) ranged from 17,569 EUR2020 (Greece) to 58,212 EUR2020 (Belgium) on a country level and from 14,320 EUR2020 to 225,860 EUR2020 on a regional level. In this comparison, we see that heterogeneity in compensation per employee intensifies with a higher granularity of data.

[3] We follow the existing literature and exclude five NUTS2 regions of the French overseas territories of French Guyana, La Reunion, Guadaloupe, Martinique and Mayotte.

Table 1: Heterogeneity at country- and regional-level (in year 2022)

		Mean	*St. Deviation*	*Minimum*	*Maximum*
Nominal compensation per employee	*Country*	38,798	14,146	20,187	64,458
	Region	44,680	12,941	15,761	250,524
Real compensation per employee	*Country*	38,383	12,546	17,317	52,864
(deflated by HICP, prices of 2022)	*Region*	37,942	10,883	14,172	219,681
Real compensation per employee	*Country*	34,789	12,812	17,569	58,212
(deflated by GDP deflator, prices of 2020)	*Region*	41,364	12,538	14,320	225,860
Number of observations	*Country*	16			
	Region	932			

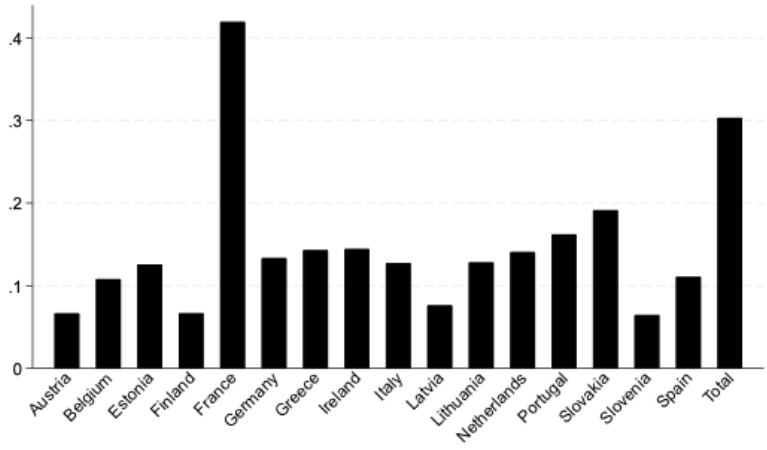
From a map of European countries included in our sample (Figures 1 and 2), we can observe a heterogeneity both across regions within countries of the euro area and within the euro area as a whole (also that there is a geographical clustering in real compensation per employee). Darkest colour shows the regions in the highest quartile of compensation per employee distribution. Patterns of some within-country income inequality can be best observed in countries like Germany and France, with a lot of regions. There are regions with high compensation per capita, usually close to the capital. Figure 2 show that there are clusters within the euro area. The highest compensation per employee is in Austria, Germany, France, and Benelux. Another cluster are regions with lower real compensation per employee in regions in southern Europe (Spain, Portugal, Greece and Italy) and Baltic countries. Moreover, looking at the countries of the euro area, the map shows a form of core-periphery division that is also emphasized in other contexts within the euro area. In the Appendix, maps of heterogeneity splitting the distribution into deciles are included (Figures 33 and 34).

Figure 1: Heterogeneity across countries in euro area in real compensation per employee (deflated by GDP deflator) in 2022

Figure 2: Heterogeneity across euro area in real compensation per employee (deflated by GDP deflator) in 2022

The coefficient of variation (CV)[4] differs from country to country, showing that the highest differences between individual regions in the compensation of employees in GDP-deflator-deflated terms were in 2022 in France, Slovakia, and Portugal. The lowest differences in compensation per employee between regions are in Finland and Slovenia. Figure 3 also shows that there are high differences between individual regions in the euro area[5] in the compensation levels. Further supporting the view that with less granular (national) disaggregation of the data on income, some important aspects of income inequality in the euro area would be missed.

Figure 3: Coefficient of variation of compensation per employee in real terms (deflated by GDP deflator, in year 2022)



Figures 4 and 6 show that compensation per employee deflated by HICP and GDP deflator (shown in the figure as index with base year 2008) grows during the period 2001 – 2022 in the bottom regional decile more than compensation per employee in the top decile, suggesting that income inequality between regions declines over the sample period. However, Figures 5 and 7 depict that even though regional income inequality has declined, the difference between the average yearly real compensation per employee (deflated by HICP) at the top and the bottom in 2022 was 16 thousand EUR2022.

Overall, descriptive analysis presented in this part of the paper show that there is some level of heterogeneity in average yearly compensation per employee in the euro area and this heterogeneity intensifies at regional level. Providing an interesting dataset to study distributional effects of monetary policy transmission.

[4] Computed as ratio of the standard deviation over the mean of real compensation per employee.
[5] Cyprus and Malta are not shown in this graph, since these countries have only 1 or 3 NUTS3 regions and are excluded from our analysis. For more details, see part about results.

Figure 4: Evolution of average real compensation per employee (deflated by HICP) in selected deciles (index, base year = 2008, whole euro area distribution)

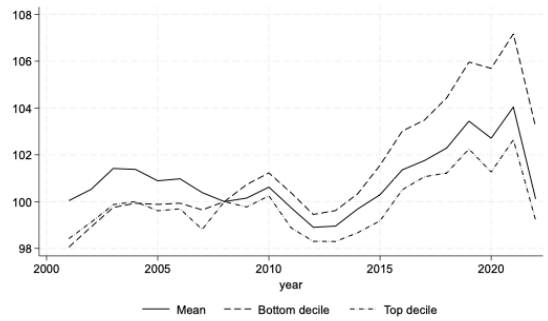


Figure 5: Evolution of average real compensation per employee (deflated by HICP) in selected deciles (, whole euro area distribution)

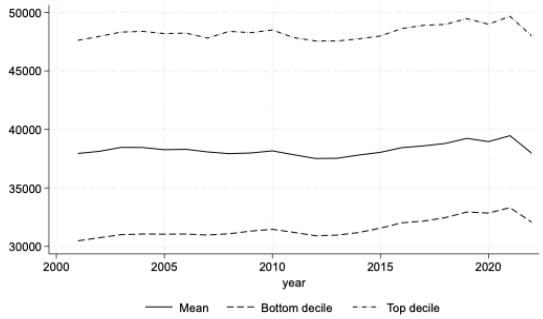


Figure 6: Evolution of average real compensation per employee (deflated by GDP deflator) in selected deciles (index, base year = 2008, whole euro area distribution)

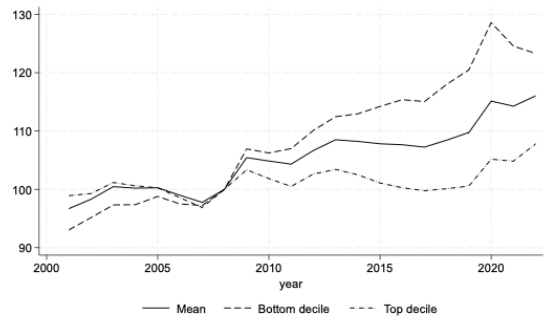
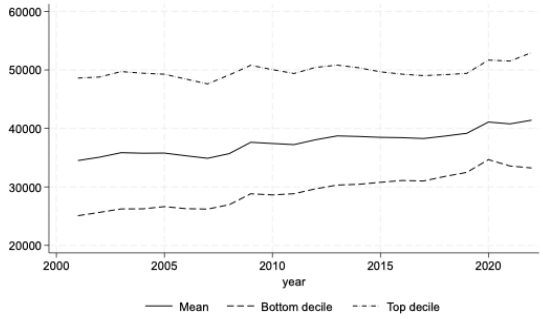


Figure 7: Evolution of average real compensation per employee (deflated by GDP deflator) in selected deciles (whole euro area distribution)



4 Methodology

4.1 Baseline model to see the mean response in the whole sample

In the analysis of the whole dataset, we apply *Jorda's (2005)* local projections combined with fixed effects[6] method on a set of regressions (used for example in *Jordà et al., 2015; Jordà and Taylor, 2016; Ramey and Zubairy, 2018; Jordà et al., 2020)* in the following form:

$$y_{i,t+h} = \alpha_i + \beta_h \Delta i_t + \gamma_h X_{i,t} + \delta_h X_{j,t} + \varepsilon_h X_{k,t} + \epsilon_{i,t+h},$$

where Δi_t is the year-on-year change in policy rate.[7] The dependent variable $y_{i,t+h}$ denotes the average compensation per employee in region *i* and year *t+h*; α_i is a set of regional fixed effects; i_t is the average monetary policy rate in year t; $X_{i,t}$, $X_{j,t}$ and $X_{k,t}$ stands for the time-

[6] By using fixed effects, we counter for the effects of population size or long-term effects of Cohesion Policy funds that have an effect on income convergence acceleration in the EU countries as shown in *Savoia (2024)*.
[7] See Figure 53 in the Appendix.

variant control variables at the regional-, country- and euro-area-level. $\epsilon_{i,t+h}$ represents the error term. Except for the monetary policy rate, variables enter the equation in a form of log-level growth. The regional control variables include worked hours per employee of the region and real gross domestic product; the country control variables include (HICP) inflation and real GDP of country *j*, of which region *i* is a part. From the control variables, real GDP and inflation on the country level are included to capture the differences in the countries' economic development. As the ECB sets monetary policy for the whole euro area and by its decision about policy rates into account HICP inflation rate and economic activity development in the euro area as a whole, we add these variables into the equation.

