Monetary Policy and Earnings Inequality: Inflation Dependencies*

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Abstract

This paper studies the distributional effects of monetary policy and its dependency on the inflation environment. We document a novel inflation dependency for the earnings heterogeneity channel of monetary policy using high-frequency, administrative individual-level tax data from eurozone member Estonia. We find that monetary policy shocks substantially influence labour income inequality during high-inflation periods, while the impact is markedly reduced in a low-inflation environment. Specifically, monetary policy disproportionately affects low-income individuals when inflation is elevated. Extending our dataset with granular marginal propensity to consume estimates, we show that the earnings heterogeneity channel amplifies the aggregate consumption response, contributing approximately 5%.

Keywords: Monetary policy, labour income inequality, inflation, state dependency, earnings heterogeneity channel, aggregate MPC

JEL classification: E52, D31, J31, J63

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1 Introduction

The recent inflation surge after the pandemic highlights the importance of studying the distributional consequences of monetary policy in a high-inflation environment. In this paper, we assess the impact of monetary policy on earnings inequality and its dependency on the inflation environment. Our focus is on the earnings heterogeneity channel of monetary policy (e.g., Auclert 2019), which captures that the distributional implications of monetary policy are unequal with disproportional losses for some workers. We document a novel inflation dependency for this channel. Specifically, we show that the inflation environment alters the distributional impact of monetary policy using high-frequency administrative data from the euro area member Estonia. Exploiting the near real-time provision of the data, we show that monetary policy shocks have a quantitatively stronger impact on earnings inequality during high inflation levels - as reached from to 2021 and 2023.

We also use our estimates to evaluate how the earnings heterogeneity channel of monetary policy affects the aggregate dynamics, in particular, the response of aggregate consumption. For this reason, we complement our administrative data with household-level marginal propensity to consume (MPC) estimates. We can use this combined dataset to calculate the aggregate MPC and back out the role of the earnings heterogeneity channel using the matching multiplier approach of Patterson (2023). Our estimate assigns 5% of monetary policy's impact on aggregate consumption to the earnings heterogeneity channel. We also find that the total impact on aggregate consumption is larger in a high-inflation environment.

The challenge to assess inflation dependencies for inequality is the availability of access to granular data with a sufficiently high frequency. While individual-level administrative data features the granularity to assess the potential impact of monetary policy on wage inequality, such data is often only available or used at an annual frequency and is provided with substantial publication lag. However, such a low frequency complicates substantially, if not even prevents, an analysis of the relationship between earnings inequality and monetary policy during both regular and heightened inflation periods. The publication lag additionally excludes the use of this data for recent influential events, such as the inflation surge after the pandemic.

For this reason, we are utilizing individual-level administrative tax data from the euro area member Estonia to exploit several key features. First, wage and employment data for the entire population (without top coding) are available on a monthly frequency. Therefore, we can measure the distributional implications of monetary policy shocks using a

monthly frequency, allowing us to evaluate short-lived but influential periods such as the recent inflation surge. Second, the availability of the data is almost real-time, covering the period from January 2006 until September 2023. Consequently, we can evaluate the earnings distribution during the high-inflation environment starting in 2021. The chosen administrative data can be used to assess state-dependencies, which are important for aggregate variables, for instance, shown in Tenreyro and Thwaites (2016). Third, Estonia joined the euro area in 2011 and had a fixed exchange rate with the euro before. Therefore, we can study the monetary shocks of the European Central Bank (ECB). In particular, we are using a high-frequency approach that captures the changes in interest rates in a tight window around Governing Council meetings (Jarocinski and Karadi 2020). Finally, we can combine the administrative tax data with survey data on the marginal propensity to consume. This combined dataset disentangles how the distributional impact of monetary policy affects aggregate consumption.

We first document that the effects of monetary policy are U-shaped over the wage distribution. Low labour-income households respond particularly strongly to monetary policy. While the average household's labour income responds less strongly, we document a slight increase in wage risk for the top earners (0.1%). Using our granular data, we decompose the overall effect into the intensive margin of wage changes and the extensive margin of entry/exit. The results for the low-income group are driven by the extensive margin, that is, by entry and exit margin. The intensive margin plays a relatively larger role for households in the middle and at the top of the income distribution. Using our high-frequency data, we also show that annual data overestimates the relative importance of the intensive margin. Our high-frequency data allows for a better capturing of shorter unemployment spells and, thus, a cleaner distinction between intensive and extensive margin. To sum up, we find that the earnings heterogeneity channel is present in our data.

However, this baseline analysis hides potentially important state-dependencies that drive key dynamics. In particular, we want to understand to what extent the impact on inequality depends on the inflation environment. Our main finding is that inflation dependencies are very present in the distributional impact of monetary policy. While monetary policy shocks have a substantial impact on wage inequality in a high-inflation environment, their effects on labour income along the distribution are much more dampened in a low-inflation environment.

The exposure of the different income groups also depends on the level of inflation. In particular, low-income workers are quantitatively much more affected than workers

in the middle or at the top of the income distribution in a high-inflation environment. The extensive margin drives these results due to a substantial increase in exits as well as a reduction in entries for low-income workers in the high-inflation environment. Additionally, the exposure features a weak U-shape as the top 0.1% earners are slightly more affected. When inspecting the low-inflation regime, the effect along the income distribution is quantitatively much smaller. However, the relative differences across some income groups are larger in the low-inflation environment. While low and medium-income individuals are negatively affected, the effect is basically muted for top earners starting from the 90th quantile. Thus, the quantitative differences are much more pronounced in the high-inflation environment, while there are more relative differences in the low-inflation environment. The results are robust to controlling for alternative monetary policy shocks, geopolitical risk, sign asymmetries for the monetary policy shocks, and using nominal wages instead of real wages

The next step is to evaluate the aggregate implications of the distributional impact of monetary policy - to what extent does the earnings heterogeneity channel of monetary policy amplify aggregate dynamics, and is the amplification state-dependent? Specifically, we measure how monetary policy's distributional impact affects the aggregate consumption response based on the matching multiplier approach of Patterson (2023). This requires that we match the individual's exposure to the monetary policy shock with an estimate of their respective marginal propensity to consume (MPC). At this stage, our Estonian data becomes again very handy. We can complement our dataset using household-level MPC estimates from the Household Finance and Consumption Survey for Estonia in 2021. In particular, we can match the surveyed households to their members' exposure to the monetary policy shock in our administrative data.

As a consequence, we obtain the aggregate MPC, which can be decomposed into two components: the income-weighted average MPC and the covariance between the individual-level response to monetary policy and the MPC. If the exposure to the shock and the MPC are positively correlated, the earnings heterogeneity channel amplifies the response of aggregate consumption to a monetary policy shock. When calculating the aggregate MPC, we find that 5% of the response stems from the heterogeneous response of the workers to the shock, and can thus be attributed to the earnings heterogeneity channel. The reason is that households with a low income have a high MPC, and these are the same households that are particularly affected by monetary policy shocks. Furthermore, the monetary policy shock increases labour income inequality, measured with the Gini-coefficient using our granular data.

We also evaluate the dependence of the aggregate MPC on the inflation environment. In particular, the exposure to the shock depends on the inflation environment. However, we need to assume that MPCs are constant across inflation regimes because the economy was in a low-inflation period when the survey on the MPCs was conducted. If low-income workers' MPCs raise proportionally more in a high-inflation environment, this limitation results in a downward bias of the aggregate MPC for the high-inflation environment, which we think is likely the case. We find that the aggregate MPC is slightly larger in the low-inflation environment (conditional on constant MPCs). The reason is that the exposure to the shock is relatively more varying, e.g., the top decile does approximately not respond to the shock if inflation is low. However, only focusing on the aggregate MPC does not take into account the overall impact of the shock. The monetary policy shock has a much larger quantitative impact in the high-inflation environment. Therefore, the total aggregate effect is considerably more pronounced in a high-inflation environment. Similarly, a contractionary monetary shock increases labour income inequality more in a high-inflation environment.

An important issue is the external validity of our results. One advantage is that Estonia is part of the euro area, and therefore, we can study the monetary shocks of the ECB. Importantly, our baseline findings, for which we do not condition on inflation or the size of shocks, are in line with similar studies that were conducted in Denmark, Norway, Sweden, Germany and France (Andersen et al. 2023, Holm et al. 2021, Amberg et al. 2022, Broer et al. 2022, Hubert and Savignac 2023). Furthermore, we also show that the aggregate risk exposure of individual earnings to GDP is very similar to the US, as studied in Guvenen et al. (2017). Additionally, the labour market features a high flexibility, being much closer to the US than to Western Europe or Scandinavia. However, Estonia has been growing relatively strong during this period, starting from a substantially lower economic level than the US or the average in the euro area. Furthermore, Estonia has a flat tax rate scheme, which could affect the incentives in the labour market.

Our results emphasize the importance of jointly accounting for heterogeneity and state dependencies when studying the impact of monetary policy within theoretical models. The findings are in line with recent work on the increasing degree of attention to rising inflation (see, e.g., Bracha and Tang, 2022; Weber et al., 2023; Korenok et al., 2023; Pfäuti, 2023). This changing attention to inflation and monetary policy can be a driver behind the increased exposure of low-income indivudals to monetary policy. The results indicate that introducing rational inattention (see, e.g. Sims, 2003; Maćkowiak and Wiederholt, 2009) within the HANK framework potentially accounts for the recent inflation surge.

Similarly, incorporating a nonlinear Phillips curve, e.g., in Benigno and Eggertsson (2023), into a HANK model could potentially account for our findings. Methods to study such outlined state dependencies and nonlinear dynamics within the HANK framework have been recently developed in Fernández-Villaverde et al. (2023) and Kase et al. (2022), among others.

Related literature The paper is connected to the literature that studies the distributional impact of monetary policy using survey and administrative data. Coibion et al. (2017) finds that monetary policy increases inequality in labour earnings for the US using survey data. Using detailed administrative data from Scandinavia, Andersen et al. (2023), Holm et al. (2021), Amberg et al. (2022) estimate the impact of monetary policy on inequality using yearly data. Broer et al. (2022) estimates the distributional impact of monetary policy using monthly (top-coded) employment data from 1995 to 2013 for Germany. They argue that the extensive margin is very relevant for low-income workers. Our contribution to studying the (non state-dependent) impact is threefold. First, our results confirm previous empirical findings of these studies using a different country. Second, we use a high-quality administrative (without top coding) dataset from a euro area country that has not been yet used in this context, and that dataset - importantly - is open to other researchers.[1] Third, we show that monthly data provides a cleaner estimation of the intensive and extensive margin as it accounts properly for the labour market spell of workers.

However, our study differs from the previous studies in a key dimension - we analyze the role of state-dependencies, in particular the role of inflation, for the distributional impact of monetary policy. Tenreyro and Thwaites (2016) emphasize the importance of state dependencies for the monetary transmission of aggregate variables. They condition the aggregate impact of monetary policy shocks on the business cycle. Gargiulo et al. (2024) find that monetary policy transmission depends on the inflation regime. Using aggregate data, they show that monetary policy can have stronger and more long-lasting effects in a high-inflation regime for the US. Canova and Pérez Forero (2024) also find that the transmission of monetary policy shocks for aggregate variables differs in inflation regimes. In a high-inflation environment, they also find a more persistent effect but a less powerful peak. We contribute to this literature by outlining a novel inflation dependency for the earnings heterogeneity channel of monetary policy. By exploiting our high-frequency administrative

[1] The data can be accessed via Statistics Estonia, as explained on their website.

data, we find that the distributional impact depends on the inflation regime.

