Monetary Policy, Labor Income Inequality and Credit: Evidence from Matched Employee-Employer and Credit Registers*

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Abstract

We investigate the effects of monetary policy on labor income inequality and the importance of financial constraints in the transmission mechanism. For identification, we exploit euro area monetary policy shocks and matched employee-employer and credit registers in Portugal over several cycles. We show that expansionary monetary policy decreases overall income inequality among workers. This effect is driven by falling labor income dispersion *between firms*. We uncover a central role of the credit channel and show that the distributional effects arise from financially constrained firms that tend to pay lower wages. We find that following an expansionary monetary policy shock, financially constrained firms receive more credit allowing them to increase wages of their workers by more. In contrast to these between-firm dynamics, we also document an increase in income inequality *within firms*. Softer monetary policy amplifies the skill premium and favors workers with a college education. Consistent with the capital-skill complementarity mechanism, financially constrained firms exhibit a stronger increase in both physical and human capital investment.

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In recent years, income and wealth inequality have become central topics in monetary policy discussions (e.g., Bernanke, 2015; BIS, 2021; Draghi, 2016; Powell, 2019; Lagarde, 2020). [1] While monetary policy is not explicitly designed to redistribute income or wealth, a growing body of research suggests that it has significant distributional effects (e.g., Coibion et al., 2017; Kaplan et al., 2018; Andersen et al., 2023). Much of the discussion focuses on how monetary policy influences wealth through asset prices, as an expansionary policy tends to boost stock, corporate bond, and government bond prices, disproportionately benefiting wealthier households which hold a disproportionate share of those assets (e.g., Bernanke and Kuttner, 2005; Gertler and Karadi, 2015; Hanson and Stein, 2015; BIS, 2021). However, labor income remains the most important determinant of wealth accumulation — except for the top 1%, where capital income and asset appreciation play a larger role (Black et al., forthcoming; Kaymak et al., 2020). Moreover, labor earnings are a key channel through which monetary policy transmits heterogeneously across households (e.g., Auclert, 2019; Kaplan et al., 2018). Despite its importance, the mechanisms driving this heterogeneity remain underexplored, particularly the relative roles of firm versus worker characteristics in shaping labor income responses to monetary policy.

Labor income inequality can arise from differences in pay both *within firms* and *between firms*, with the latter playing a significant role in overall earnings inequality (e.g., Song et al., 2018; Alvarez et al., 2018). Understanding how monetary policy affects these dimensions of inequality requires examining both worker characteristics, which can influence pay gaps within firms; and firm characteristics, which shape earnings disparities across firms. In particular, credit frictions have been shown to affect firm-level wages (e.g. Michelacci and Quadrini, 2009; Guiso et al., 2013) and represent a key channel through which monetary policy transmits to firm-level outcomes (e.g., Bernanke and Gertler, 1995; Jimenez et al., 2014; Ottonello and Winberry, 2020). On the worker side, differences in skill levels have been established as a major determinant of within-firm inequality and are central to evaluating the role of capital-skill complementarity in shaping earnings disparities (Acemoglu, 1998; Krusell et al., 2000; Fonseca and Van Doornik, 2022). However, progress in this area has been limited by the lack of comprehensive micro-level data linking employer-employee records with firm credit information, which is crucial for capturing the interplay between financial constraints, firm behavior, and worker-level labor market outcomes.

This paper provides novel evidence on the effects of monetary policy on labor income inequality

[1] A comprehensive overview of central bank speeches in both advanced and emerging markets by BIS (2021) finds that approximately 10% of all recent central bankers' communications mention keywords such as "inequality" or "distributional consequences/impact of monetary policy".

and the importance of the credit channel in the transmission mechanism. To identify the causal effects of monetary policy, we leverage euro area monetary policy shocks and a unique, granular administrative dataset that links employee-employer records with firm loan-level credit registry data in Portugal since the creation of the Eurozone. Our findings show that expansionary monetary policy significantly reduces overall labor income inequality, primarily by decreasing income dispersion between firms. However, it simultaneously increases inequality within firms, with the reduction in between-firm inequality dominating. We highlight the credit channel as a key mechanism driving these effects, underscoring the importance of financial constraints in shaping labor market outcomes.

We find that between-firm effects are primarily driven by financially constrained, small, and young firms, which tend to pay lower wages. Expansionary monetary policy relaxes financial constraints, enabling small and young firms to access more credit and raise wages of their workers more substantially than larger and older firms. To corroborate the importance of the credit channel, we first use loan-level credit registry data to analyze how firm credit responds to monetary policy across firm size and age. Our results reveal that expansionary monetary policy leads to significantly larger increases in bank credit for smaller and younger firms, highlighting the importance of financing constraints in shaping wage outcomes. Furthermore, we document that these heterogeneous wage effects are present only for financially constrained firms with existing bank credit relationships, in contrast to firms without bank credit, which do not exhibit any effect. Finally, we introduce a novel, agnostic approach to estimate firm-level credit sensitivity to monetary policy using loan-level data. Our findings demonstrate that workers employed at firms with stronger sensitivity of credit to monetary policy (i.e., firms that receive more bank credit following a monetary policy softening) experience disproportionately positive wage effects.