The choice of methodology is based on the fact that we are able to explore how monetary policy (and macroeconomic variables) influence the growth of compensation per employee at different time horizons, while at the same time, this model does not impose dynamic restrictions embedded in VAR models and these two methodologies perform similarly at short horizons (*Li et al., 2024*). Moreover, as presented in *Jordà and Taylor (2024)*, LP's framework is an encompassing one for studying heterogeneous effects in panel data even when faced a decision between lower bias and lower variance. As our sample covers the period after the Great Recession, when unconventional monetary policy instruments have been used by the ECB, therefore we run the equation also with the shadow policy rate (*Krippner, 2013*; *Krippner, 2020*) as a robustness check.

In our analysis, we focus on the effect of monetary policy on the compensation of employees, so our main result is the impulse response of regional compensation of employees to a change in the monetary policy rate in year *t*. This is captured by the coefficient β_h for yearly-horizons *h*, which is unbiased under the assumption that in the equation, we control for relevant macroeconomic conditions and the monetary policy does not respond to the development of the economic activity and labour market at regional level according to the mandate of the ECB. Regional data also usually suffer from a long lag of publication delays and availability mainly on yearly frequency. Therefore, at the time when monetary policy is set, the data are usually missing.

As we cover countries that are part of the euro area, we decided to also look for potential heterogeneity in effects on income inequality within the monetary union as a whole and not only at heterogeneity within the countries. The monetary policy for all countries included in the

sample is set by the ECB, while the Governing Council is targeting inflation in the euro area as a whole.[8]

4.2 Modelling differences across regions

In our analysis, we also want to analyse how the response of compensation per employee to the changes in monetary policy differs across the regional distribution based on this variable. To estimate the heterogeneity of responses, we rely mainly on sub-sample analysis. [9]

In the sub-sample analysis, we group the regions according to their position in the distribution of the level of compensation per employee[10] and allow the coefficients in our baseline model to differ across groups. Specifically, we split the dataset based on a dummy variable D_{it}^{d} for each decile (quartile) d that becomes 1 for all NUTS3 regions whose level of real compensation per employee belongs to the decile (quartile) d within year t and D_{it}^{d} is zero otherwise. The results we obtained are quartile- and decile-specific coefficient estimates, providing us a different view and informative cross-check on the effects of monetary policy on regions with various compensation-of-employees levels. Even though this type of analysis is conceptually distinct from quantile regressions (pointed out and presented as a valid approach by *Koenker and Hallock, 2001*), we are interested in the long-time effects of widening or closing the income gap in the euro area and thus, sub-sample analysis approach is used as it provides a quite flexible framework to capture differences in the adjustment to monetary policy states across various regions. In the analysis, we focus on both within-country and across the whole euro area inequality.

4.3 Units of the dependent variable

In our analysis, we run the regressions in two specifications: in real terms deflated by country HICP, and in real terms deflated by regional GDP deflator. All countries in our sample

[8] Countries entering the euro area after 2000 are part of the sample only for the years they are part of the euro area.

[9] We tried to use quantile analysis as well, where the regions are grouped by their position in the compensation per employee distribution, and the coefficients are allowed to differ across individual groups. We followed the quantile regression approach by *Powell* (*2022*). This approach enables us to control for unobserved heterogeneity while estimating quantile-specific coefficients of the covariates in our model, and the estimates are consistent for small T, which is the case in our panel data. We estimated the model using Markov-Chain-Monte-Carlo methods *(Baker, 2014).* The approach follows the growing literature on quantile estimation techniques on macroeconomic data *(Adrian et al., 2019; Adrian et al., 2022; Hauptmeier et al., 2020).* However, this approach fails to provide an answer to our research question as the regions included in our sample switch the quantiles back and forth during our sample period. Therefore, the results only show the effects of monetary policy on regions with the highest and the lowest tempo of growth during the specific year. Failing to show whether it intensifies or reduces the heterogeneity of compensation per employee between regions over our sample period, we therefore decided not to use it in our analysis.

[10] For each specification of the variable (HICP deflated, GDP deflator deflated), we rerun the grouping of regions.

are part of the euro area, thus, they use a common currency, the Euro. In order to capture the labour income inequality between the regions, nominal terms may not fully capture the story because of various inflation developments between the countries. HICP is available at a country level; thus, by deflating the nominal variable by HICP, we capture different price levels between various countries. GDP deflator is available at a regional level, thus we are able to, to a limited extent, capture price developments in individual regions. Even though we do not capture various price levels between the regions perfectly (for example, data for the deflator of consumption on the regional level would be a better fit), we believe that the results of our analysis still show the story about inequality between regions.

5 Results

5.1 Responses to monetary policy at the mean

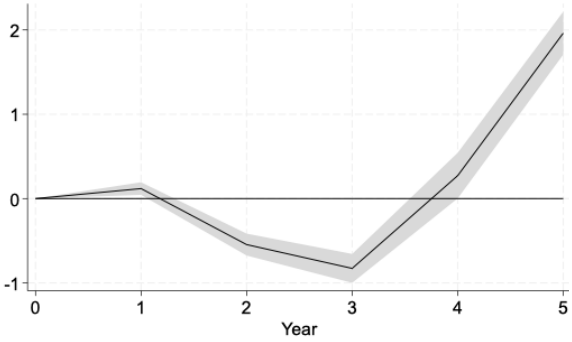
First, we estimate the mean response of compensation per employee in real terms by local projections with fixed effects. Since we are interested in the income inequality across European regions, we are more interested in the effects of monetary policy on compensation per employee in real terms than in nominal terms. Results of the estimation are presented in Figures 8A and 8B, Figure 8A showing the response of real compensation per employee (HICP deflated) to a 100 basis points increase in policy rate. There is a transmission lag between monetary policy rates change and real compensation per employee. Examining the results of the real variables, we must consider an observed trend noted by, for example, *Jordà & Nechio (2023),* which indicates that nominal wages increase with a lag after inflation rises. Since policymakers usually react with monetary policy to inflationary pressures and try to bring inflation close to the inflation target not immediately but within the medium-term (inflation-target horizon), the effect of monetary policy on real compensation per employee with the aim of calming down additional inflation pressures from labour market may be not seen at 1-year horizon. Therefore, one should not be surprised that the effect of monetary policy on real compensation per employee starts to be more propagated with a two-year lag. The monetary policy impact cumulatively builds up and peaks at the three-year horizon, and then it bounds back. Figure 8A shows an implied contraction of 0.5 ppt and 0.8 ppt, respectively, of the real compensation per employee (average yearly growth rate of real HICP-deflated compensation per employee in our sample is 0.24 %) in years *t+2* and *t+3* by the impulse response. Overall, the effect of monetary policy tightening on HICP-deflated compensation per employee seems to be delayed but significant at the mean. Meaning that tightening of monetary policy helps to decrease inflationary pressures from the labour income, where higher growth in labour income could

possibly further propagate into quicker growth of consumption of households and inflationary pressures.

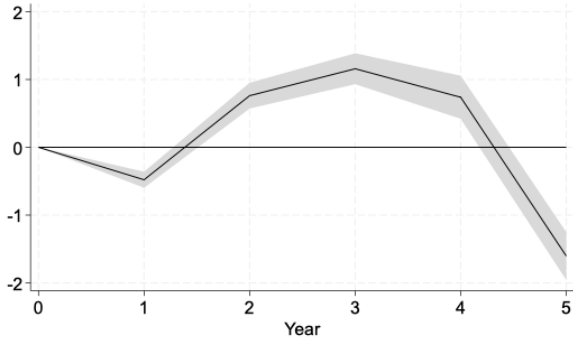
Results of the estimation presented in Figure 8B show the response of real compensation per employee (deflated by GDP deflator) to a 100 basis point increase in policy rates. In comparison with the results for compensation per employee deflated by HICP, the effect is more propagated in year *t+1*. In year *t+2,* the effect of monetary policy bounces back and is not propagated further till the end of the plotted horizon. The impact of monetary policy the impulse response implied contraction by 0.5 ppt in year t+1 in real compensation per employee (average yearly growth rate of real compensation per employee in our sample is 1.8 %). Overall, the impact of monetary policy on HICP-deflated compensation per employee is significant and delayed. This is in line with results of *McCallum and Smets* (2007). However, these results are not in line with results of *Cantore et al. (2021)*, their estimated the effect of monetary policy rate shock on real wages in the euro area is statistically insignificant and close to zero.