We also contribute to the literature that disentangles the role of heterogeneity for aggregate amplification. Recent literature on the matching multipliers by Patterson (2023) shows that the heterogeneous effect of business cycles or fiscal stimulus on households can amplify the aggregate consumption response if more exposed households also have higher MPC. Adapting the approach to our data and the transmission of a monetary policy shock, we estimate the role of the earnings heterogeneity channel. Thus, our aggregate MPC estimate provides a benchmark for the strength of the earnings heterogeneity channel in HANK models. A key strength in our analysis is the possibility of matching our estimated exposure to monetary policy shocks in the administrative data with household-level survey data on MPCs. Thereby, our work complements recent work that uses an indirect approach that combines empirical evidence and theory to measure the consumption effects (e.g., Auclert 2019, Slacalek et al. 2020, Lenza and Slacalek 2024, and McKay and Wolf 2023).

2 Data: Labour Income & Monetary Policy

In this section, we first provide a brief institutional background on Estonia before outlining the employed administrative labour income data for the entire population at a monthly frequency. Afterwards, we discuss the employed high-frequency monetary policy shock series.

2.1 Institutional Context: Labour Market & Monetary Policy

This paper uses data from Estonia, a small open economy that joined the euro area in 2011 and had before a fixed exchange rate with the Euro as an anchor currency as part of the European Exchange Rate Mechanism. Importantly, this allows us to study the monetary policy of the ECB. The transmission of monetary policy shocks for the Estonian economy has been documented, for instance, in Errit and Uusküla (2014) and Almgren et al. (2022). The growth rate of loans in Estonia is tightly related to policy interest rates, as there is a high dependency on flexible interest rates that are linked to the 6-month Euribor.

An important institutional feature is the flexible labour market, which is an important adjustment margin to absorb the shocks. The labour market is characterised by low nominal wage rigidity and also adjustment to shocks through employment status as there is no regular job retention support scheme (Babecký et al. 2010).[2] The union power is

[2]The exception was the Covid-19 crisis when Estonia introduced, like many other EU countries, a

very low and the minimum wage is the most important labour market institution.The minimum wage hikes have had a strong effect on wages at the lower part of the wage distribution (Ferraro et al. 2018b) with a limited negative effect on employment (Ferraro et al. 2018a). Taken together, the institutional setting in Estonia is, in our opinion, due to the flexible labor market closer to the US than to Western European countries such as France and Germany or the Scandinavian countries. Appendix A provides more details on the aggregate dynamics of the Estonian economy.

2.2 Monthly Administrative Data on Labour Income

We are using Estonian administrative tax data to have monthly and near-real-time available earnings distribution. The data on labour income are obtained from administrative records of the Estonian Tax and Customs Board based on employers' filings. Employers report the paid wage to the Tax and Customs Board and all the related taxes of all their employees on a monthly frequency.[3] The resulting database covers the universe of employees, their total labour income, and their employers. The data is complete since there is no top coding, and the entire set of employees is covered.

We construct the individual-level labour income database at the monthly frequency for our horizon from 2006M1 to 2023M9. There are roughly 410 to 510 thousand individuals observed each month, and in total, there are 900 thousand unique individuals. To trace entries and exits, we use a balanced panel of all the individuals employed at least one month in the observed timespan and set the labour income equal to zero when the individual was not working. We restrict the age of individuals to be inside the prime working age, at 26-65, in our panel. After balancing the panel, the year-month and individual observations are ca 88 million.

The total labour income is derived as the sum of two income sources: i) wage income (from permanent and temporary contracts), and ii) income of employees who serve as managers or board members. While the two types of labour income, wage and board member fees, are very similar in their function and subject to taxation, the management fee is not subject to unemployment insurance payments. Most income comes from the wage income; the board member fees make only a small contribution but are potentially very

temporary job retention support scheme from March 2020 until May 2022. This was an on-off support scheme, which had a temporary effect that muted the reallocation of jobs between firms (Meriküll and Paulus 2024).

[3]These tax declarations are called form TSD, and the employer submits these to the tax office by the 10th day following the payment month.

important to measure the labour income of the highest income earners. Our labour income covers all wage income, bonuses, and holiday payments and is reported in gross terms.[4] The labour income is deflated to real terms using the Harmonised Index of Consumer Prices (HICP) in 2015 prices.

We sort the individuals into twelve income groups conditional on gender and age each month. The income bins use cutoffs at the 10th, 20th, ..., 90th, 99th, and 99.9th percentiles. The age groups are divided as follows: 26-35, 36-45, 46-55, 56-65.[5] For sorting into income groups, we use a proxy of permanent income - the average labour income during the last 12 months.[6] Even though it is common to base permanent income measures on a longer history, we explicitly limit the past income to one year only to keep the years around the Great Recession in the sample. These years were characterised by high inflation, so our sample covers two high-inflation periods. Our effective sample in the empirical analysis starts from 2008M1; as the income group's derivation requires the first 12 months of data, and conditional on income groups, we can derive the yearly income growths starting from 2008M1. More details on the data are provided in Appendix B.

External Validation: GDP Betas in Estonia and in the USA As part of the external validity evaluation, we compare our labour market data to the US. Specifically, we estimate how workers' real labour income growth depends on aggregate real GDP growth, i.e., the worker betas as introduced by Guvenen et al. (2017). They estimate this relationship for US data and find that workers' exposure to economic growth has a U-shape. High- and low-wage earners' income is the most sensitive to aggregate growth. A similar pattern is also observed in a related paper on Swedish data by Amberg et al. (2022). However, the estimated U-shape for Sweden is not symmetric, and the lower part of the distribution is affected more proportionally.

Figure 1 shows the estimates for Estonian data, where we aggregate our monthly data to yearly data for comparison. The figure presents the total labour income response, the

[4]As cross-validation, we show that our calculated labour income data aligns with the labour income reported by Statistics Estonia, the statistical agency that provides the official labour income statistics. More details on the sources and comparison are in Appendix B.

[5]This implies that the 12 permanent income groups are derived for the eight segments of workers by gender and age. Due to the conditional nature of these income groups, the income level within the same income group can be different for different segments of workers.

[6]Note that the necessary condition for entering into the analysis is that an individual has to report labour income at least one month in the last year. We prefer average yearly income over average monthly income as this provides a better link to the existing literature on yearly data where monthly income and transitions are unobserved.

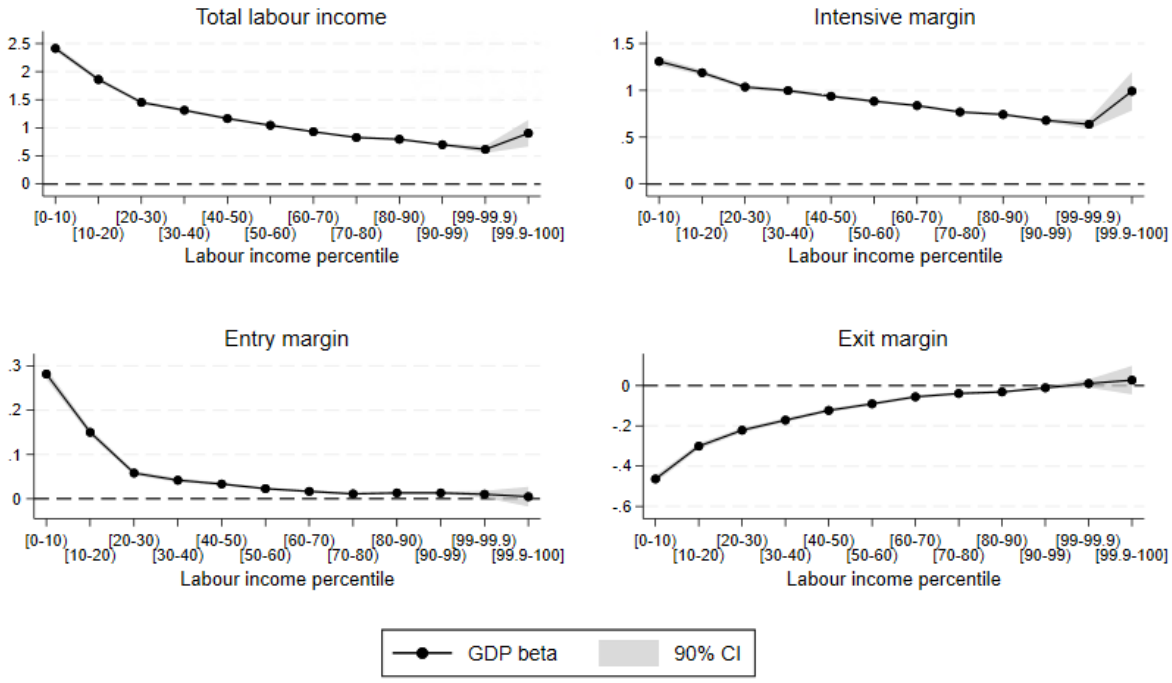

Figure 1: The GDP betas by income groups, yearly data, 2008-2022.

intensive margin (labour income growth conditional on participation), the entry margin, and the exit margin. The intensive margin shown in the upper-right panel replicates the estimates of Guvenen et al. (2017) and shows very similar estimates to the ones on the US data. The only deviation from the US estimates is a more modest upswing at the upper end, while in the US, both of the top income groups from the top 1% experienced increased sensitivity to aggregate growth. This pattern is weaker and present only for 0.1% in Estonian data.[7] Like in the US also, in our data, the most affected segment is at the lower end of the distribution, and this asymmetry is much more pronounced in our data. Additionally, the reaction is also similar to that of the US in terms of gender and age groups, as discussed in Appendix C.

2.3 Monetary Policy Shocks: A High-Frequency Approach

We use a high-frequency approach to obtain the monetary policy shock series for our monthly sample from 2008M1 to 2023M9. We are focusing on the ECB's monetary policy

[7]The level of income at these top income percentiles also has a completely different magnitude in the US. While the 0.1% labour income earners have their median yearly income occasionally above million dollars, the 0.1% labour income earners in our sample get 11,000 euros per month, see Table B.1.

for our entire sample. Estonia joined the euro area in 2011. Before, it had a fixed exchange rate as part of the European Exchange Rate Mechanism and, therefore, imported the monetary policy from the ECB during the entire sample. Another advantage of Estonia is that monetary decisions can be seen as exogenous due to the relatively small size of Estonia.

We are computing the monetary policy surprises based on high-frequency changes in interest rates around Governing Council meetings following Jarocinski and Karadi (2020).[8] The changes in the interest rates are based on the Euro Area Monetary Policy Event-Study Database (Altavilla et al., 2019), which covers all Governing Council meetings between January 1999 and September 2023.[9] The measure is based on the changes in the 1-month, 3-month, 6-month, and 1-year OIS rates, for which the principal component is calculated. The change in the OIS rates is the difference between the median quote before the press release and the median quote after the press conference. To focus on the surprise monetary shock and disentangle it from central bank information effects, we use the poor man's sign restriction approach, which imposes restrictions on the rates and stock market response, following Jarocinski and Karadi (2020). As a robustness check, we later also use sign restrictions based on Jarocinski and Karadi (2020), and the change in the 3-month OIS rate directly - ignoring potential information effects - as, e.g., in Broer et al. (2022).

Figure 2 shows the identified monetary surprises at a monthly frequency. An important point is that the monthly frequency of the Estonian administrative data enables us to directly use this shock series - without aggregating it to yearly data as usually done in this strand of the literature. Exploiting this larger sample, we can analyze potential state dependencies and sign asymmetries. Additionally, the higher frequency allows for a cleaner composition as we can now measure the impact on the extensive and intensive margin using our monthly observations. Our data can track exactly when the person works or is not working during the year. In contrast to an analysis with yearly data, a person who works only one month and generates a positive income would count as employed throughout the year.