We further show that within-firm inequality effects are closely linked to the rise in the skill premium. Expansionary monetary policy boosts the hiring of college-educated workers and amplifies the skill premium. We show that these effects are consistent with the capital-skill complementarity mechanism. In particular, financially constrained firms exhibit a more pronounced increase in both physical and human capital investment in response to expansionary monetary policy, driven by increased access to bank credit.

Our setting allows us to overcome key data and identification challenges. First, we exploit an unparalleled match of granular longitudinal data on workers, firms, banks and firm-loans in Portugal. The administrative employee-employer data encompass all private sector workers over

two full monetary policy cycles (1999–2013). The dataset includes a wealth of information on workers, including their occupation, education, regular wage, any additional wage supplements, and hours worked. It also contains relevant data on employers, such as their industry, region, age, sales, investment. Consequently, the data enable the analysis of all critical labor market outcomes (wages and employment) and the tracking of workers over an extended period as they move across firms. Furthermore, a novel aspect of this paper is that we match the administrative employee-employer data with the universal coverage of loans from the credit registry to investigate the importance of the credit channel.[2] This is the first paper to make use of the universal credit registry matched with administrative employee-employer data covering the totality of private sector employees to study the labor market effects of monetary policy. This allows us to highlight the critical role played by firm and worker characteristics in the heterogeneous effects of monetary policy on labor market outcomes and to uncover the underlying mechanism associated with the existence of financial frictions. As a result, the availability of such a comprehensive and novel dataset enables us to make significant contributions to the existing literature.

Second, the institutional setting also helps us overcome potential endogeneity issues between monetary policy and the labor market. Since 1999, Portugal has been part of the Eurosystem, and monetary policy has been jointly set by the European Central Bank (ECB) for all member states. The euro area's monetary policy has been largely exogenous to the state of the Portuguese economy for several reasons: (i) Portugal accounts for only 1.8% of Eurozone GDP, (ii) the Portuguese business cycle has not yet converged with that of the core euro area economies (Giannone et al., 2011), and (iii) the Portuguese economy was very sluggish at the creation of the eurozone (Blanchard, 2007; Reis, 2013). Importantly, to address any remaining identification challenges, in accordance with the monetary economic literature, we use identified monetary policy surprises for the Eurozone as a proxy for the monetary policy stance based on Jarocinski and Karadi (2020). Finally, Portugal also represents an appropriate setting to examine the state-dependent labor market effects of monetary policy. The country was severely impacted by the Global Financial Crisis and the European Sovereign Debt Crisis, making it possible to analyze the role of the credit channel not only during normal times but also in crisis periods when credit constraints are particularly salient.

Third, the use of administrative employee-employer data allows us to follow workers over time as they move across firms. This enables us to disentangle the time effects as well as the role of the

[2]The high-quality granular credit registry in Portugal collects information on all firm credit above the reporting threshold of just EUR 50. In addition to loan amounts, the credit register includes information on other key loan characteristics, such as the maturity, currency and loan type.

permanent firm and worker components in workers labor market outcomes, using time, firm, and worker fixed effects. This modeling approach builds on the seminal work of Abowd et al. (1999), which we extend to assess the impact of monetary policy. We use this framework to explore the heterogeneous responses of labor market outcomes across different firms and workers. We explore two dimensions of heterogeneity. On the firm side, we differentiate firms based on their size and age, which serve as proxies for financial constraints. Furthermore, we introduce micro-level credit data to directly measure firm-level credit sensitivity to monetary policy. On the worker side, we analyze the role of the skill premium, as proxied by educational attainment, to understand how monetary policy impacts workers differently within firms. This comprehensive approach allows us to capture the labor market effects of monetary policy both through firm- and worker-level channels.

In our baseline analysis, we use monetary policy surprises, following the approach of Coibion (2012); Döttling and Ratnovski (2023); Nakamura and Steinsson (2018). We construct cumulative monetary policy shocks based on surprises identified from high-frequency data for the Eurozone by Jarocinski and Karadi (2020).[3] Furthermore, we also demonstrate that our results are robust to the use of the shadow rate (Wu and Xia, 2016) and the overnight interbank interest rate for the Eurozone (EONIA) as in Jimenez et al. (2014). In all specifications, we also control for the heterogeneous effects of the domestic business cycle and the global financial cycle.

We start by examining the impact of monetary policy on overall inequality in labor earnings. We show that monetary policy easing reduces overall income inequality by disproportionately benefiting low-wage workers compared to high-wage workers. To better understand this effect, we decompose the overall impact into between- and within-firm labor income inequality. Our findings reveal that monetary policy softening benefits low-wage firms the most, which in turn decreases wage dispersion between firms. Currently, high earners within a given firm benefit the most, resulting in an increase in inequality within firms. When considering cumulative effects, we find that while the increase in within-firm inequality is economically and statistically significant, the between-firm effects dominate the overall dynamics of labor income inequality. Consequently, softer monetary policy ultimately leads to a net reduction of income inequality among workers.