Figure 8: Impact of policy rate increase on compensation per employee at the mean

Panel A: Real compensation per employee (deflated by HICP, prices of 2022)



Panel B: Real compensation per employee (deflated by GDP deflator, prices of 2020)



Note: Vertical axis refers to the cumulative reaction (in p.p.) of nominal compensation per employee to 100 basis point increase in policy rates. Horizontal axis refers to horizon of IRF (year). Solid line shows point estimates, shaded areas denote 95 % confidence bands.

Our sample spans the period from 2014 to 2021, during which monetary policy rates were near zero and remained relatively unchanged, which may impact our results. The focus in recent literature is on periods when policy rates were near zero. Therefore, the existing literature on the euro area primarily examines the impact of loosened monetary policy on reducing income inequality (*Lenza & Slacalek, 2018; Samarina & Nguyen, 2024*). Our results are in line with

these two papers; however, we do not take into account unconventional monetary policy tools. Therefore, we replace the policy rate with the shadow rate (see part Robustness Checks).

5.2 Heterogeneity across quantiles within countries of the euro area

In this part, we focus on the possible heterogeneity in the effects of monetary policy on labour income between regions within the same country. Thus, we present results for various parts of the distribution. From the perspective of the sub-sample analysis based on the distribution of HICP-deflated compensation per employee, there appears to be little or no heterogeneity in monetary policy transmission across the regions. Figures 9 and 10 suggest that there is no heterogeneity in the interquartile range or between the bottom and top deciles from year *t+3* to year *t+5* and a little heterogeneity in year *t+1* and *t+2*.[11] The negative impact of monetary policy on the growth of HICP-deflated compensation per employee is pronounced in both quartiles; however, it is a bit stronger (in year *t+3*: 0.7 ppt for the bottom decile vs. 0.4 ppt for the top decile) in the bottom quartile. The effect of monetary policy is negative for the bottom decile, however, it is slightly positive or zero for the top decile of regions.

Looking from the perspective of GDP-deflator-deflated in various specifications (Figures 11 and 12), the heterogeneity of monetary policy effects between the same-country-regions at the other ends of the distribution mostly appears to be propagated between top and bottom deciles and not propagated in the interquartile range. Using GDP-deflator-deflated-real-terms, there seems to be a difference in reaction between the regions with the highest and lowest average labour income. There is a significant negative effect of monetary policy in year t+1 in the bottom quartile (decile) and a negligible reaction till the end of the plotted horizon. In the top quartile (decile), there seems to be a positive effect of monetary policy. Compared with the HICP-deflated values, we can see that the positive sign is primarily influenced by the development of the deflator, rather than by nominal compensation per employee.

Overall, the results imply that even though the country-HICP-deflated real wages would imply that there is no difference in the reaction to monetary policy between high- and low-average-labour-income regions, taking into account various developments in prices between the regions, there is a difference in effects in high- and low-average-labour-income regions, implying some effects on the purchasing power. This can be interpreted as when we take into account the variance in price developments as a reaction to monetary policy in the individual regions, monetary policy loosening does help to further ease the gap between regions with low

[11] In the regressions for the top and bottom quartile, Malta and Cyprus are not included since these countries contain less than 4 NUTS3 regions. In the regressions for top and bottom decile, Cyprus, Estonia, Ireland, Latvia, Malta, and Slovakia are excluded for the same reason (as they contain less than 10 NUTS3 regions).

compensation per employee and high compensation per employee within the individual countries in the euro area in the interquartile range.

To our knowledge, there is no paper on the effects of monetary policy on regional inequality in terms of labour income. However, the results in real terms (HICP deflated) in top and bottom quartiles and deciles are in line with the results based on the whole-country income distribution of *Coibion et al. (2017), Mumtaz & Theophilopoulou (2017), Furceri et al. (2018)* and *Guerello (2018)* that tightened monetary policy increases income inequality.

Figure 9: Impact of policy rate increase on real compensation per employee (deflated by HICP): bottom vs. top quartile of within-country regions

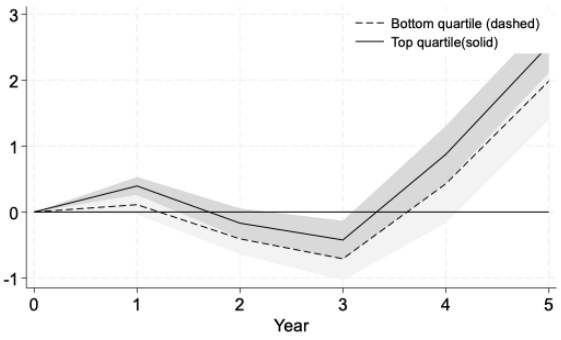


Figure 10: Impact of policy rate increase on real compensation per employee (deflated by HICP): bottom vs. top decile of within-country regions

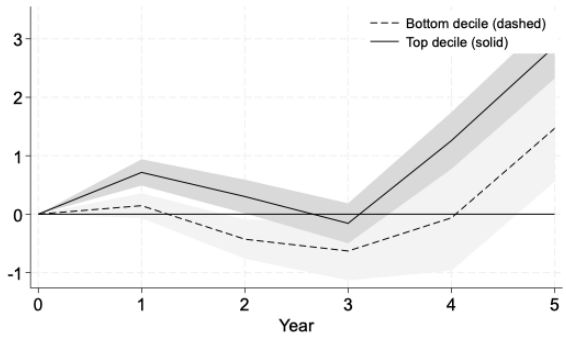


Figure 11: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator): bottom vs. top quartile of within-country regions

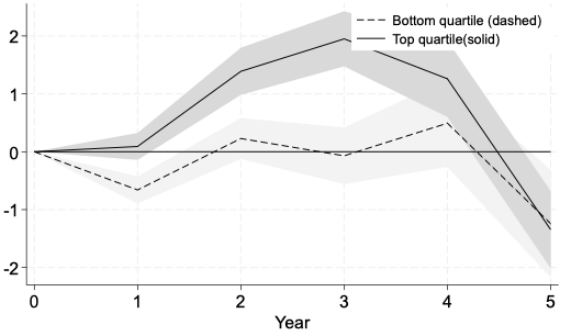
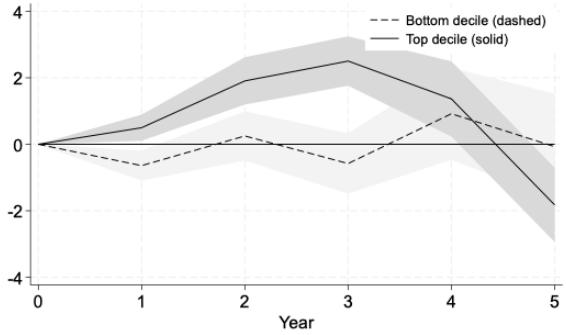


Figure 2: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator): bottom vs. top decile of within-country regions



Note: Vertical axis refers to the cumulative reaction (in %) of compensation per employee to 100 basis point increase in policy rates. Horizontal axis refers to horizon of IRF (year). The solid (dashed) line shows point estimates, shaded areas denote 95 % confidence bands.

5.3 Heterogeneity across quantiles within the euro area as a whole

As the ECB conducts monetary policy for the entire euro area, it may be interesting to investigate whether monetary policy has an effect on income inequality between regions within the euro area as a whole. Only countries with four or more NUTS3 regions are considered in this analysis to maintain consistency with the previous part.[12] In HICP-deflated terms, there is a significant difference in the impact in the bottom and top quartiles (Figure 13), while in the top quartile of the distribution, the cumulative effect of monetary policy change by 1 ppt is -0.7 ppts on HICP-deflated compensation per employee; in the bottom quartile, the effect is 1.6 ppts in year *t+3*. Similar differences in estimated effects can be spotted between the top and bottom deciles (Figure 14). Thus, the results suggest that, in HICP-deflated terms, loosened monetary policy helps to widen the gap between high- and low-labour-income regions in the euro area.

Opposite to the HICP-deflated compensation per employee analysis, in the GDP-deflator-deflated analysis, the results (Figures 15 and 16) show a stronger negative effect of monetary policy tightening on real compensation per employee in the bottom quartile of the distribution (and not the top quartile). Thus, the results for these specifications suggest that monetary policy has heterogeneous effects on the labour incomes between the regions in the whole euro area from both interquartile and interdecile perspectives. Moreover, it pinpoints the difference in using regional price developments and whole-country price developments.