Importantly, both data sources - monetary surprises and administrative data - cover the recent inflation surge. Therefore, we can shed light on potential inflation dependencies for the distributional impact of monetary policy. We define a high-inflation regime as a

[8]The high-frequency approach to identify monetary policy shocks has been initially introduced in Kuttner (2001), Bernanke and Kuttner (2005), and Gürkaynak et al. (2005). For a recent discussion on high-frequency identification for monetary policy surprises, see, for instance, Bauer and Swanson (2023).

[9]We drop the Governing Council meeting on October 8th, 2008.

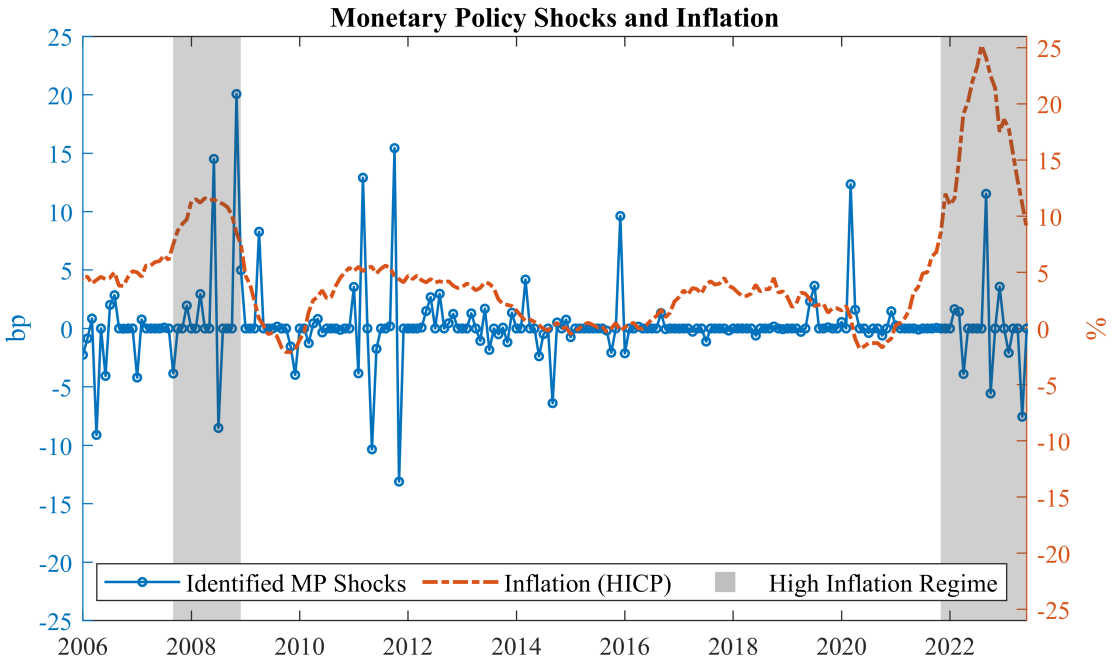

Figure 2: High-frequency identification of monetary policy shocks following Jarocinski and Karadi (2020). The blue line shows the identified shocks, while the red line shows inflation.

period in which inflation exceeds 7%. This threshold corresponds to inflation being half a standard deviation above its mean. While the 7% threshold seems maybe large, inflation in Estonia has been, on average, considerably above 2%, as can be seen in Figure 2. We observe two periods of high inflation - around the Great Recession in 2008 and in the follow-up to the pandemic. At the same time, the period between these events is characterized as a low inflation regime. The figure also highlights that inflation in Estonia has been above the average for the euro area. For instance, inflation peaked around 20% in the period after the pandemic. Therefore, Estonia is particularly suitable for our analysis of inflation dependencies.

One concern in our analysis could be that there is a systematic relationship between the monetary shocks and the inflation regime. However, as the figure shows, there does not seem to be a relationship between the direction or size of the high-frequency monetary policy shock and the inflation regime.

3 Distributional Impact of Monetary Policy

We estimate the distributional impact of the monetary policy shock without accounting for the role of inflation. This provides our benchmark result for analysing the earnings heterogeneity channel of monetary policy, which we also contrast with studies from other countries as external validation. In the next section, we analyse how the inflation level affects the earnings heterogeneity channel of monetary policy.

3.1 Empirical Specification

We estimate first how high-frequency monetary policy shocks affect individual wage-earners across the wage distribution following the related papers on heterogeneous effects of monetary policy (e.g., Holm et al., 2021; Andersen et al., 2023; Amberg et al., 2022). We use a monthly frequency for our estimation, exploiting our administrative data, while the related papers usually use a yearly frequency. An exception is Broer et al. (2022), who also use a monthly frequency. In the beginning, we do not condition on the different inflation regimes to provide a benchmark for our results.

The empirical specification to estimate the impact of aggregate monetary policy shocks on individual wage-earners by labour income groups reads as follows:

$$\Delta y_{i,t+h} = \alpha_g^h + \beta_g^h \Delta i_t + \Gamma_g^h \Delta X_{t-1} + \epsilon_{i,t+h}, \tag{1}$$

where the dependent variable $\Delta y_{i,t+h} = (y_{i,t+h} - y_{i,t}) \,/\, ((y_{i,t+h} + y_{i,t})/2)$ is the mid-point average growth of labour income of individual i at month $t+h$. The advantage of the mid-point average growth rate over the conventional log difference growth rate is that it also allows zero incomes in the base or reference year to be taken into account. For this reason, we can account for the adjustment by the extensive margin resulting from job creation and destruction (Davis et al. 1996). The horizon of our estimation is determined by h. Our baseline specification studies the effect over twelve months ($h = 12$), while we also evaluate alternative labour income growth rates for 6, 18, and 24 months.[10]

The monetary policy shock at month t is denoted by Δi_t. As positive values of the shock correspond to a contractionary shock, we expect that this leads to lower labour income growth, that is a negative coefficient for $\beta_g < 0$ for the different income groups, at least on average. We also allow for control variables X_{t-1}. Following related literature, we opt for

[10]The seasonality is addressed by using year-on-year growth rates in case of $h = 12, 24$ and including monthly dummies for the specifications with $h = 6, 18$.

a rather parsimonious specification for control variables. In our baseline specification, we control for the economic activity during the previous month before the monetary policy shock by GDP growth ΔGDP_{t-1}.[11]

We estimate this empirical specification separately for each of our 12 permanent income groups g conditioned on age and gender following Guvenen et al. (2017). The coefficient α_g shows the income group-specific intercept. β_g estimates the income group-specific effect of monetary policy on labour income and allows to assess the distributional impact of monetary policy. The income groups are based on the average labour income in the last 12 months before the monetary policy shock.[12]

Disentangling the total effect: Extensive and intensive margin The equation (1) is estimated for the total labour income change captured by $\Delta y_{i,t+h}$. To disentangle the role of the intensive and extensive margin, we also estimate the equation separately for i) the intensive margin change where $\Delta y_{i,t+h}$ is derived only for these observations where both, $y_{i,t+h}$ and $y_{i,t}$, have positive values; ii) the entry margin that is derived as a binary 0,1 variable for all the observations with some value of total labour income change and taking value 1 when $\Delta y_{i,t+h}$ equals to 2; iii) the exit margin that is derived as a binary 0,1 variable for all the observations with some value of total labour income change and taking value 1 when $\Delta y_{i,t+h}$ equals to -2.[13]

3.2 Results

The effect of a monetary policy shock on labour income by income groups is shown in Figure 3. The shock has a negative effect on total labour income across the entire income distribution. However, the effect is unequally distributed, with the low-income workers being much more strongly affected than the high-income workers. This highlights the heterogeneous exposure of workers to a monetary policy shock. When disentangling the effect, we see that workers are unequally affected by the different adjustment margins. Low-income workers are mostly affected by the extensive margin, as shown by their strong

[11]The real GDP at quarterly frequency is converted into monthly frequency using the interpolation approach of Chow and Lin (1971). The interpolation uses the related series of the unemployment rate, industrial production and retail trade as in Almgren et al. (2022).

[12]This implies that a first-time worker does not affect the entry margin. The first-year labour income of a newly entering worker is used to derive the labour income group.

[13]There can be periods as long as one month of no labour income in the data because of vacations. We do not want to treat these as entries or exits. To avoid this, we impose that the spell of the employment status change needs at least a two-month duration.

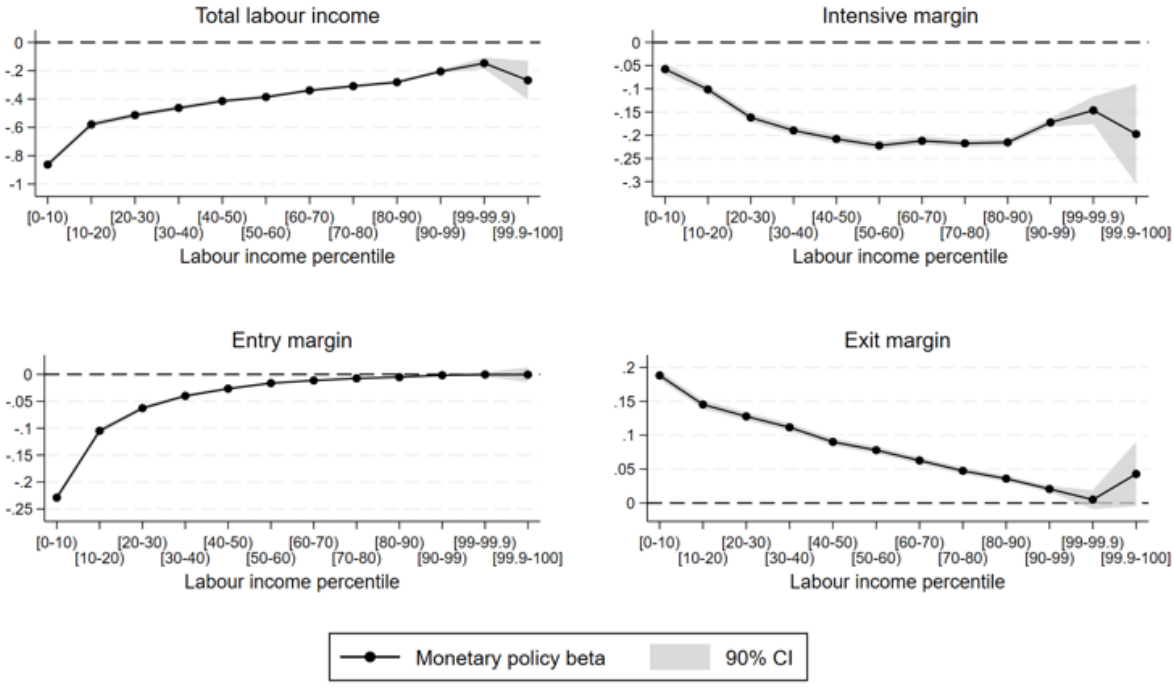

Figure 3: The effect of monetary policy shock (100 bps) on labour income growth by income groups, 2008M1-2023M9. The effect on total income, the intensive margin, the entry margin and the exit margin are shown.

response via the entry and exit margin; middle-income workers from the fourth to eighth decile are affected by both (intensive and extensive) margin, with the importance of extensive margin decreasing in income. The two highest income deciles are almost unaffected by extensive margin. So, low-income workers are affected by monetary policy mostly by transitioning into and out of employment status. In contrast, high-income workers hardly enter or exit employment status due to monetary policy but have real wage adjustments. These findings on the intensive and extensive margin overlap with the findings of related papers on earnings heterogeneity channel (Broer et al., 2022; Hubert and Savignac, 2023).