Via which channel does monetary policy reduces between-firm inequality? We show that financial constraints and the credit channel play a central role in driving the between-firms wage effects of monetary policy. Consistent with the firm balance sheet channel of monetary policy (e.g. Bernanke

[3]The existing literature has shown that this level measure capturing cumulative monetary policy surprises is a strong instrument for the 1-year policy rate compared to contemporaneous high-frequency shocks, which yield little explanatory power (see Döttling and Ratnovski, 2023).

and Gertler, 1995), we show that softer monetary policy allows financially constrained low-wage firms to access more credit and increase the wages of their workers by more. To establish this result, we proceed in three steps. First, we proxy firm financing frictions using measures previously established in the literature, such as firm size and age. Furthermore, we leverage the granularity of credit registry data and develop a novel and agnostic approach to compute the firm-level credit sensitivity to monetary policy using loan-level data. The proposed strategy offers a flexible approach that does not require observing (or taking an ex ante position on) which firm characteristics are the main drivers of the heterogeneous response to monetary policy.[4] Our findings consistently indicate that firms with higher credit sensitivity tend to be smaller and younger and pay lower wages.

Next, we exploit the cross-sectional variation in firm financing frictions and examine the heterogeneous response of worker-level wages to monetary policy. We show that softer monetary policy disproportionately improves labor market outcomes in low-wage, financially constrained firms. Following a one-standard deviation expansionary monetary policy shock, workers in small (young) firms experience a 1.61 (0.65) stronger increase in wages in the following year compared to workers in large (old) firms. Taken together, a one-standard deviation expansionary monetary policy shock reduces the wage gap between small and large firms by approximately 5.9%, and between young and old firms by approximately 6.1%. Our novel measure of firm-level credit sensitivity to monetary policy yields consistent findings. Specifically, we show that following an expansionary monetary policy shock, workers in firms with stronger sensitivity of credit to monetary policy (i.e. firms that receive more credit when central bank lowers the interest rate) benefit disproportionately more.

To corroborate the importance of the credit channel, we also compare the wage response in firms with and without bank credit. Our findings indicate that a relaxation of monetary policy is associated with economically and statistically significant increases in wages in small and young firms, but only for firms with previous bank-borrowing relationships. Conversely, the effects are either opposite or null for workers in firms that have not previously borrowed from banks. Furthermore, using loan-level credit registry data, we also analyze the response of firm credit to monetary policy easing across firm size and age. To address key identification challenges, we incorporate bank-time, industry-time, region-time, and firm-level fixed effects, ensuring that the results account for heterogeneity in bank credit supply responses, as well as local and industry-specific time-varying factors

[4]In the estimation of the firm-level credit sensitivity to monetary policy changes, we introduce bank-time fixed effects to control for the time-varying bank-level credit supply, as well as industry-time and region-time fixed effects to absorb any heterogeneity at the industry-time and region-time level, including changes in the firm's demand for credit, which could be triggered by local and industry time-varying conditions. Our results are also robust to an alternative estimation that also controls for time-varying firm demand for credit using firm-time fixed effects.

such as change in credit demand. Our findings show that monetary policy easing significantly increases bank credit for smaller and younger firms, underscoring the importance of financing constraints in driving stronger wage effects for these firms. Finally, we find that the credit channel exerts stronger effects in crisis periods than in normal times. Our results suggest that expansionary monetary policy has state-dependent effects and is particularly effective in alleviating firm financial constraints during periods of financial distress, thereby mitigating labor income inequality between firms. In conclusion, our findings demonstrate that the credit channel plays a pivotal role in the distributional shifts between firms induced by monetary policy.

We also test an alternative explanation for why smaller and younger firms increase wages more strongly in response to monetary easing, namely that these firms might benefit disproportionately from increased product demand rather than relaxed financing constraints. We provide two pieces of evidence that rule out this demand-based mechanism. First, we incorporate industry- and region-time fixed effects into the wage regression, controlling for industry- and region-specific changes in product demand, and find that the stronger wage increases for smaller and younger firms remain robust. Second, we examine firm sales data and observe no significant differential effects of monetary policy on sales across firms of varying sizes and ages. Together, these findings reinforce the conclusion that the relaxation of financing constraints, rather than shifts in product demand, drives the observed between-firms wage effects of monetary policy.

How does monetary policy affect within-firm labor income inequality? Finally, we document that a monetary policy relaxation leads to an increase in income inequality within firms. To gain further insight, we examine worker-level heterogeneity with respect to skill. The existing literature has provided substantial evidence that the composition of workers in firms plays a pivotal role in understanding the dispersion of wages in the economy (Abowd et al., 1999; Card, 1999; Card et al., 2013). Our findings show that following a softening of monetary policy, high-skilled college-educated workers benefit the most, both in terms of employment and wages, leading to an increase in the skill premium. Furthermore, by exploiting the granularity of detailed education coding in the worker-level data. We show that the rise in the skill premium is most pronounced for workers with STEM college degrees, in line with the idea that technology is complementary to specific fields and workers performing non-routine cognitive tasks (Acemoglu and Autor, 2011; Fonseca and Van Doornik, 2022).

Next, we combine worker and firm heterogeneity and find that the increased employment of skilled workers is concentrated in financially constrained firms. Our findings align with the capital-

skill complementarity mechanism, indicating that softer monetary policy enables financially constrained firms to increase both physical capital and human capital investment.