Figure 13: Impact of policy rate increase on *real compensation per employee (deflated by HICP)*: *bottom vs. top quartile* of within-euro-area regions

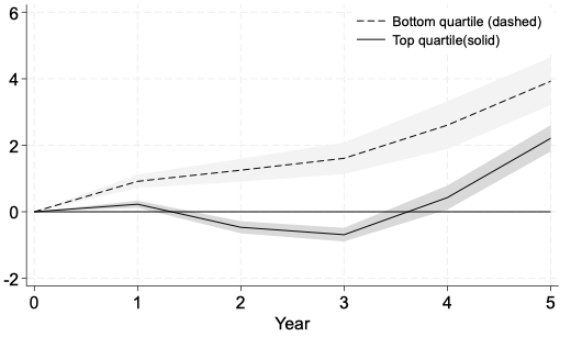
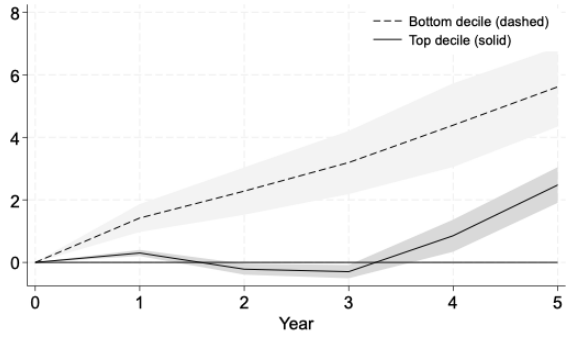


Figure 14: Impact of policy rate increase on *real compensation per employee (deflated by HICP)*: *bottom vs. top decile* of within-euro-area regions



[12] The results have been estimated also for the whole euro area (including Cyprus and Malta) with no significant difference in the results.

Figure *15*: Impact of policy rate increase on real compensation per employee *(deflated by GDP deflator)*: *bottom* vs. *top quartile of within-euro-area regions*

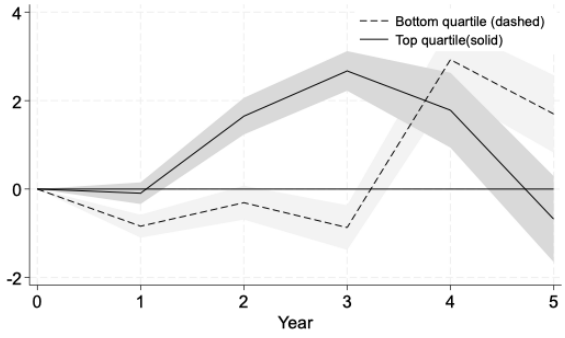
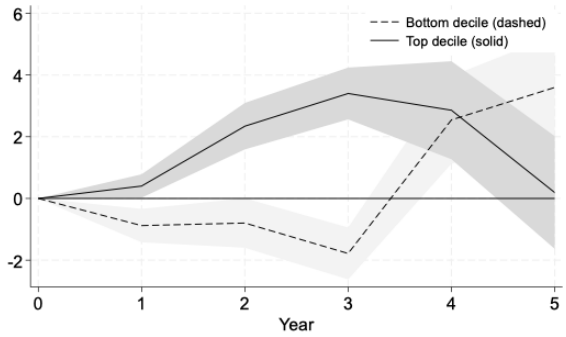


Figure 16: *Impact of policy rate increase on real compensation per employee (deflated by* GDP deflator*): bottom vs. top decile* of within-euro-area regions



Note: Vertical axis refers to the cumulative reaction (in %) of compensation per employee to 100 basis point increase in policy rates. Horizontal axis refers to horizon of IRF (year). The solid (dashed) line shows point estimates, shaded areas denote 95 % confidence bands. The solid line depicts the estimates for the higher percentile and dashed line depicts estimates for the lower percentile.

5.4 Analysis by Economic Sectors (NACE)

In this part, we look at whether compensation per employee in individual economic sectors plays some role in the story. Figures 17-22 present within-country results for the available split of the data by Economic Sectors of *Agriculture* (NACE A), *Industry* (NACE B-E), *Construction* (NACE F), *Trade, Transport, Accommodation and Information Services* (NACE G-J), *Financial, Real Estate, Professional and Administrative Services* (NACE K-N) and *Non-market services* (NACE O-U). Presented here are results in compensation per employee deflated by the GDP deflator, as we consider them the most representative to show the effects on labour income. The results show that in regions in the bottom quartile of the average compensation per employee for all sectors and in the top quartile of the average compensation per employee for all sectors, monetary policy has not significantly heterogenous effect on compensation per employee in *sectors of Agriculture and Construction.* In the industries of *Industry, Trade, Transport, Accommodation and Information Services,* and *Financial, Real Estate, Professional, and Administrative Services, as well as Non-market services,* the effect of monetary policy is heterogeneous between the top and bottom quartiles; in most cases, the slowing effect of monetary policy change is stronger for the bottom quartile. Results for part of the sectors support the original story of a heterogeneous reaction of real compensations per employee between the top and bottom quartiles from an all-sectors-combined point of view; others show that this is not a sector-wide story.

Figure 17: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Agriculture* (NACE A), within-country distribution

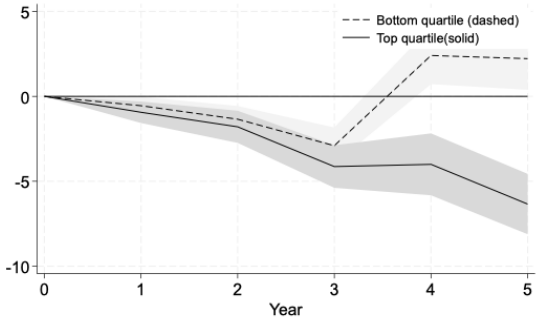


Figure 18: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Industry* (NACE B-E), within-country distribution

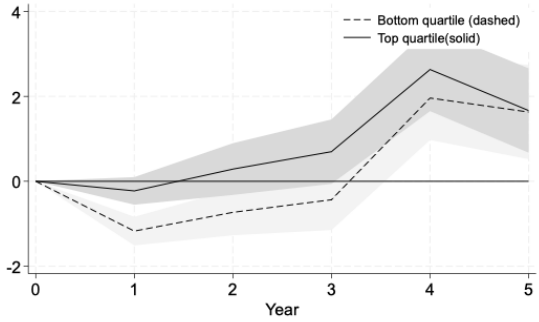


Figure 19: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Construction* (NACE F), within-country distribution

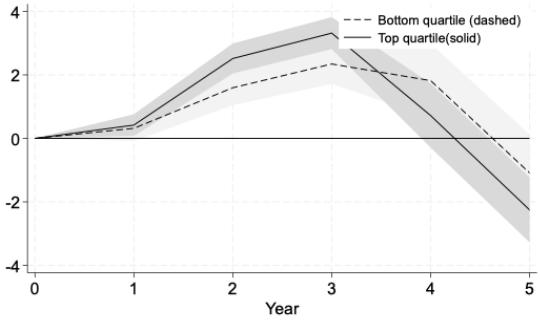


Figure 20: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Trade, Transport, Accommodation and Information Services* (NACE G-J), within-country distribution

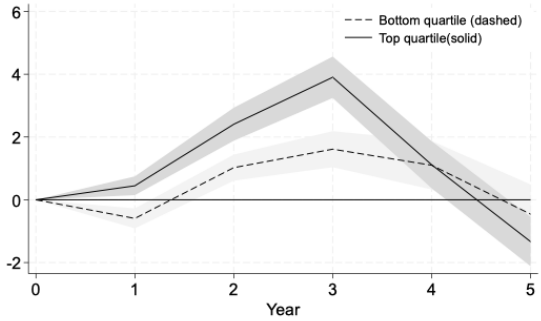


Figure 21: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Financial, Real Estate, Professional and Administrative Services* (NACE K-N), within-country distribution

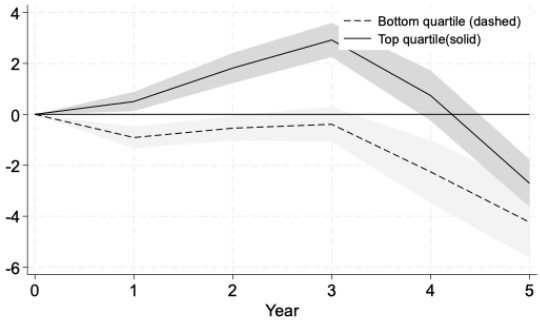
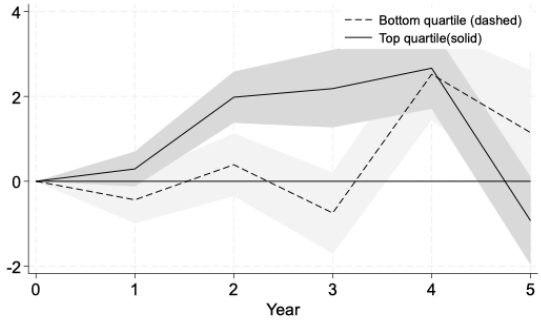


Figure 22: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Non-market services* (NACE O-U), within-country distribution



Results for within the euro area (Figures 35-40 in the Appendix) compared to the within-country results show a difference in the effects of monetary policy between top and bottom quartiles in all sectors. Supporting the original all-sectoral story that the monetary policy tightening slows down compensation per employee in regions in the bottom quartile of the distribution more compared to the regions in the top quartile. The confidence bounds in the estimation are seemingly not overlapping in most subgroups of sectors.