An important observation is that the adjustment patterns differ for monthly and yearly data. The yearly data misses a lot of within-year transitions into and out of employment. A majority of the monetary policy effect on low-income people originates then from the intensive margin by construction.[14] Specifically, we find that the intensive margin accounts for 40% of the total effect in monthly data, while it explains 75% when using yearly data. Thus, using our higher frequency allows better identification of the impact of the intensive

[14]Our estimates with yearly data for the intensive margin are very close to the estimates of Amberg et al. (2022).

and extensive margin. The details are in Appendix D.1.

Our baseline specification studies the effect of monetary policy on labour income growth over twelve months. Additionally, we also estimate equation (1) with alternative horizons. We use labour income growth rates over six, 18 or 24 months ($h = 6, 18, 24$). The results are in line with related literature for aggregate dynamics. Most of the effect of monetary policy materialises by month 12, and the peak effect appears in month 18. The effect by months 18 and 24 does not differ for the total labour income. The pattern along the income distribution is also stable. More details are in Appendix D.2. In the same appendix, we show the effects depend on gender and age group. Men and older workers are more exposed to monetary policy shock than women and younger workers.

4 Inflation Dependent Distributional Impact

We now analyse how the inflation level affects the earnings heterogeneity channel of monetary policy. In particular, we study if the inflation environment affects the distributional impact of monetary policy.

4.1 Inflation-Dependent Empirical Specification

We are now extending our baseline specification to condition the impact on the inflation environment. To evaluate the inflation-dependency for the earnings heterogeneity channel of monetary policy, we estimate the distributional impact in a low-inflation and high-inflation regime:

$$\Delta y_{i,t+h} = \alpha_g^h + \beta_g^{h,L} \Delta i_t (\Pi_{t-1} < 7\%) + \beta_g^{h,H} \Delta i_t (\Pi_{t-1} \geq 7\%) + \Gamma_g^h X_{t-1} + \epsilon_{i,t+h}, \qquad (2)$$

We now have two coefficients for the monetary policy impact: $\beta_g^{h,L}$ captures the impact in the low-inflation regime (below 7%) and $\beta_g^{h,H}$ captures the impact of MP shock in the high-inflation regime (above 7%) for the income group g. To determine the inflation regime, we rely on the annualized inflation rate from the previous month to exclude that the monetary policy shock affects the chosen regime. The control for economic activity is also interacted with the inflation regime to control for the potentially heterogeneous impact of economic growth on labour income growth by the regime.

The parameters $\beta_g^{h,L}$ and $\beta_g^{h,H}$ determine the potential role of the inflation regime for the earnings heterogeneity channel of monetary policy. While we expect that the directions of the shock is rather constant across the regimes, that is, the signs $\beta_g^{h,L}$ and

$\beta_g^{h,H}$ are similar, the magnitude of the impact is potentially very different. For instance, if $\mid \beta_g^{h,H} \mid > \mid \beta_g^{h,L} \mid$, monetary policy has a stronger effect for income group g in the high-inflation regime than in the low-inflation regime. The shape of the distribution could be affected as well. We also disentangle the effects to evaluate the intensive and extensive margin separately, allowing for different response mechanisms in a low- and high-inflation environment.

4.2 Inflation-Dependent Results

Figure 4 presents the distributional impact of monetary policy conditional on being in a low- or high-inflation regime. The first key takeaway is that the impact of monetary policy on labour earnings is substantially elevated during the high-inflation period. The total labour income response is much more negative. This pattern is consistent along the income distribution. Low-, medium-, and high-income households are all much more affected by the monetary policy shock in the high-inflation environment.

The figure also demonstrates that the exposure to monetary policy across the income distribution depends on the inflation regime. In particular, low-income workers are quantitatively much more affected than workers in the middle or at the top of the income distribution in a high-inflation environment. Additionally, the exposure features a weak U-shape as the top 0.1% earners are slightly more affected. When inspecting the low-inflation regime, the effect across the income distribution is quantitatively much smaller. However, the relative differences are larger for some parts of the distribution. While low and medium-income individuals are negatively affected, the effect is basically muted for top earners starting from the 90th quantile. This is in contrast to the high-inflation environment in which each agent was negatively affected. Furthermore, the slightly stronger response of the top 0.1% income households is not present in the low-inflation environment. As a result, the exposure to the monetary policy shock is monotonously declining by income groups in a low-inflation regime.

The inflation regime also has an impact on the adjustment margins. While the stronger impact of the monetary policy shock in the high-inflation regime holds for all adjustment margins, there are relevant differences. The higher exposure of the lowest income deciles to the monetary policy shock is driven primarily by the extensive margin in the high-inflation regime. Entry and exit in the labour market dominate the response. For instance, for the lowest decile, more than 90% of the response is explained by the entry and exit margin, as can be seen in detail in Table D.2 in the appendix. Instead, in the low-inflation regime,

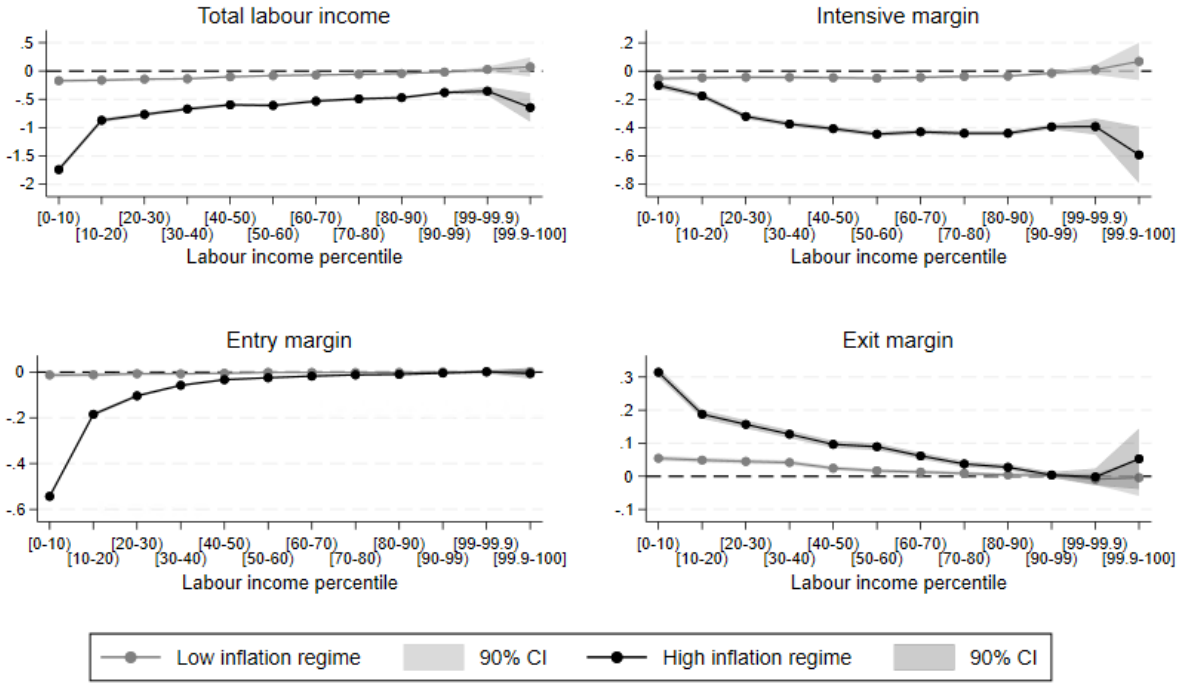

Figure 4: The effect of monetary policy shock (100 bps) on labour income growth by inflation regime and income groups, 2008M1-2023M9. The effect on total income, the intensive margin, the entry margin and the exit margin are shown.

the exposure of the low-income workers stems to a much larger extent from the intensive margin of the low-inflation regime.

Taken together, the earnings heterogeneity channel of monetary policy depends on the inflation environment. Specifically, the quantitative impact for low-income households is substantially stronger in the high-inflation environment. The effect is mainly driven by labour market entry and exit. Nevertheless, the relative differences may be even larger in the low-inflation environment as there are qualitative differences in the exposure of different groups. While there is a weak U-shape in the high-inflation environment, the top decile is not affected at all during the low-inflation regime.

4.3 Robustness Checks

We provide a set of robustness checks by evaluating potential sign asymmetries between positive and negative shocks, using alternative measures of the monetary shock, changing the set of control variables and using nominal wages instead of real wages. Figure 5 summarizes most of the results.

Sign Asymmetries. We compare the effect of monetary policy shock on labour income by accommodative and contractionary shocks. The results for the shock asymmetry are shown in the upper left panel of Figure 5. Our results highlight that contractionary shocks are the main driver. Expansionary shocks have a much more limited impact. The shape of the response for the different percentiles also differs to some extent. This implies an important sign asymmetry for the distributional impact of monetary policy. However, the sign asymmetry cannot explain our observed inflation dependency as we observe a mix of both shocks during both inflation regimes.

Alternative Monetary Policy Shocks. We consider alternative monetary policy shock measures by adding and relaxing the restrictions in shock identification.[15] We first add restrictions by considering the sign-restriction approach of Jarocinski and Karadi (2020).[16] We also remove restrictions and use direct changes in the 3-month OIS rate. In this case, we do not account for potential information effects. The results for these two series are shown in the upper right and lower left panel of Figure 5. The estimates for the total labour income response with more restrictions are very close to our baseline estimates and confirm our distributional effects by the inflation regime. The estimates with no restrictions confirm that monetary policy has a stronger effect during a high-inflation regime than during a low-inflation regime. However, the distributional effects differ for the lowest-income decile during the low-inflation regime.

Alternative Control Variable. We also add the geopolitical risk measure from Caldara and Iacoviello (2022) as an additional control variable to the baseline specification. The advantage of this control is that geopolitical risk is unlikely to be affected by monetary policy shocks. Thus, it can be entered contemporaneously with income. Controlling for it can be very important because geopolitical risk has affected the income dynamics in Estonia substantially. This is especially the case during the high-inflation regime that coincided with the full-scale war in Ukraine in 2022 and also, to some extent, stemmed from the associated surge in energy prices. The results are shown in the lower right panel of Figure 5. The results are very assuring because they are very close to our baseline

[15] Brennan et al. (2024) discusses how different data series and methods create differences in the identified shock series.

[16] Similar to the poor man's sign restriction for our main series, the goal is to focus on the surprise monetary shock and disentangling it from central bank information effects. In this case, we use their sign restriction approach, which imposes restrictions on the rates and stock market response. The median response provides then shock series.