Overall, our results indicate that firm credit frictions are a key factor to understand the effects of monetary policy on labor income inequality. We show that the decline in labor income inequality is mainly attributable to the stronger increase in worker wages in credit-constrained firms. In addition, the rise in the within-firm skill-premium is instead mainly driven by capital-skill complementarity effects, which are stronger in financially constrained firms.

Related literature. Our paper relates to several strands of the academic literature. First, we contribute to the expanding body of empirical research on the impact of monetary policy on inequality (e.g. Coibion et al., 2017; Ampudia et al., 2018; Bergman et al., 2020; Holm et al., 2021; Amberg et al., 2022; Andersen et al., 2023; Lenza and Slacalek, 2024) by examining its effects on both between- and within-firm earnings inequality and the transmission mechanisms through which these effects materialize. Our paper closely relates to Coibion et al. (2017), which, using survey data, shows that expansionary monetary policy decreases labor income inequality in the US. We break new ground by revealing that expansionary monetary policy reduces overall labor income inequality by narrowing income disparities between firms, while simultaneously increasing income inequality within firms. This novel finding is made possible by leveraging a unique, granular administrative dataset that enables us to disentangle the roles of worker and firm characteristics in wage determination. The dataset provides comprehensive coverage of all private-sector firms, permitting to track workers over time as they transition between employers. Additionally, it also enables us to reveal that the credit channel emerges as a key transmission mechanism driving the effects of monetary policy on labor income inequality.

Our results are relevant for at least two reasons. First, the dispersion of earnings between firms accounts for an increasing share of total earnings inequality both in countries where inequality increased, such as Germany (e.g. Card et al., 2015) and the US (e.g. Song et al., 2018) and in those where it decreased, like Brazil (e.g. Alvarez et al., 2018). Hence, understanding if and how monetary policy affects between-firm inequality is crucial to understand its overall effects on labor income inequality. Our results reveal that disentangling the effect of monetary policy on within- and between-firm inequality is also crucial to uncover the key transmission channels of monetary policy to inequality. Second, the theoretical literature demonstrated that expansionary monetary policy directly increases consumer and firm demand, which in general equilibrium translates into higher labor incomes, with effects unevenly distributed across individuals (see e.g. Gornemann et al., 2016;

Kaplan et al., 2018; Auclert, 2019).[5] Our results on the role of firms characteristics offer valuable insight on the importance of financial frictions and supply effects for the heterogeneous transmission of monetary policy to labor market outcomes. These effects are key for the microfoundation of the drivers of heterogeneity in the effects of monetary policy on labor income across different types of households in theoretical models.[6]

Second, by showing that the credit channel of monetary policy is key in driving the effects of monetary policy on inequality, our paper contributes to the large and growing literature on the role of firm and bank balance sheet positions and credit frictions as key elements in the heterogeneous transmission of monetary policy (e.g., Bernanke and Gertler, 1995; Kashyap and Stein, 2000; Drechsler et al., 2017). We build on the recent studies that use credit registry data to study the transmission of monetary policy (e.g., Jimenez et al., 2012, 2014; Jasova et al., 2021) or credit shocks (e.g., Amiti and Weinstein, 2018; Khwaja and Mian, 2008; Paravisini, 2008; Schnabl, 2012) on lending to firms and firm-level real outcomes. Existing papers focus on the investment and employment effects through the firm balance-sheet channel. We show that monetary policy also has important heterogeneous effects across firms' worker wages and, as a result, on earnings inequality. Further, the effects are fully driven by firms with bank credit. Our results also indicate that the credit channel is substantially stronger in times of crisis.

We also connect to the literature that focuses on the labor market outcomes of credit shocks (e.g., Guiso et al., 2013; Chodorow-Reich, 2014; Berton et al., 2018; Moser et al., 2021) by showing that credit access and credit frictions are also key in assessing the distributional effects of monetary policy. Prior studies often focus on large syndicated borrowers or specific regions.[7] By utilizing comprehensive administrative micro-level data that cover the entire private sector workforce and is matched with the universe of loan data, we find that the redistributive effects of monetary policy are exclusive to firms with bank credit, highlighting the credit channel's significance. Additionally, our longitudinal data reveals state-dependent effects of the credit channel, offering fresh insights into its role during normal and crisis periods.

Third, by showing that the capital-skill complementarity effects drive the rise in within-firm

[5] As low income individuals are generally more depended on labor income, in these frameworks, they are also disproportionately more exposed to aggregate changes in labor income induced by monetary policy.

[6] The incidence function in Auclert and Matthew (2020) represents a reduced form attempt to model this type of heterogeneity.

[7] For instance, Moser et al. (2021) use syndicated-loan data in Germany which allows them to cover 36% of the labor force, primarily in large firms. Berton et al. (2018) analyze data from a single Italian region relying on the credit reporting threshold of 75,000 EUR (later 30, 000 EUR). We observe all credit contracts above just 50 EUR which allows us to (i) observe the entirety of bank borrowing of private sector non-financial firms in the economy, (ii) use firms that are not borrowing for external validity to corroborate the importance of the credit channel.

inequality we coplement the papers on financial frictions and labor market outcomes (e.g. Fonseca and Van Doornik, 2022; Dolado et al., 2021; Bai et al., 2018). Closely related to our paper is Fonseca and Van Doornik (2022), which show that relaxing financial frictions increases the skill premium and skilled employment, especially in financially constrained firms, due to capital-skill complementarity. Dolado et al. (2021) document aggregate and industry-level evidence that monetary policy easing increases labor income inequality between high- and low- skilled workers. Using our unique and granular administrative dataset, we connect these findings and show that expansionary monetary policy amplifies the within-firm skill premium and favors workers with a college education. In addition, these effects are especially pronounced in financially constrained firms.