5.5 Analysis of tightening and loosening periods of monetary policy

As we are analysing the period, when monetary policy easing prevails over monetary policy tightening, it is interesting to see whether there is some asymmetry between effects under these two directions of changes in policy rates, and whether our results are driven primarily by monetary policy tightening or monetary policy loosening. We estimate the equations by including two interaction terms, one between the change in the policy rate and dummy for monetary policy tightening, and the second one between the change in the rate and a dummy for monetary policy loosening. Figure 23 shows that in the case of within-country heterogeneity of effects of monetary policy on HICP-deflated compensation per employee, there is a negative effect on both top and bottom quartiles of monetary policy tightening, where it is stronger in the bottom quartile. However, during monetary policy easing periods, there is no difference in the effect of monetary policy between the two ends of the distribution. Thus, the results presented in part 5.2 are mainly driven by monetary policy easing.

From the euro-area perspective, there is a negative heterogeneous effect of monetary policy tightening on HICP-deflated compensation per employee in the top and bottom quartiles (stronger in the bottom quartile). While during monetary policy easing, the effect is even more heterogeneous (Figure 24), for the bottom quartile, it implies that even though the monetary policy eases, the compensation per employee in HICP-deflated terms decreases (so that the growth of nominal compensation per employee is slower than the growth of HICP inflation). At the same time, in the top quartile, the effect on compensation per employee in HICP-deflated terms is positive. Thus, the results presented in part 5.3 (with a non-intuitive sign) for the bottom quartile are mainly driven by monetary policy easing; at the same time, the results for the top quartile are not that asymmetric between monetary policy tightening and loosening.

Effects of monetary policy on GDP-deflated compensation per employee for both top and bottom deciles are asymmetric between times of monetary policy tightening and loosening, while the reaction in the bottom quartile is in both cases more negative compared to the top quartile (Figure 25). The implications regarding the heterogeneity of effects at the ends of the distribution presented in part 5.2 are thus valid for both types of periods. The effects of monetary policy change are more pronounced during monetary policy tightening and less in times of monetary policy easing in both quartiles.

From the euro-area perspective, the effects are again very heterogeneous between times of monetary policy tightening and loosening (Figure 26). The heterogeneity in the effects presented in part 5.3 is mainly driven by monetary policy loosening periods, where in the bottom quartile, the effect of monetary policy easing on GDP-deflator-deflated compensation

per employee is positive, supporting the growth. While in the top quartile is around zero or slightly negative at the end of the shown horizon. Meaning that during the monetary policy loosening periods, monetary policy helps to shorten the gap between high- and low-labour-income regions across euro area.

Figure 23: Impact of policy rate increase on *real compensation per employee (deflated by HICP)*: *bottom vs. top quartile* of within-country distribution

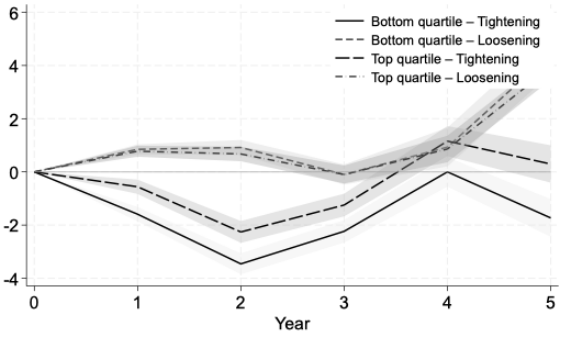


Figure 24: Impact of policy rate increase on *real compensation per employee (deflated by HICP)*: *bottom vs. top quartile* of within-euro-area distribution

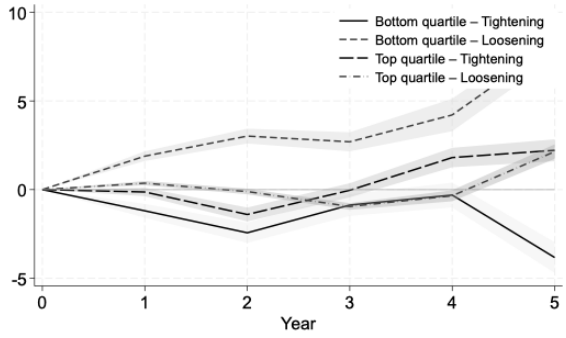


Figure *25*: Impact of policy rate increase on real compensation per employee *(deflated by GDP deflator)*: *bottom* vs. *top quartile of within-country distribution*

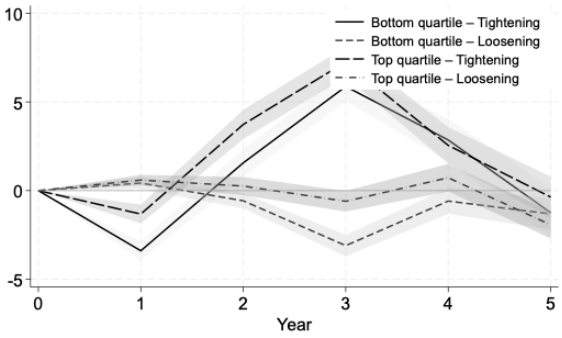
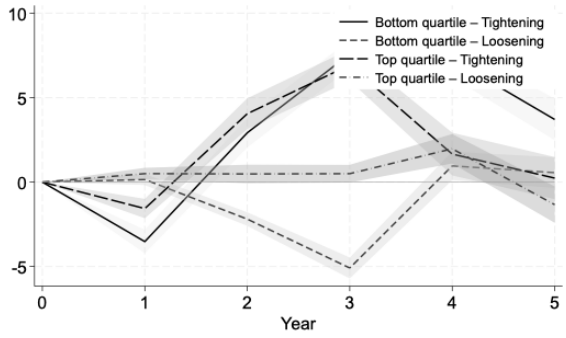


Figure 26: *Impact of policy rate increase on real compensation per employee (deflated by* GDP deflator*): bottom vs. top quartile* of within-euro-area distribution



6 Robustness Checks

6.1 Below the mean vs. above the mean regions

In this robustness check, we look at whether the results hold if the sample is split into two halves. From the within-country perspective (Figures 27 and 29), there is no significant heterogeneity in the average effect of monetary policy on compensation per employee in top and bottom half of the distribution in HICP-deflated compensation per employee and some

heterogeneity in GDP-deflator-deflated compensation per employee. This supports the original findings that the effects differ significantly only when taking into account various price level developments in individual regions. From the within-euro-area perspective (Figures 28 and 30), again, the results support the original findings, where we can see significant differences in the reaction of compensation per employee in regions in the top and bottom half of the distribution in both specifications of real compensation per employee in the first three years.

Figure 27: Impact of policy rate increase on real compensation per employee *(deflated by HICP):* bottom vs. top half (within-country distribution)

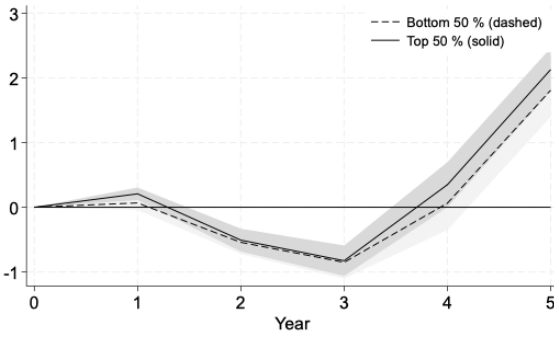


Figure 28: Impact of policy rate increase on real compensation per employee *(deflated by HICP):* bottom vs. top half (within-euro-area distribution)

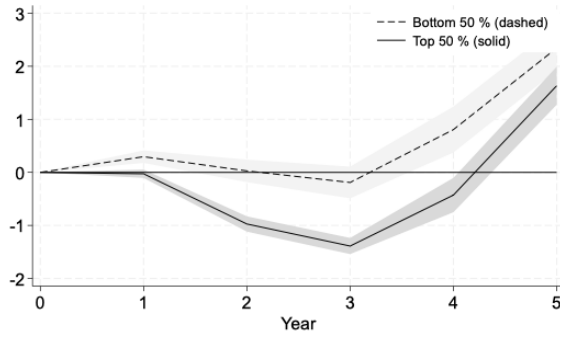


Figure 29: Impact of policy rate increase on real compensation per employee *(deflated by GDP deflator):* bottom vs. top half (within-country distribution)

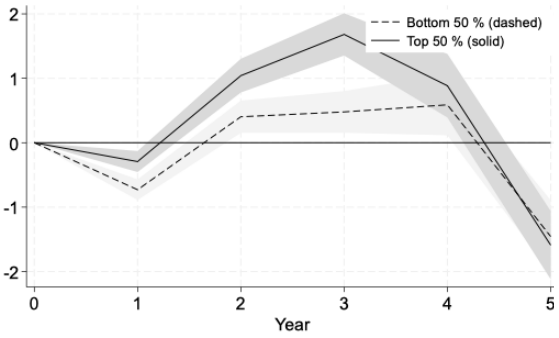
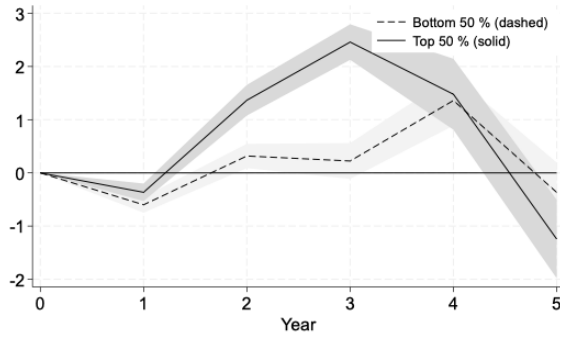


Figure 30: Impact of policy rate increase on real compensation per employee *(deflated by GDP deflator):* bottom vs. top half (within-euro-area distribution)



6.2 Smaller sample covering only countries entering euro area after 2008

Our sample covers 5 countries[13] that experienced only monetary policy easing during the observed period, with the exception of the year 2022 due to their later entry into euro area. The results for a smaller set of regions and countries, omitting these countries, are presented in

[13] Estonia, Lithuania, Latvia, Slovakia, and Slovenia.