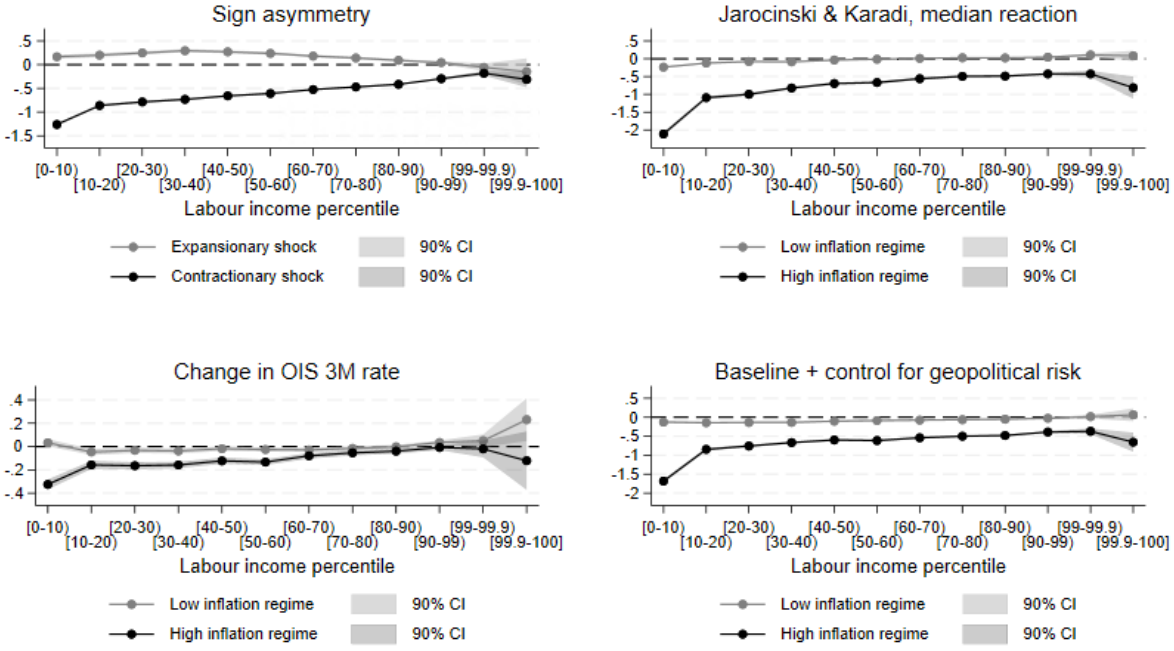

Figure 5: The effect of monetary policy shock on total labour income by income groups for alternative empirical specifications, 2008M1-2023M9. Upper left panel: Impact of an accommodative (-100 bps) and contractionary (100 bps) shock, respectively. Upper right panel: Impact of 100 bps monetary policy shock, which is identified with sign restrictions, by inflation regime. Lower left panel: Impact of a 100 bps direct change in the 3-month OIS rate, by inflation regime. Lower right panel: Impact of a monetary policy shock with geopolitical risk as an additional control variable, by inflation regime.

estimates. Thus, the strong impact of monetary policy shocks during a high-inflation regime seems to be not driven by geopolitical tensions.[17]

Nominal Wage We estimate the effect of monetary policy by inflation regime on nominal wages. The results for total effect and the different margins are shown in Figure D.5 in the Appendix. The results by entry and exit margin are unaffected by deflating the dependent variable or not. The intensive margin with nominal wages shows a slightly stronger effect throughout the distribution in the low-inflation regime and vice versa in the high-inflation regime. This is due to the effect of inflation on real wages. For instance, in the low-inflation regime, the negative effect on nominal wages is compensated by lower

[17] Of course, the geopolitical tensions affect the inflation regime, e.g., via energy prices.

inflation, and there is only small effect of monetary policy on real wages. However, the inflation effect is rather small so the estimated results with nominal and real wages are very similar.

5 Aggregate Implications of the Earnings Heterogeneity Channel

In this section, we evaluate the aggregate implications of the earnings heterogeneity channel. In particular, we determine how different exposures to monetary policy across the income distribution amplify or dampen the response of aggregate consumption. To achieve this, we must complement our individual-level estimates of income risk to monetary policy shocks with information on the MPC. Again, we exploit the advantages of using our Estonian data, namely by merging our administrative data with household-level MPC estimates from the Household Finance and Consumption Survey (HFCS) for Estonia.[18] Using this merged dataset, we evaluate the aggregate MPC in response to a monetary policy shock. We also analyze the impact of a monetary policy shock on total labour income and the Gini coefficient. Furthermore, we account for inflation dependencies when assessing the aggregate impact.

5.1 Aggregate Marginal Propensity to Consume

The aggregate MPC in response to a monetary policy shock can be disentangled into two components, as shown in Patterson (2023). It depends on the income-weighted average MPC and the covariance between the household-level response to aggregate shocks and MPC:

$$\text{Aggregate MPC} = \sum_j \frac{dC_j}{dE_j}\frac{dE_j}{dY} = \sum_j \frac{E_j}{Y}\frac{dC_j}{dE_j} + cov\left(\frac{dC_j}{dE_j}, \gamma_j\right) \tag{3}$$

where E_j is the labour income of household j, C_j is the consumption of household j, Y is the aggregate labour income, $\gamma_j = \frac{dE_j}{dY}\frac{Y}{E_j}$ is the elasticity of household j labour income to the monetary policy shock. We focus here entirely on aggregate labour income change dY that originates from the monetary policy shock. Note that we express this equation in household-level terms due to the availability of MPC estimates. When describing the

[18]The Household Finance and Consumption Survey is an ECB-coordinated survey of household assets, liabilities, and consumption.

data below, we explain how we adjust our initial estimates to have them on a household level.

The first term on the right-hand side is the income-weighted average MPC of households. The second term captures the covariance between household-level response to monetary policy shocks and household-level MPCs. We use this expression to investigate the role of the earnings heterogeneity channel in the transmission of monetary policy. Specifically, the second term determines the contribution of the earnings heterogeneity channel for the monetary policy shock transmission. A positive covariance between the MPC and the exposure to the shock, $cov(\cdot) > 0$, results in an amplification of the monetary shock due to earnings heterogeneity. In contrast, a negative correlation, $cov(\cdot) < 0$, would dampen the impact. Similarly, if the household-level response to monetary policy shock is unrelated to their MPC, $cov(\cdot) = 0$, the earnings heterogeneity channel would not contribute to the transmission of monetary policy.

When inspecting the different terms, it turns out that we have access to most of the required objects using our administrative dataset and results. We can calculate the income share of household j, E_j/Y. Similarly, we can estimate the income response to the monetary policy shock, that is dE_j/dY. Thus, we have the elasticity of household j labour income to the monetary policy shock, γ_j. However, we are missing household-level estimates of the marginal propensity to consume, that is dC_j/dE_j.

5.2 Merged Dataset with MPCs

To obtain MPC estimates, we are using the HFCS for Estonia conducted in 2021. The survey provides a household-level MPC estimate using the unexpected windfall gain question[19]. It has been shown that such self-reported MPC measures provide very similar MPC estimates as ones revealed from actual behaviour and are highly informative in predicting actual spending (Parker and Souleles 2019). Table 1 shows the average MPC for the different labour income percentiles. We observe a substantial heterogeneity for the MPCs over the income distribution, like in related literature by Jappelli and Pistaferri (2014).[20]

[19]The exact phrasing of the MPC question is (HFCS question HIZ040a): "Imagine you unexpectedly receive money from a lottery, equal to the amount of income your household receives in a month. What per cent would you spend over the next 12 months on goods and services, as opposed to any amount you would save for later or use to repay loans". The reference unit is the household.

[20]Our average MPC estimate is 37% for all the households with at least one employed member from prime working age. This is somewhat lower than the estimates using exactly the same wording of windfall gain question in Jappelli and Pistaferri 2014 and the revealed-preference estimates from spending after income shocks such as unemployment or tax rebates in Patterson 2023.

We merge the sample of Estonian households that were interviewed in the HFCS with our administrative data-based estimates of responsiveness to monetary policy so that we have all household-level data to determine the aggregate MPC. We are switching to the household level, j, here as the MPC in HFCS is measured at the level of household and not individual. We derive the γ_j and dE_j due to monetary policy shock for each household using the heterogeneous β_g in equation (1) or (2). We reestimate separately β_g for 11 labour income groups conditional on gender and age as before. We merge the two highest income groups as the HFCS survey data does not allow us to observe the 0.1% income groups. Given the 88 different β_g for various socio-economic groups, we derive the individual's response to monetary policy given their socio-economic group and labour income in 2020 and aggregate the individual responses to the household members.[21] This way, we obtain the household reaction to a monetary policy shock. Note that only the households are included that have at least one member from prime working age, 26-65, who has received labour income. Our final sample contains then 1527 households with at least one member aged 26-65 with employment income in 2020.

5.3 Aggregate Results

We calculate and analyze the aggregate MPC estimates, as shown in Table 1. We first characterize a baseline scenario in which we assume an equal effect of monetary policy on all income groups. This corresponds to the income-weighted MPC captured by the first term at the right-hand side of equation (3) and abstracts from the earnings heterogeneity channel. The income-weighted aggregate MPC equals 0.328, as shown in column (1). In such a world, a one standard deviation contractionary monetary policy shock would lead to a 0.49% decline in consumption. This measure is calculated as the response of total labour income to a monetary policy shock, which is 0.015 (see also Table D.1) times the income-weighted MPC ($0.015 \cdot 0.328$).

However, the income groups are not equally affected by the monetary policy shocks, as shown in the previous sections. Specifically, low-income groups with high MPCs are much more affected by the shock in monetary policy. There is a positive correlation between the labour income elasticity with respect to monetary policy and MPC, as is shown in detail in Figure E.1 in the Appendix. Since households are not equally affected by monetary policy, the aggregate MPC rises to 0.347. This matching multiplier calculation assigns 5% of the impact of monetary policy on aggregate consumption to the earnings heterogeneity

[21] The 2021 wave of the HFCS reports the income from the last calendar year.

Table 1: The MPCs and monetary policy effects by household income groups

Labour income percentile	MPC	(1) Income weight	(2) MP effect weight	(3) MP weight by inflation regime Low inflation	(4) MP weight by inflation regime High inflation
$[0-10)$	0.465	0.013	0.026	0.038	0.028
$[10-20)$	0.420	0.033	0.052	0.084	0.047
$[20-30)$	0.436	0.046	0.059	0.088	0.054
$[30-40)$	0.351	0.061	0.078	0.113	0.071
$[40-50)$	0.391	0.073	0.085	0.114	0.079
$[50-60)$	0.328	0.086	0.095	0.098	0.093
$[60-70)$	0.375	0.105	0.112	0.106	0.111
$[70-80)$	0.353	0.130	0.135	0.134	0.133
$[80-90)$	0.302	0.169	0.155	0.131	0.157
$[90-99)$	0.265	0.229	0.172	0.093	0.186
$[99-100]$	0.227	0.056	0.032	0.000	0.040
Weighted Aggregate MPC		0.328	0.347	0.367	0.345
Consumption response to MP shock		0.49%	0.52%	0.11%	0.83%
Income Gini response to MP shock		-	0.35%	0.15%	0.42%

Notes: Table shows the MPC, the income weight, the weight adjusted by the response to monetary policy shocks, the weight adjusted by the response to the shock conditional on being in the low inflation and high inflation, respectively, for the different income groups. The aggregate MPC is calculated using the different weighting schemes numbered (1) to (4), which come from income or exposure to the monetary policy shock. The last two rows show the response of consumption and inequality to a contractionary one standard deviation monetary policy shock. The response is conditioned on the different weighting schemes and the size of the monetary policy shock.

channel. A one standard deviation contractionary monetary policy shock leads to a 0.52% decline in consumption ($0.015 \cdot 0.347$). Furthermore, the 1SD monetary policy shock increases inequality by 0.35%, which we measure using the Gini coefficient for labour income.[22]. Thus, the heterogeneous reaction of households to monetary policy shocks amplifies the impact of monetary policy and increases earnings inequality.

We can also condition the aggregate impact on the inflation environment to some extent. Using the inflation dependent estimates, the aggregate MPC in equation (3) is calculated with the elasticity γ_j^L and γ_j^H for the low and high inflation regime, respectively. However, the survey data on MPC for 2021 only covers the low-inflation regime.[23] Thus, the household-level MPCs are necessarily based on the low inflation environment. This

[22]The labour income Gini was 0.4029 in our sample in 2020.