Finally, our paper also broadly relates to the growing labor-finance literature (e.g., Giroud and Mueller, 2015; Mueller et al., 2017a,b; Barbosa et al., 2020; Howell and Brown, 2023; Fonseca and Liu, 2024). Among the most closely related studies, Fonseca and Liu (2024) show that monetary policy can influence labor mobility and reallocation through its effects on mortgage rates via the mortgage lock-in mechanism, while Howell and Brown (2023) highlight the role of financing frictions in the propagation of firm cash flow shocks to employee earnings. Building on these insights, we explore how monetary policy shapes labor outcomes, such as wages within firms and the reallocation of skilled workers across firms. Our analysis underscores the importance of firm financing in determining both physical and human capital investment, offering new insights into the interplay between monetary policy, corporate finance, and labor markets.

1 Data and Empirical Strategy

1.1 Data

We build a novel granular dataset that matches the employee-employer and credit registers in Portugal. This allows us to fully trace the transmission of monetary policy through banks and firms to worker labor market outcomes. We focus on the period since the creation of the euro area in 1999 until 2013, i.e., a sample that covers two monetary policy cycles.

Employee-employer data. *Quadros de Pessoal* (QP) is the linked employee-employer dataset covering all private sector employees in Portugal compiled by the Portuguese Ministry of Labor, Solidarity and Social Security. Private sector firms in Portugal with at least one paid employee are required to provide information on their entire workforce on an annual basis. The dataset includes information on the employee's occupation, education, regular monthly wage, any additional wage supplements, hours worked, etc. On the employer side, we observe the firm's industry, region, of establishment, and sales in the previous year. In addition to the rich description of worker and firm observables, the dataset also allows us to follow workers over time as they move across different firms.[8]

Credit register. One of the main contributions of this paper is to analyze the role of the credit channel in the transmission of monetary policy to labor market redistribution. For this purpose, we exploit the matching of QP with the credit registry - *Central de Responsabilidades de Credito* (CRC) - collected and managed by the Bank of Portugal. The CRC reports monthly data on all loans above the reporting threshold of EUR 50 that firms receive from credit institutions supervised by the Bank of Portugal. The dataset includes information on loan amounts and key loan characteristics, such as maturity, currency, type of loan, and guarantee/collateral used to secure the loan, if any. In this paper, we use the credit registry data on total credit (drawn credit and unused credit lines) between private NFCs and banks. We restrict our focus to domestic banks

[8]There are the two limitations of the QP dataset. First, while the dataset covers the universe of private sector employees, it abstracts from government employees (about 20% of the Portuguese workforce). Second, QP provides a snapshot of the labor market outcomes in the reference month (October). Individuals who are unemployed or out of the labor force at the time of the census do not have a labor market record for that year. We address these challenges by checking for any significant discrepancies in the coverage of the QP dataset. We match the QP data to the aggregate quarterly labor statistics and we do not identify any potential concerns for our analysis. In particular, we do not observe significant flows of workers between the private and public sectors during the sample period. In addition, the annual data collection takes place at the end of October and therefore does not suffer from significant flows of seasonal workers and appears to be representative of overall labor market conditions. The annual frequency of the data also does not pose a major challenge, as wages are generally renegotiated only once per year. In the literature, it is common to focus on annual data even when higher frequency data are available (see e.g., Patterson, 2023; Sorkin, 2018).

and domestic subsidiaries of foreign banks.

Additional bank- and firm-level data. We complement the dataset with firm-level census data *Informacao Empresarial Simplificada* (IES) managed by the Bank of Portugal. IES provides detailed annual information on firms' balance sheets, income statements, etc. We use this information to construct key firm-level variables such as size (total assets), total debt, or investment. In addition, we use a set of bank variables from the Bank of Portugal's proprietary dataset on banks' balance sheet - *Balanco das Instituicoes Monetarias e Financeiras* - to construct a measure of bank liquidity.

Monetary policy. Finally, we measure ECB monetary policy conditions using monetary policy shocks as a level measure of monetary policy surprises, following the approach of Bu et al. (2021); Coibion (2012); Döttling and Ratnovski (2023); Romer and Romer (2004). We construct cumulative monetary policy shocks based on surprises identified from high frequency data for the euro area by Jarocinski and Karadi (2020). The existing literature has shown that the level measure capturing cumulative monetary policy surprises is a strong instrument for the 1-year policy rate compared to contemporaneous high-frequency shocks, which yield little explanatory power (see Döttling and Ratnovski, 2023). For robustness, we also use alternative monetary policy measures, namely the shadow rate (Wu and Xia, 2016) and the overnight interbank interest rate for the euro area (EONIA) as in Kashyap and Stein (2000) and Jimenez et al. (2014). Finally, we also control for the heterogeneous effects of the domestic business cycle and the global financial cycle.