Figures 45 - 48 in the Appendix, showing that the results are robust and do not depend on including or excluding these countries.

6.3 Shadow rates

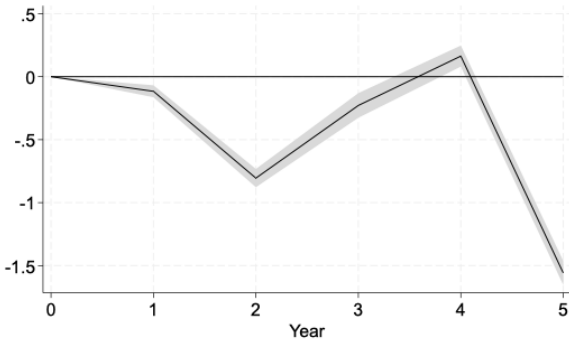
To check the robustness of our findings, we replace policy rates in the equations with shadow rates. Our sample period covers the times when the ECB has used some unconventional monetary policy tools, when the policy rate hit the lower bound and was almost not changing of policy rate even on a yearly basis; therefore, it appears worthwhile to test whether findings of our analysis hold for a broader set of monetary policy tools. Our baseline model is re-estimated with shadow rates estimated by Krippner (*Krippner, 2013*; *Krippner, 2020*).

The results for the response of compensation per employee at the mean are that the through is hit already at the 2-year horizon (compared to the original estimation, where the through is hit at 3-year horizon), reaching an effect of slowing down the growth by 0.8 ppt in HICP-deflated terms (Figure 31A). In the case of GDP-deflator-deflated compensation per employee, compared with the original estimation, the effect is still negative in year $t+2$; otherwise, it is similar to the original estimation (Figure 31B).

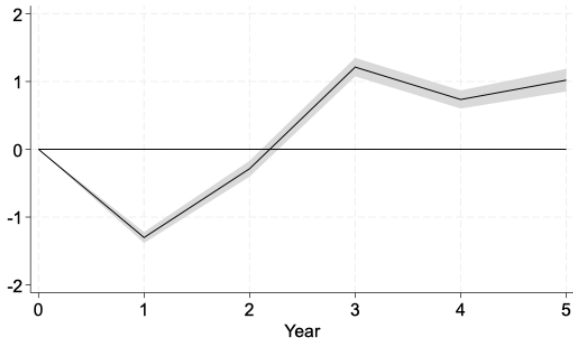
The results of the sub-sample analysis at the interquartile range (Figures 41 - 44 in the Appendix), there is no heterogeneity in the effect between the top and bottom quartiles in the within-country analysis for HICP-deflated compensation per employee variable. There is a heterogeneity in the effect on GDP-deflator-deflated compensation per employee in both within-country and within-euro-area estimation. As well, there is a heterogeneity in the effect on HICP-deflated compensation per employee at the ends of within-euro-area distribution. Thus, the robustness check supports the original findings that monetary policy (even after taking into account unconventional monetary policy tools) has different effects on labour income between regions with high and low average labour income in the euro area as a whole and in individual countries when taking into account various price level developments in the regions.

Figure 31: Impact of policy rate increase on compensation per employee at the mean

Panel A: Nominal compensation per employee



Panel B: Real compensation per employee (deflated by HICP)

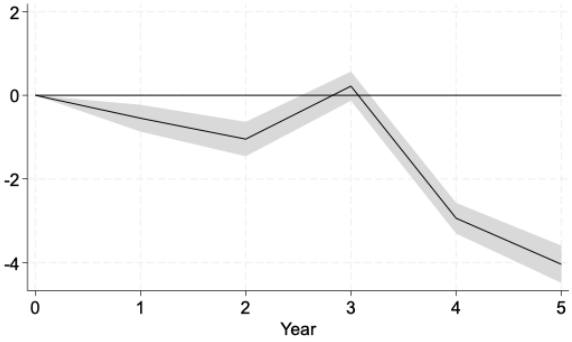


6.4 Reactions to instrumented monetary policy shock

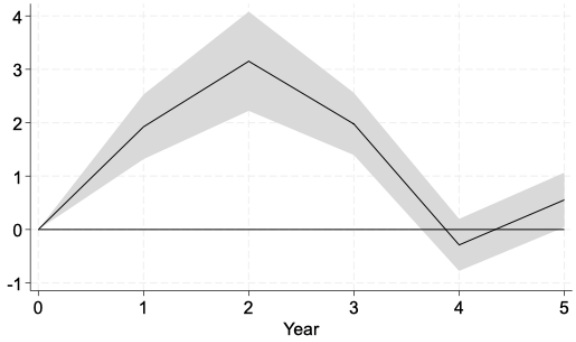
Last but not least, we estimate the reactions of compensation per employee to an instrumented monetary policy shock (MP shock). As the analysis is dependent on yearly data, the monetary policy shocks computed, for example, by *Jarociński and Karadi* (*2020*) on a daily basis, averaging these to a yearly frequency may lead to a loss and bias in the information. Therefore, in order to capture "monetary policy shocks," we decided to follow an approach of combination of local projections with instrumental variables. As instruments, inflation (HICP) and real GDP of the euro area are used. Figures 32A and 32B present results for HICP-deflated and GDP-deflator-deflated compensation per employee at the mean. The reaction to a positive MP shock is negative in the case of HICP-deflated compensation per employee and positive in the case of GDP-deflator-deflated compensation per employee. Regarding the heterogeneity of effects of MP shocks on the ends of labour income level distribution (Figures 49 – 52 in the Appendix), there is no heterogeneous effect of MP shocks between regions within individual countries in both specifications of real compensation per employee. This is partly in line with the original estimation of effects of changes in the policy rate. In the within-euro-area distribution, there are heterogenous effects of MP shocks of compensation per employee in high and low average labour income regions. This is in line with original estimations.

Figure 32: Impact of policy rate increase on compensation per employee at the mean

Panel A: : Real compensation per employee (deflated by HICP)



Panel B: Real compensation per employee (deflated by GDP deflator)



7 Conclusions

During the "inflation above the inflation target" era that happened after the pandemic, the challenges in monetary policy setting in heterogeneously developing economies have been underscored in the euro area. Even though the debate usually interprets these challenges as a country-level phenomenon, our analysis tries to show that heterogeneity exists even on deeper, regional levels.

Our paper provides an alternative regional perspective on labour income differences and monetary policy transmission. The analysis is based on regional data on compensation per employee in the euro area; the sample covers the period 2000 – 2022 and 932 NUTS3 regions in 16 countries. The model is first estimated for the whole sample, and then sub-sample analysis based on different variations of compensation per employee is used to evaluate whether there is some heterogeneity in monetary policy transmission effects on various ends of the regional distribution, both within individual countries and within the euro area as a whole. Where the sub-sample analysis provides us with the results that we are able to use to answer the question of whether monetary policy increases or decreases labour income regional inequality within the euro area. The results are robust to unconventional monetary

policy tools (included in the form of shadow rates), different specification of the sample and sub-samples, and mostly also to instrumented monetary policy shocks. Looking at the two ends of compensation per employee level distribution, there is some heterogeneity in the effects of monetary policy in the bottom and top quartile of the within-country-income-distributions in real terms (deflated by GDP-deflator), meaning that the monetary policy of the ECB does influence income inequality between regions in individual countries of the euro area. However, the results are not heterogeneous in HICP-deflated terms (where we have price level indicator only on the country level). From the point of view of the whole euro area, there is a heterogeneity in the reaction of compensation per employee to monetary policy in the top and lower parts of the distribution in the whole monetary union. These results support the view that monetary policy has effects on labour income inequality between subnational regions in the euro area as a whole. Sectoral story also plays a role, showing that within individual countries, there is a heterogeneity in the effects on compensation per employee in real terms, where in other sectors, there is no heterogeneity in the effect. Our results are mostly driven by monetary policy loosening; the implications for (non-)heterogeneity are mostly valid even for monetary policy tightening periods. Although the sizes and directions of the effects of monetary policy on compensation per employee differ quite a lot.