[23]The interviews in 2021 were conducted between January and August, stopping shortly before the surge in inflation.

implies that our aggregate MPC only partly accounts for the different inflation regimes. However, we believe this is a cautious assumption, as we would expect that the MPCs would increase in a high-inflation environment. Similarly, the effect should be largest for low-income groups as they spend the largest part of their income already on essentials. Therefore, we likely downward bias the aggregate MPC for the high-inflation environment and provide a downward estimate. However, it should still provide a useful starting because there is also evidence that MPCs are quite stable over the business cycle (Patterson 2023). The results are shown in the last two columns of Table 1. The covariation between the exposure to monetary policy shock and MPC is stronger during the low-inflation regime than during the high-inflation regime. As a consequence, the aggregate MPC is larger in the low-inflation regime. This result may seem surprising at first glance. The stronger response of the aggregate MPC comes from two observations. The middle-income groups are relatively more affected from the shock during the low-inflation regime. Furthermore, the high-income groups are much less affected in the low inflation-environment. In fact, the top 1% are not affected by a monetary shock. Consequently, the correlation between shock exposure and MPC is stronger in the low-inflation environment. More details on the covariation are in Figures E.2 and E.3.

The earnings heterogeneity channel accounts for 11% of the response in aggregate consumption during a low-inflation regime and 5% of the response during a high-inflation regime. However, to fully assess the effect, we need to account for the average impact of a monetary policy shock. A one standard deviation monetary policy shock is much stronger in a high-inflation regime with an average impact of -0.3% relative to -2.4% on average earnings, please refer to Table D.2. Given the dominant effect of monetary policy during a high-inflation regime, the total effect of monetary policy on inequality is still stronger in this regime. A one standard deviation monetary policy shock has roughly an eight times larger effect on consumption during high-inflation regime than during low-inflation regime. When inspecting the impact on inequality, we simulate with our microdata and find that the effect of monetary policy on income inequality is also stronger during a high-inflation regime.

6 Conclusions

Our results shed new light on the earnings heterogeneity channel of monetary policy. We document that monetary policy shocks have a stronger quantitative impact on earnings

inequality during a high inflation environment - resulting in a novel inflation dependency. Our findings also raise the concern that taming high inflation affects disproportionately low-income workers due to their strong exposure to monetary policy shocks in a high-inflation environment. Turning to the aggregate implications, we show that the earnings heterogeneity channel amplifies aggregate fluctuations and increases inequality. Specifically, we assign approximately 5% of the impact of monetary policy on aggregate consumption to the earnings heterogeneity channel.

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Appendices

A Estonian Economy: Aggregate Dynamics

Estonia has a dynamic economy where the growth rate and inflation have been larger than on average in the euro area, but with more pronounced ups and downs, see Figure A.1. GDP volatility is high due to strong exposure to foreign shocks and limited automatic fiscal stabilisers. The country experienced a vast decline during the Great Recession, followed by a fast recovery and then solid growth for a decade until the Russo-Ukrainian war led to another substantial interruption of growth. The coincidence of a post-pandemic recovery and a surge in energy prices due to the war raised inflation above 20% in 2022 – a level unseen for decades and rarely witnessed in high-income economies, making it an excellent case study for inflation dependencies. There is another high-inflation period in our sample - during the Great Recession. This was mostly a demand-driven inflation episode driven by the housing boom.

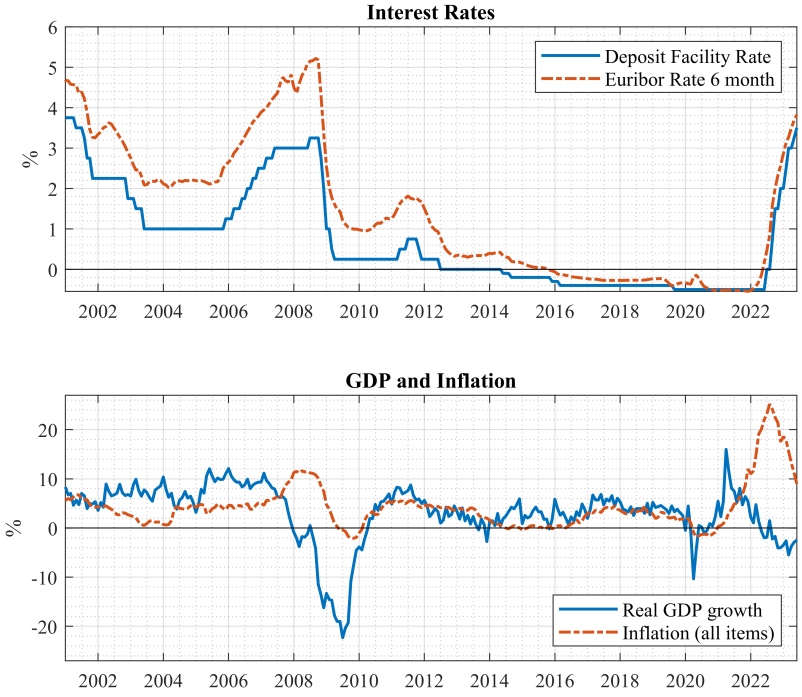

Figure A.1: Aggregate time series, 2001M1-2023M6. Upper chart: Deposit Facility Rate & the 6 month Euribor interest rate. Lower chart: real GDP growth (interpolated at monthly frequency) & inflation (HICP all items).

B Data

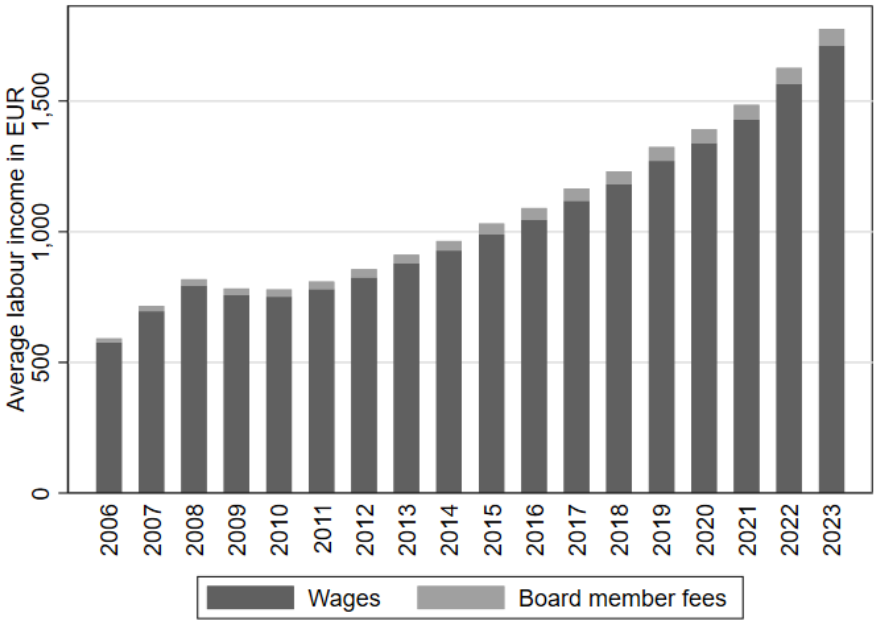

Figure B.1: Average labour income by type in 2006-2023M9.

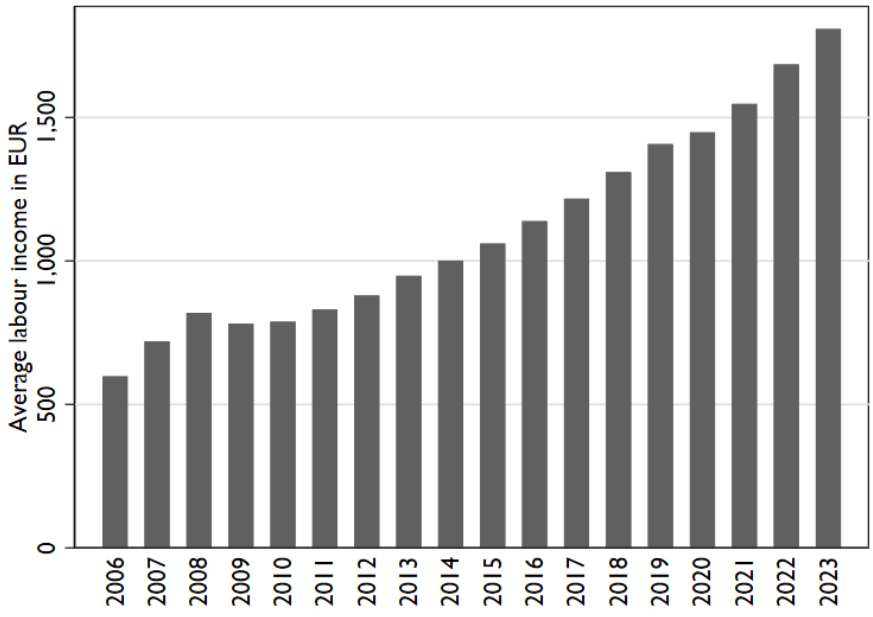

Figure B.2: Average labour income by Statistics Estonia in 2006-2023M9.

Table B.1: Labour income descriptives by permanent income group, 2008M1-2023M9

Income percentile from $t-13$ to $t-24$	(1) Mean income in 2015 prices	(2) Mid-point average income growth over 12 months	(3) Intensive margin growth over 12 months	(4) Entry rate over 12 months	(5) Exit rate over 12 months	(6) Number of observations
$[0-10)$	548.9	0.351	0.140	0.316	0.175	11,431,991
$[10-20)$	564.5	0.014	0.073	0.110	0.130	8,933,066
$[20-30)$	641.8	-0.053	0.045	0.066	0.111	8,677,750
$[30-40)$	747.1	-0.088	0.023	0.043	0.096	8,534,858
$[40-50)$	862.1	-0.101	0.010	0.029	0.084	8,494,491
$[50-60)$	992.0	-0.109	0.004	0.019	0.075	8,465,227
$[60-70)$	1147.2	-0.111	0.000	0.013	0.068	8,453,494
$[70-80)$	1349.0	-0.114	-0.005	0.009	0.063	8,446,902
$[80-90)$	1670.5	-0.117	-0.011	0.006	0.060	8,455,514
$[90-99)$	2558.4	-0.127	-0.021	0.004	0.058	7,617,517
$[99-99.9)$	5196.1	-0.138	-0.040	0.005	0.055	764,947
$[99.9-100]$	11183.0	-0.186	-0.062	0.006	0.070	86,012
All sample	1135.1	-0.032	0.022	0.070	0.095	88,361,769

Notes: Labour income is deflated by HICP in 2015 prices. Number of observations refers to the observations in the second, fourth and fifth column. The number of observations for the third column, intensive margin, is smaller and corresponds to observations where labour income was reported at time t and $t-12$.

C External validation: GDP Betas

Figures C.1 and C.2 show the GDP betas conditional on gender and age. The results are similar to that of the US. The labour income of men is more sensitive to aggregate growth than the one of women. Similarly to the US, we find that the youngest workers are the most sensitive to aggregate growth.