Table 1 summarizes the data. Our sample covers the period 1999–2013.[9] We focus on the worker's primary occupation in year t.[10] In total, we observe more than 5.5 million prime-age workers employed by nearly 800,000 firms. 33% of all workers are employed in firms with fewer than 50 employees, and we refer to these firms as small.[11] 11% of the workforce is employed in young firms, i.e. firms with an age below five years.[12] The average worker in our dataset is 38 years old. The percentage of workers over 35 years of age is 57%. In addition, 61% of the workers have at least a high school degree and 23% have a college degree or higher. Finally, 45% of the workers are women.

[9] Due to limitations in matching employee-employer and credit registries, the analysis cannot be extended beyond 2013.

[10] If the worker has multiple occupations in year t, we define the primary occupation based on the years of employment at the firm and the wage level.

[11] The 50-employee threshold is consistent with the staff headcount definition of small and medium-sized enterprises (SMEs) in the European Union.

[12] Our age categorization is consistent with other papers in the literature (e.g., Haltiwanger et al., 2013; Babina et al., 2019).

1.2 Empirical strategy

We examine the heterogeneous effects of monetary policy on workers' labor market outcomes by estimating the following regression:

$$\log\left(\text{wage}_{w,f,t}\right) = \alpha_t + \alpha_f + \alpha_w + \beta\Big(H_{f/w} \times (-i_t)\Big) + \gamma\Big(H_{f/w} \times \Delta X_{t-1}\Big) + \zeta C_{w,t-1} + \epsilon_{w,f,t}. \quad (1)$$

We start by focusing on workers' wages. The outcome variable denotes the log of the hourly wage of the worker w in thefirm f in year t. In line with Card et al. (2015), we construct hourly wages by dividing the sum of a worker's base salary plus earnings supplements by the hours worked.[13]

In the baseline, we use identified monetary policy shocks for the euro areabased on Jarocinski and Karadi (2020). Throughout, the interpretation focuses on the expansionary monetary policy shock with a negative sign as $(-i_t)$. We also present the robustness using alternative monetary policy measures, such as the shadow rate by Wu and Xia (2016) or the effective overnight reference rate (EONIA) as in Kashyap and Stein (2000) and Jimenez et al. (2014). The robustness results are reported in Section 5.

Firm and worker heterogeneity are denoted by H_f and H_w, respectively.[14] The estimate of β on the interaction between the monetary policy rate and firm/worker characteristics is our main coefficient of interest. It measureshow much more the wages of workers of a certain type (H_w) or employed by a certain type of firm (H_f) react to monetary rate changes relative to a reference group of workers.

Next, we also control for the heterogeneous effects of the domestic business cycle and the global financial cycle on labor market outcomes. Specifically ΔX_{t-1} denotes the lagged real GDP growth for Portugal and the lagged log level of the U.S. VIX.[15] This setting allows us to control for the heterogeneous wage effects driven by business cycle dynamics and financial distress, and to focus on the effects associated with monetary policy.

Using the administrative employee-employer data, we follow workers over many years as they move across different firms in the labor market to disentangle the permanent worker and firm components of wages using fixed effects. This modeling approach is consistent with the seminal

[13] We focus on hourly instead of monthly wages to disentangle the impact of monetary policy directly on wages from any potential effects triggered by adjustments in the working time. Our results are robust to the use of the log of the monthly wages.

[14] When applicable, we consider both a time-varying and a time-invariant version of worker and firm characteristics, such as the lagged level of the worker education or the highest education attained.

[15] We also show robustness to the additional inclusion of euro area macroeconomic controls in Section 5. In line with the standard Taylor (1993) rule logic, we include euro area GDP growth and inflation.

framework proposed by Abowd et al. (1999). We progressively saturate our specification with fixed effects until we reach the benchmark specification (Equation 1). To absorb time variation as well as the unobserved permanent worker and firm components of an individual's annual wage, we use time, firm and worker fixed effects denoted as α_t, α_f and α_w, respectively. We also include controls for worker characteristics ($C_{w,t-1}$), namely a quadratic polynomial in worker age. We cluster standard errors at the firm and worker levels.

2 Monetary policy and inequality

We start our analysis by examining the impact of monetary policy softening on average worker-level wages in the economy. Table 2 presents the results on the relationship between monetary policy shocks and wage dynamics in Portugal. The positive and statistically significant coefficient estimates suggest that monetary policy softening is associated with an increase in average worker level wages, and this relationship is robust to macro and worker level controls as well as the inclusion firm and worker FE. This finding is consistent with the existing monetary economics and heterogeneous agents literature highlighting that softer monetary policy boosts consumption of goods, which leads firms to increase their demand for labor pushing up wages (e.g., Kaplan et al., 2018)

Guided by this evidence, the key focus of this paper is to analyze heterogeneous effects of monetary policy on labor income inequality and the underlying economic mechanisms. As a first step, we study the impact of monetary policy softening on the overall, unconditional wage inequality. To this end, we categorize workers into quintiles (j) based on their past wages (in year $t-1$), where the bottom quintile represents the lowest earners and the top quintile denotes the highest earners. We estimate the following empirical model:

$$\log\left(\text{wage}_{w,f,t}\right) = \alpha_t + \alpha_f + \alpha_w + \sum_{j=1}^{5} \beta_j \left(H_w^j \times (-i_t)\right) + \sum_{j=1}^{5} \gamma_j \left(H_w^j \times \Delta X_{t-1}\right) + \zeta C_{w,t-1} + \epsilon_{w,f,t}. \quad (2)$$

Figure 1 illustrates the effect of monetary policy conditions on the overall wage inequality. Each point represents the coefficient estimate β_j for every bin (quintile) of workers' past position in the income distribution, interacted with the monetary policy. We exclude the top quintile (80–100 percentile), utilizing it as a reference category. The results show that low-wage workers benefit disproportionately more from monetary policy softening. Hence, expansionary monetary policy

reduces labor income inequality across workers.