The use of geographically disaggregated data for the subnational regions in this paper provides alternative insights into how the effects of policy rate hikes are propagated into the economy and especially on the labour market. By providing a view on the monetary policy tightening impact on regional inequality, our paper aims to contribute to the growing literature on income inequality and also the research on monetary policy transmission. Moreover, our paper underlines the importance of using regional-level price indicators in these types of analysis, as this analysis provides different results from those based on country price level indicators.

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A Appendix A - Tables

Table 2: List of countries and number of regions

Country	**Number of NUTS 3 regions**
Austria	35
Belgium	44
Cyprus	1*
Estonia	5
Finland	19
France	101*
Germany	401
Greece	52
Ireland	8
Italy	107
Latvia	6
Lithuania	10
Malta	2*
Netherlands	40
Portugal	25
Slovakia	8
Slovenia	12
Spain	59

Note: *5 French overseas territories (French Guyana, La Reunion, Guadaloupe, Martinique and Mayotte) are omitted following the existing literature. Malta and Cyprus are not included in the original estimation.

Figure 33: Heterogeneity across countries in euro area in *real* compensation per employee *(deflated by GDP deflator)* in 2022

Figure 34: Heterogeneity across euro area in *real* compensation per employee *(deflated by GDP deflator)* in 2022

Figure 35: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Agriculture* (NACE A, within-euro-area distribution)

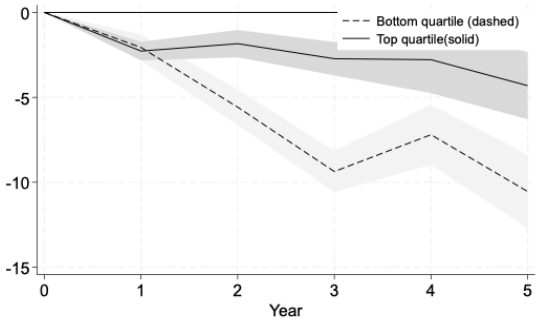


Figure 36: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Industry* (NACE B-E, within-euro-area distribution)

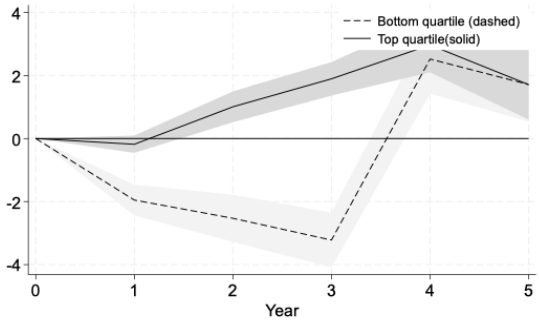


Figure 37: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Construction* (NACE F, within-euro-area distribution)

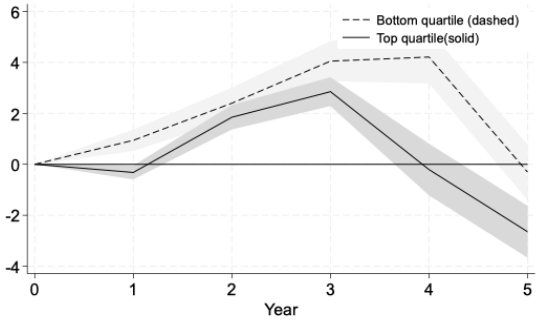


Figure 38: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Trade, Transport, Accommodation and Information Services* (NACE G-J, within-euro-area distribution)

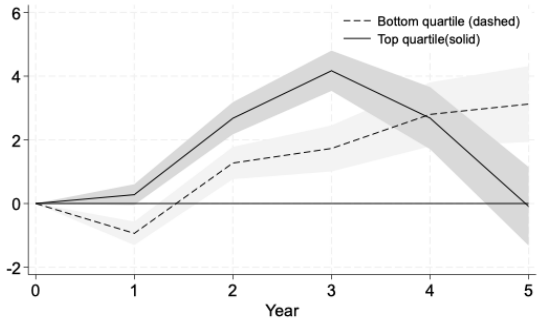


Figure 39: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Financial, Real Estate, Professional and Administrative Services* (NACE K-N, within-euro-area distribution)

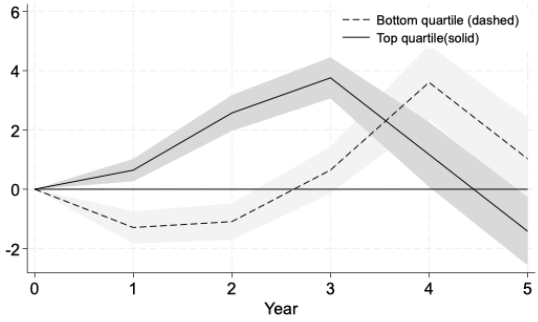


Figure 40: Impact of policy rate increase on real compensation per employee (deflated by GDP deflator) in *Non-market services* (NACE O-U, within-euro-area distribution)

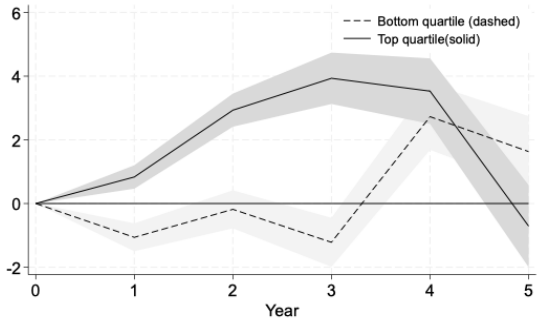


Figure 41: Impact of shadow rate increase on real compensation per employee (deflated by HICP): bottom vs. top quartile (within-country distribution)

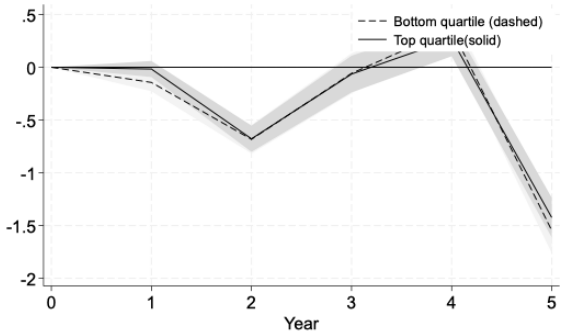


Figure 42: Impact of shadow rate increase on real compensation per employee (deflated by HICP): bottom vs. top quartile (within-euro-area distribution)

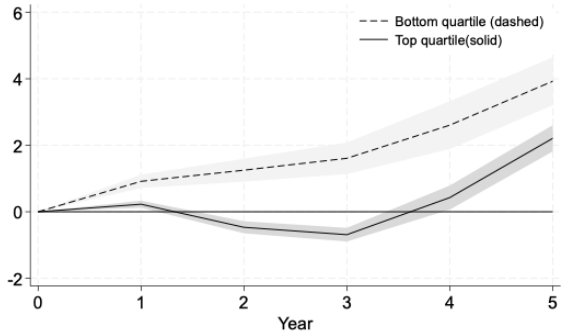


Figure 43: Impact of shadow rate increase on *real* compensation per employee *(deflated by GDP deflator)*: bottom vs. top quartile (within-country distribution)

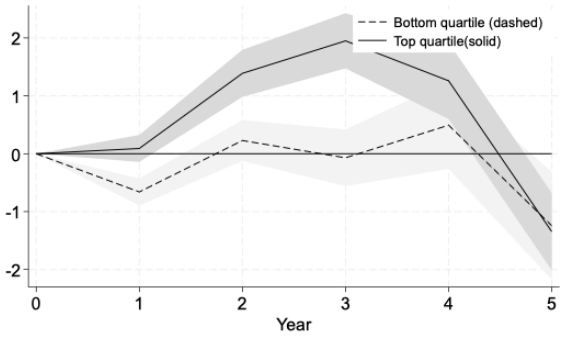


Figure 44: Impact of shadow rate increase on real compensation per employee *(deflated by HICP)*.: bottom vs. top decile (within-euro-area distribution)

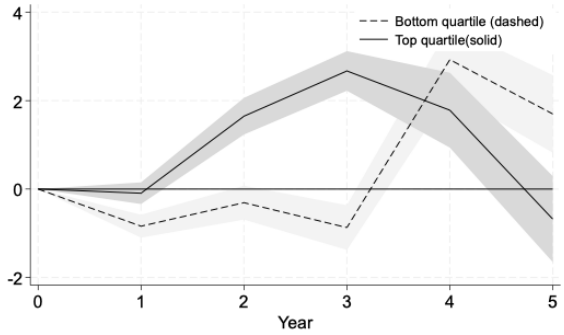


Figure 45: Impact of policy rate increase on real compensation per employee (deflated by HICP): bottom vs. top quartile (within-country distribution, 11 countries)