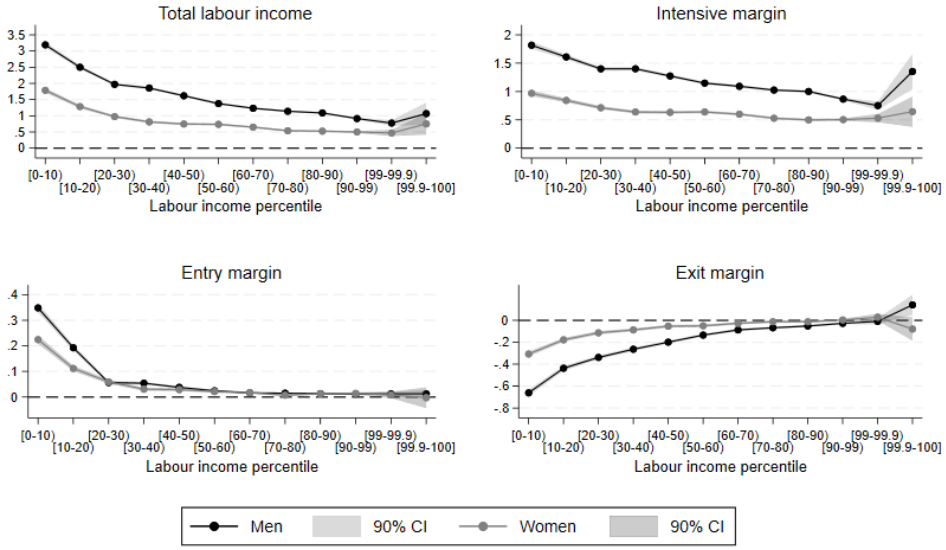

Figure C.1: GDP betas by income groups & gender, yearly data, 2008-2022.

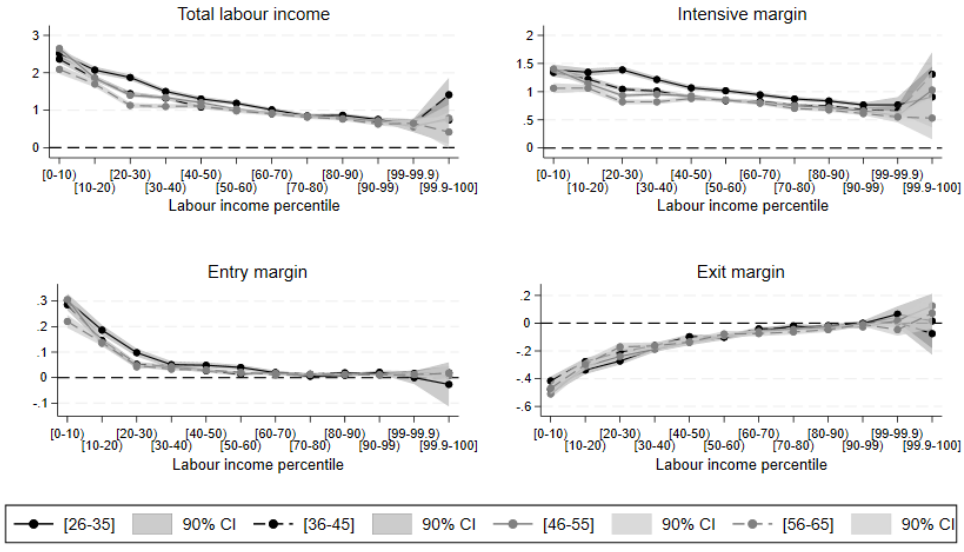

Figure C.2: GDP betas by income & age groups, yearly data, 2008-2022.

D Robustness Tests

D.1 Benchmark Specification: Yearly versus Monthly Frequency

Figure D.1 shows the impact and decomposition in intensive and extensive margins for an annual frequency. A lot of within-year transitions into and out of employment, and a majority of the monetary policy effect on low-income people originates by construction from the intensive margin. Consequently, the intensive margin at monthly frequency only accounts for half of the adjustment relative to annual data, as shown in Table D.1.

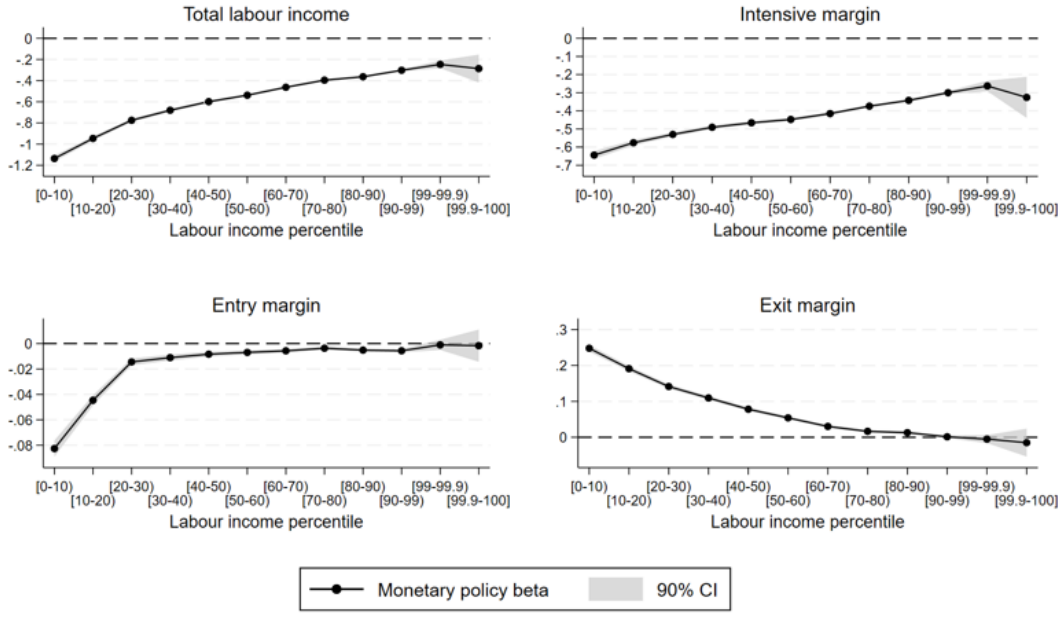

Figure D.1: The effect of monetary policy shock on labour income by income groups, yearly data, 2008-2022. The estimates at yearly frequency do not control for lagged GDP growth, because we cannot follow the same dynamic structure.

Table D.1 also demonstrates the economic size of the estimated effects. The shocks at monthly and yearly frequencies are not directly comparable because the expansionary and contractionary shocks cancel each other out at the yearly frequency. The shock at the yearly frequency cannot be taken as twelve times larger than the monthly shock. By standard deviation terms, the yearly shock is three times larger than the monthly shock (9.5 basis points versus 3.2 basis points). A one standard deviation contractionary shock reduces real wage growth by month 12, the intensive margin, by 4.3% in our yearly data

and by 0.6% in the monthly data. This estimate aligns with findings that monetary policy has a stronger pass-through in Estonia than in other euro area countries. For example, Hubert and Savignac (2023) find that a one standard deviation shock reduces total wage income, intensive margin, by 0.44% in French data at yearly frequency. Broer et al. (2022) estimate a 0.45% fall for the aggregate wage growth, intensive margin, with German monthly data. The number aligns with Almgren et al. (2022), who find the peak and cumulative effect of monetary policy in Estonia to be 6-7 times larger than in France and 2-3 larger than in Germany.

Table D.1: The effect of 1SD monetary policy shock on labour income by income groups

	Monthly frequency 2008M1-2023M9		Yearly frequency 2008-2022	
	(1)	(2)	(3)	(4)
	Total labour income	Intensive margin	Total labour income	Intensive margin
$[0-10)$	-0.027***	-0.002***	-0.108***	-0.061***
$[10-20)$	-0.018***	-0.003***	-0.090***	-0.055***
$[20-30)$	-0.016***	-0.005***	-0.074***	-0.050***
$[30-40)$	-0.015***	-0.006***	-0.065***	-0.047***
$[40-50)$	-0.013***	-0.007***	-0.057***	-0.044***
$[50-60)$	-0.012***	-0.007***	-0.051***	-0.043***
$[60-70)$	-0.011***	-0.007***	-0.044***	-0.040***
$[70-80)$	-0.010***	-0.007***	-0.038***	-0.036***
$[80-90)$	-0.009***	-0.007***	-0.035***	-0.033***
$[90-99)$	-0.006***	-0.005***	-0.029***	-0.029***
$[99-99.9)$	-0.005***	-0.005***	-0.023***	-0.025***
$[99.9-100]$	-0.008***	-0.006***	-0.027***	-0.031***
All sample	-0.015***	-0.006***	-0.057***	-0.043***

Notes: Labour income is deflated by HICP in 2015 prices. 1SD corresponds to a 3.2 basis point shock at monthly frequency and a 9.5 basis point shock at yearly frequency. ***, ** and * refer to statistical significance at 1, 5 and 10% level based on Huber-White heteroscedasticity robust standard errors.

D.2 Extensions: Horizon Length, Gender and Age

We present further results for our benchmark specification here. We estimate with alternative horizons and condition the impact on age and gender.

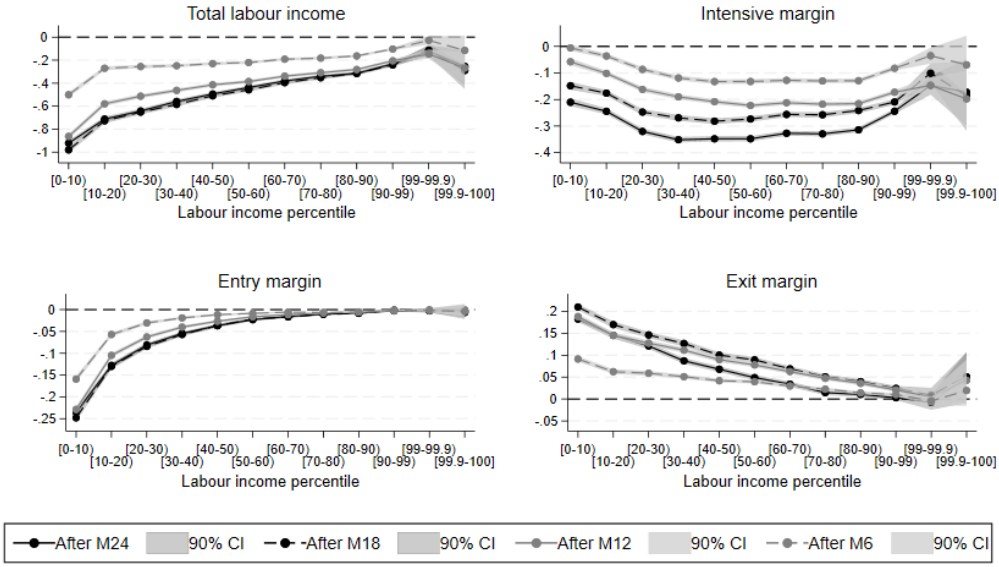

Figure D.2: The effect of monetary policy shock on labour income by income groups, local projections by month 6, 12, 18, 24, 2008M1-2023M9.