Second, we decompose the overall effect into between-firm and within-firm inequality. As documented by Song et al. (2018), one of the main reasons behind the rise in income inequality in the US is the increase in the dispersion of average labor earnings between firms. Yet, the main existing evidence on monetary policy and income inequality relies on consumer survey data (e.g., Coibion et al. (2017)) that cannot observe firms and hence does not allow us to disentangle the importance of worker and firm characteristics on wages. However, the availability of employee-employer data allows us to separate the between- and within-firm forces. Specifically, we begin by investigating the between-firm effects by assigning workers into quintile bins based on the average wages offered by their firms in the previous period $(t-1)$, thereby distinguishing between workers affiliated with high-wage vs. low-wage firms.

Panel (a) of Figure 2 plots the estimates of β_j for each bin (quintile) of firm past wages. Notably, Panel (a) depicts strikingly similar dynamics to the unconditional effect shown in Figure 1. The markedly linear effect highlights that monetary policy softening benefits benefits low-wage firms more and, thus, decreases inequality between firms.

Finally, in Panel (b) of Figure 2, we plot the coefficients for the wage dynamics within the firm. Here, we split workers into quintile bins based on their wage position within the firm in $t-1$. In contrast to the previous results, Panel (b) shows that, in response to an expansionary monetary policy shock, high-earners within firm benefit disproportionately more, thus causing the inequality within the firm to rise.

Overall, these results highlight that monetary policy decreases labor income inequality, and this overall effect is fully driven by diminishing dispersion of labor income between firms. At the same time, we also document two opposing effects for between- and within-firm inequality. In what follows, we examine the mechanisms behind these effects by focusing on the roles of firm and worker heterogeneities in greater detail.

3 Between-firm Inequality and the Credit Channel

Next, we investigate the mechanism through which softer monetary policy reduces inequality between firms. Our hypothesis posits that financial constraints and the credit channel play a pivotal role in explaining the distributional changes among firms. Balance sheet positions and credit frictions are crucial in the heterogeneous transmission of monetary policy across firms and banks (e.g.,

Gertler and Gilchrist, 1994; Bernanke and Gertler, 1995; Kashyap and Stein, 2000; Jimenez et al., 2012; Drechsler et al., 2017). Furthermore, financial market imperfections significantly shape wage contracts, with financially constrained firms often offering lower wages (e.g., Brown and Medoff, 1989; Oi and Idson, 1999; Michelacci and Quadrini, 2009; Guiso et al., 2013). Nevertheless, the literature lacks a systematic empirical investigation into the significance of the credit channel's effects on the transmission of monetary policy to worker-level labor market outcomes. In our empirical analysis, we test the following hypothesis: According to the balance sheet channel of monetary policy (Bernanke and Gertler, 1995), softer monetary policy eases the financing constraints of firms, enabling financially constrained firms to obtain more credit and increase their workers' wages. As financially constrained firms typically offer lower wages, a softening in monetary policy leads to a decrease in labor income dispersion among firms.

To test this hypothesis, we proceed in three steps. First, we proxy firm financing frictions using measures previously established in the literature, such as firm size and age. In addition, we shed more light on the role of credit channel by leveraging the richness of credit registry data and developing a novel measure of firms' credit sensitivity to monetary policy as a proxy for financing frictions. Second, we examine whether financially constrained firms indeed pay lower wages. Third, we exploit cross-sectional variation in firm financing frictions and investigate the differential responses of wages to monetary policy.

3.1 Firm heterogeneity: size and age

We start by proxying for financing constraints using firm size and age. Our focus on these firm characteristics is motivated by theoretical literature on the role of credit market frictions in the transmission of monetary policy (see e.g., Kiyotaki and Moore, 1997). Furthermore, previous empirical literature has documented a stronger response to monetary policy shocks for small and young firms, which are presumably more financially constrained (see e.g., Gertler and Gilchrist, 1994; Kashyap et al., 1994; Cloyne et al., 2023; Bahaj et al., 2020).

Existing literature has highlighted that workers in financially constrained, small or young firms tend to earn lower wages (see e.g., Brown and Medoff, 1989; Oi and Idson, 1999). In Table 3, we compute the wage gaps by comparing the wages of workers in the same region, industry, and job title across small-large and young-old firms. We find that the wage differential is around 23% for small vs. large firms (Columns (1)–(3)), and 9% for young vs. old firms (Columns (4)–(6)). This finding shows that financially constrained firms are indeed lower-wage firms. In light of this finding,

we examine the heterogeneous effect of monetary policy on worker wages across firms of different size and age.