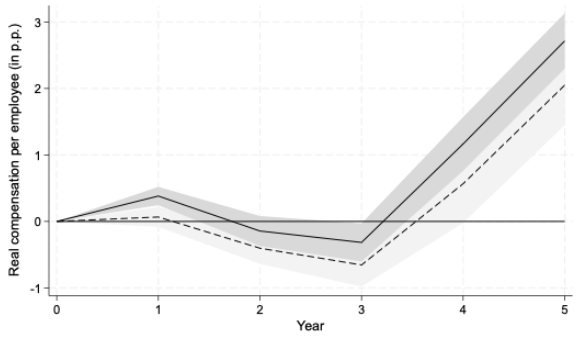


Figure 46: Impact of policy rate increase on real compensation per employee (deflated by HICP): bottom vs. top quartile (within-euro-area distribution, 11 countries)

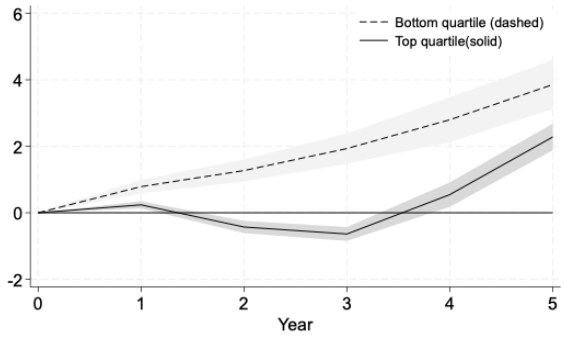


Figure 47: Impact of *policy* rate increase on real compensation per employee *(deflated by GDP deflator)*: bottom vs. top quartile (within-country

Figure 48: Impact of policy rate increase on real compensation per employee *(deflated by HICP)*.:

distribution*, 11 countries*)

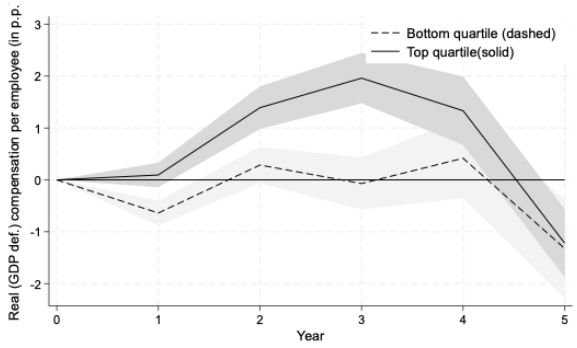


Figure 49: Impact of instrumented MP shock on real compensation per employee (deflated by HICP): bottom vs. top quartile (within-country distribution)

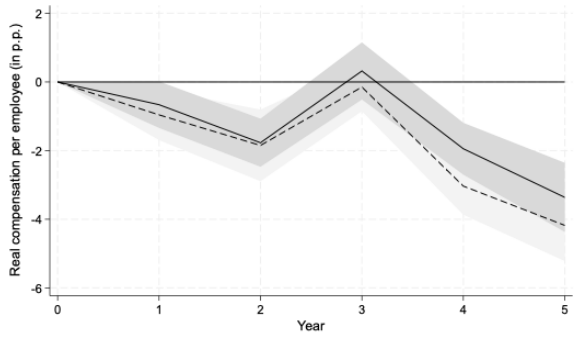
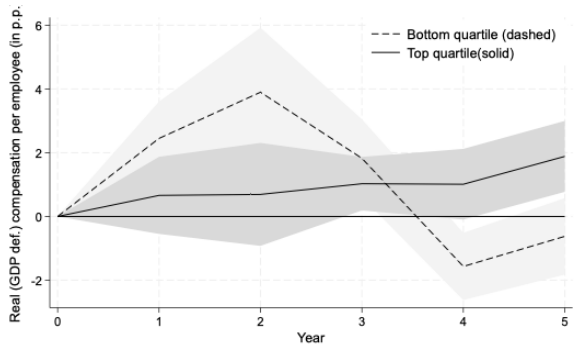


Figure 51: Impact of *instrumented MP shock* on real compensation per employee *(deflated by GDP deflator)*: bottom vs. top quartile (within-country distribution)



bottom vs. top decile (within-euro-area distribution, 11 countries)

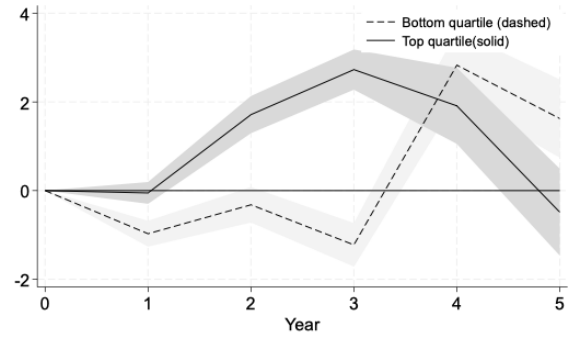


Figure 50: Impact of instrumented MP shock on real compensation per employee (deflated by HICP): bottom vs. top quartile (within-euro-area distribution)

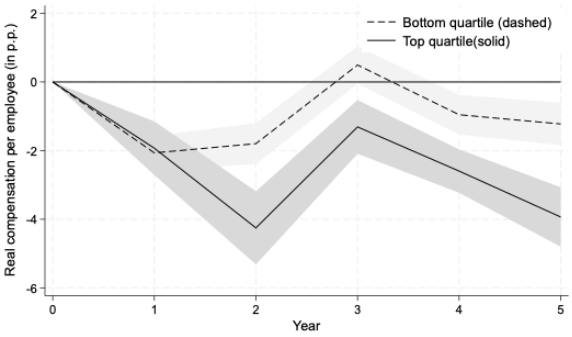


Figure 52: Impact of instrumented MP shock on real compensation per employee *(deflated by HICP)*:: bottom vs. top decile (within-euro-area distribution)

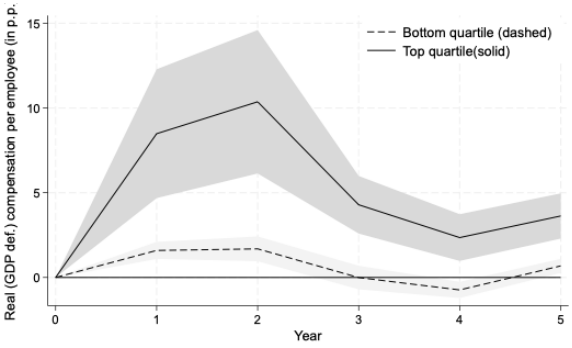
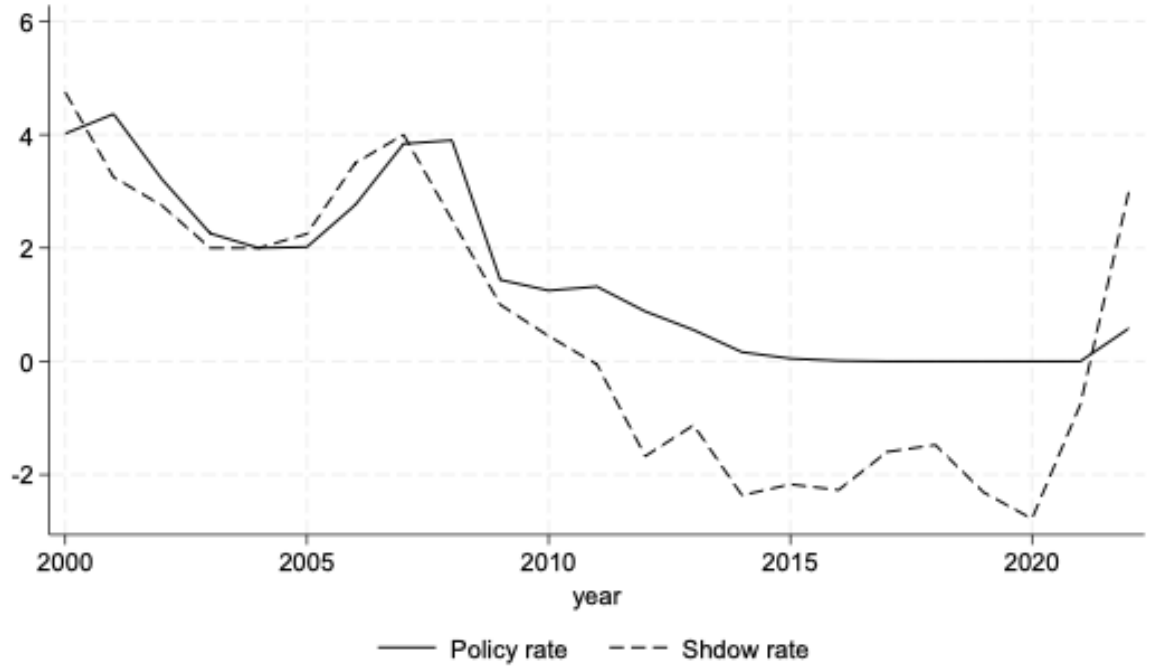


Figure 53: Policy rates and shadow rates as yearly data in our sample



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