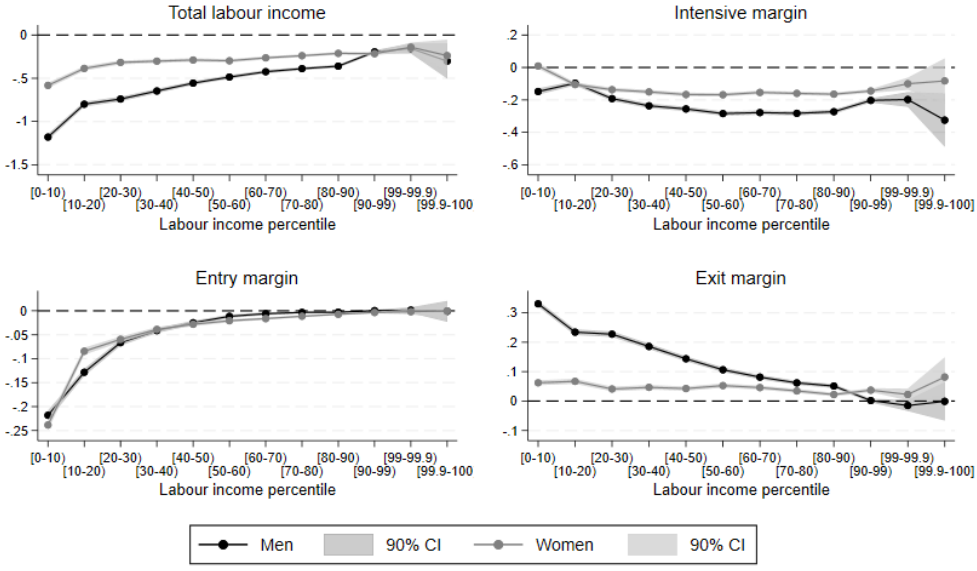

Figure D.3: The effect of monetary policy shock on labour income by income groups and gender, 2008M1-2023M9.

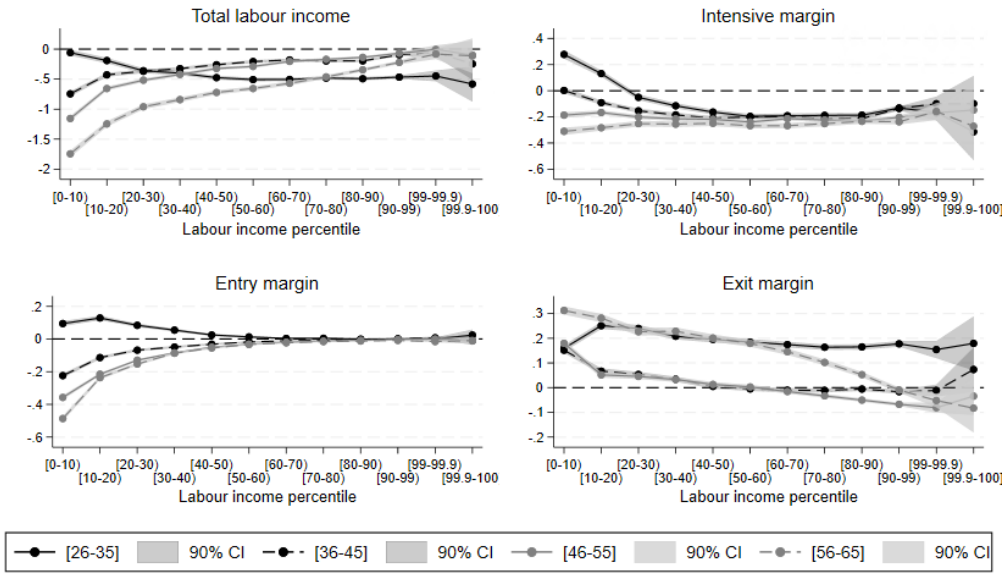

Figure D.4: The effect of monetary policy shock on labour income by income groups and age, 2008M1-2023M9.

D.3 Inflation Dependent Specification: Further Results

Here, we present further results for our inflation dependent specification.

Table D.2: The effect of 1SD monetary policy shock on labour income by income groups and inflation regime, 2008M1-2023M9

	Low inflation		High inflation	
	(1) Total labour income	(2) Intensive margin	(3) Total labour income	(4) Intensive margin
$[0-10)$	-0.005***	-0.002***	-0.055***	-0.003***
$[10-20)$	-0.005***	-0.001***	-0.028***	-0.006***
$[20-30)$	-0.005***	-0.001***	-0.024***	-0.010***
$[30-40)$	-0.004***	-0.001***	-0.021***	-0.012***
$[40-50)$	-0.003***	-0.001***	-0.019***	-0.013***
$[50-60)$	-0.003***	-0.002***	-0.019***	-0.014***
$[60-70)$	-0.002***	-0.001***	-0.017***	-0.014***
$[70-80)$	-0.002***	-0.001***	-0.016***	-0.014***
$[80-90)$	-0.001***	-0.001***	-0.015***	-0.014***
$[90-99)$	-0.001**	0.000**	-0.012***	-0.012***
$[99-99.9)$	0.001	0.000	-0.011***	-0.012***
$[99.9-100]$	0.002	0.002	-0.020***	-0.019***
All sample	-0.003***	-0.001***	-0.024***	-0.012***

Notes: Labour income is deflated by HICP in 2015 prices. 1SD corresponds to a 3.2 basis point shock. ***, ** and * refer to statistical significance at 1, 5 and 10% level based on Huber-White heteroscedasticity robust standard errors.

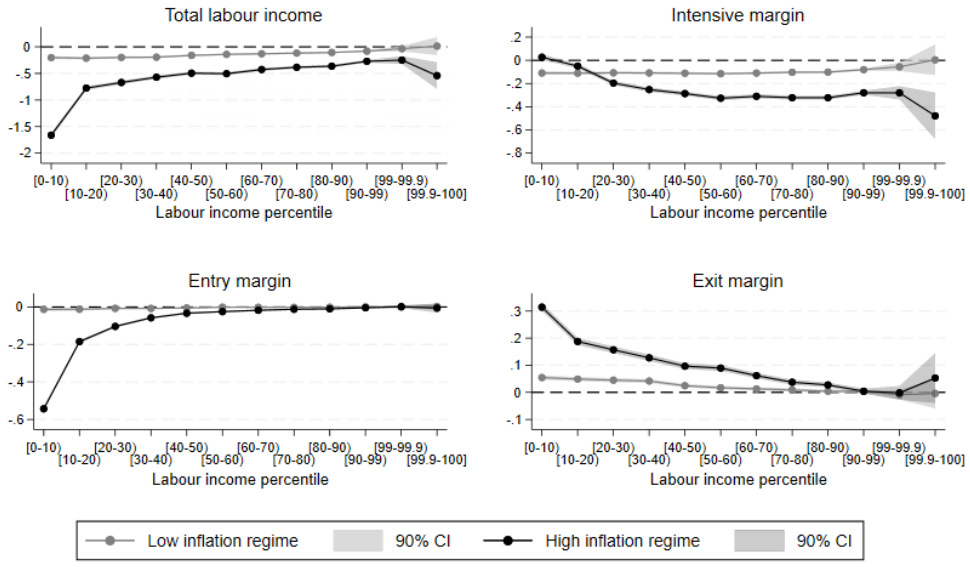

Figure D.5: The effect of monetary policy shock on labour income by income groups, nominal wages, 2008M1-2023M9.

E Aggregate Implications

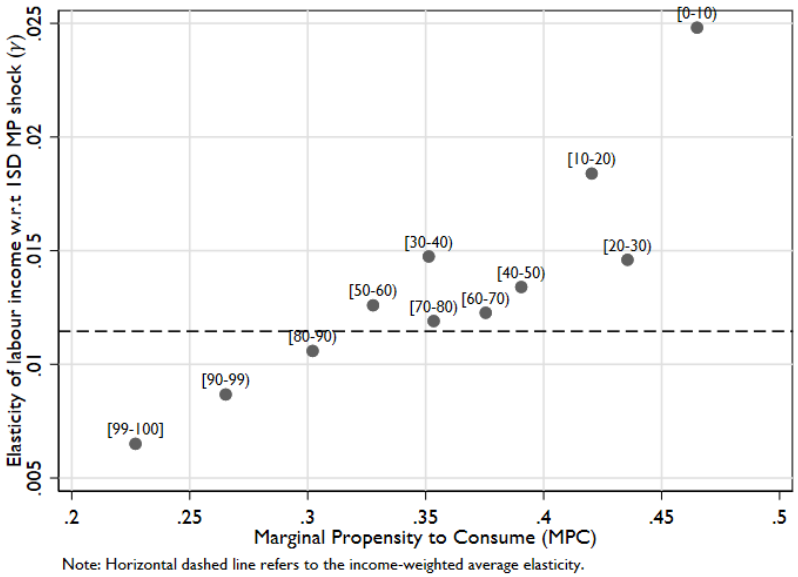

Figure E.1: MPCs and labour income elasticity with respect to monetary policy by income groups, simulation on HFCS data from 2021.

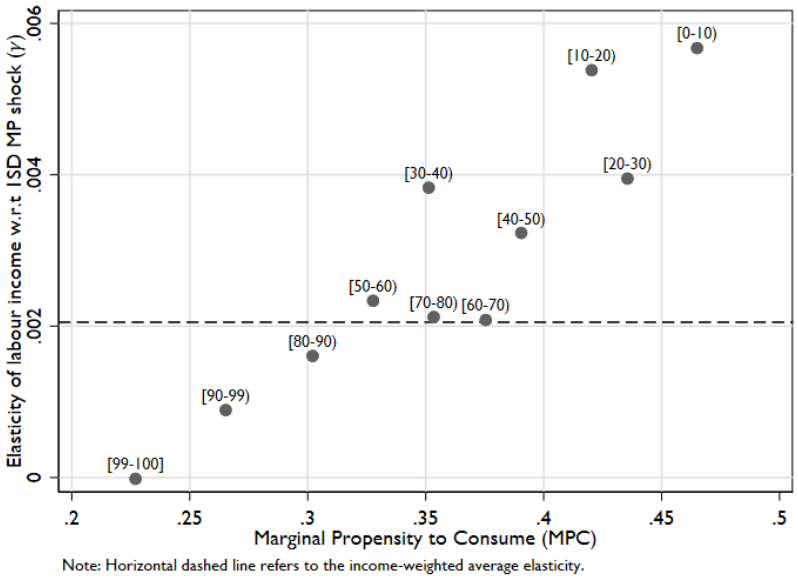

Figure E.2: MPCs and labour income elasticity with respect to monetary policy by income groups during low-inflation regime, simulation on HFCS data from 2021.

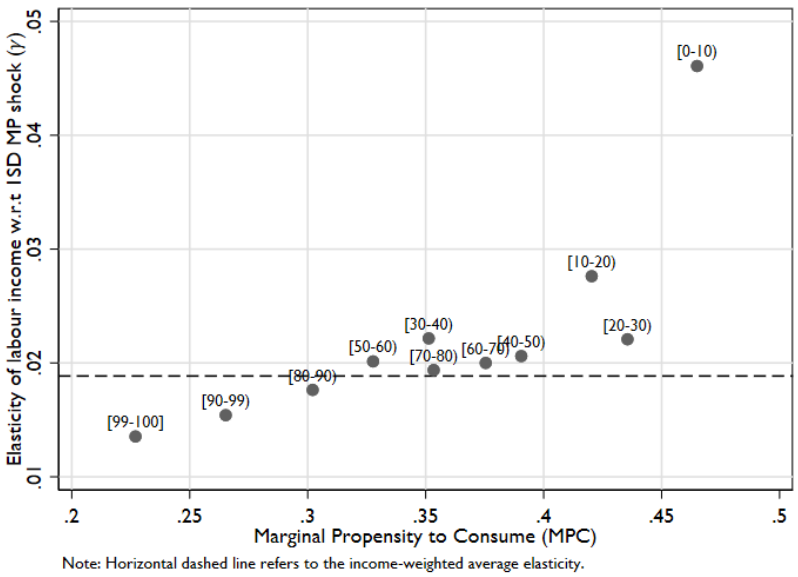

Figure E.3: MPCs and labour income elasticity with respect to monetary policy by income groups during high-inflation regime, simulation on HFCS data from 2021.