Firm size. Table 4 Columns (1)–(4) present the estimates of Equation 1 where we interact the monetary policy with the firm size. A dummy variable SmallFirm_f takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. We run several additional specifications with different combinations of fixed effects to corroborate the robustness of our results. We start with the empirical specification without any fixed effects (Column 1) and saturate it gradually with time, firm, and worker fixed effects until we reach the baseline specification in Column (4) corresponding to Equation 1. We find that small firms increase wages by more than large firms following softer monetary policy conditions. The baseline estimate in Column (4) shows that a one standard deviation expansionary monetary policy shock is associated with a 1.61 percentage point (pp) larger increase in wages of workers in small firms compared to large firms.[16] Our results are robust to the coefficient stability and omitted variable bias test proposed by Oster (2019).[17]

Our results are not driven by the presence of micro firms in which all workers might have close ties to the owner and/or mobility patterns could substantially differ. Following Andrews et al. (2008), we eliminate firms at bottom 10th and 25th percentile and we find that these estimates are consistent with the results reported in the main sample (see Online Appendix Table A1).

Figure 3 Panel (a) shows the effect of monetary policy conditions on log hourly worker wages for each quintile of firm size. Each point represents the coefficient estimate for each bin (quintile) of firm size interacted with the monetary policy. We omit the top quintile (80-100 percentile) which we use as a reference category. Consistent with the results in Table 4, workers in the bottom quintiles of the firm size distribution (small firms) benefit the most from monetary policy softening. In addition, the effects appear to be markedly linear in firm size – the workers in the smallest firms benefit the most and the effect progressively decreases in firm size.

Our findings relate to the large literature showing that smaller firms are more exposed to the propagation of the monetary policy (e.g., Gertler and Gilchrist, 1994; Kashyap et al., 1994; Cloyne et al., 2023). This result has often been interpreted as supporting evidence on the importance of

[16] Column (1) reports a sanity check in the full sample without the use of any fixed effects. The estimates suggest that following an expansionary monetary policy, wages on average increase and the rise is larger for small firms. The effect on the wage dispersion between small and large firms continues to be economically and statistically significant even after saturating the model with the relevant time, worker and firm fixed effects.

[17] We compute lower bound of the size estimate using the coefficients and R^2 in Columns (1) and (4), $\delta = 0$ and max R^2 of 1. Later, in the analysis we also perform the robustness test for firm age using Columns (5) and (8). In both cases, we find that the calculated lower bounds are close to the estimated coefficients and satisfy the Oster (2019) test.

the credit channel. We explore these implications in more detail in Section 3.2. More broadly, small firms are also found to be more vulnerable to credit supply shocks (see e.g., Khwaja and Mian, 2008; Chodorow-Reich, 2014; Greenstone et al., 2020).

Firm age. Table 4 Columns (6)–(9) show that following a monetary policy expansion, young firms increase wages by more than old firms. Using Equation 1, we interact the monetary policy with a dummy variable $\text{YoungFirm}_{f,t-1}$ that takes a value of 1 if the firm is younger than five years, and 0 otherwise. The baseline estimate in Column (9) show that a one standard expansionary monetary policy shock is associated with a 0.65 pp larger increase in wages for workers in young firms compared to workers in old firms.

Figure 3 Panel (b) illustrates the heterogeneous effects of monetary policy conditions for workers by quintiles of firm age. We show that the effect is the largest for the workers in the youngest firms (bottom quintile). In addition, the effect of monetary policy on wages for the two lowest quantities (p0–p20 and p20–p40) is statically significantly different from the estimates for workers in the oldest firms (our reference group). Our results complement recent papers on the effects of monetary policy on labor market outcomes at the firm level. In particular, Bahaj et al. (2020) show that young firms are more sensitive to monetary policy and react more in terms of firm-level employment. We show that workers in young firms are also more strongly affected in terms of wages.

Finally, in Column (11) of Table 4, we show that both the firm size and the age margin are economically relevant. We horse-race the effects of monetary policy interacted with small firms and young firms respectively and find that both estimates remain negative and statistically significant.

Importance of bank credit. We corroborate the significance of financing frictions and assess the overall relevance of bank credit by providing two key pieces of evidence.

The first piece of evidence is based on loan-level credit registry data, where we analyze how firm credit responds to monetary policy easing across the dimensions of firm size and age. Specifically, we estimate the following regression:

$$\log(\text{credit}_{f,b,t}) = \kappa_{b,t} + \kappa_{i,t} + \kappa_{r,t} + \kappa_f + \beta\Big(H_f \times (-i_t)\Big) + \gamma(H_f \times \Delta X_{t-1}) + \epsilon_{f,b,t}, \qquad (3)$$

where the outcome variable $\log(\text{credit}_{f,b,t})$ denotes the log level of total credit that firm f borrows from bank b at time (quarter) t. The term H_f represents firm characteristic, such as firm size or age.

Estimating the impact of monetary policy through the credit transmission mechanism requires addressing several identification challenges. One challenge arises because firms are connected to different banks, which may respond heterogeneously to monetary policy in terms of their credit supply. For example, prior research shows that banks with weaker balance sheets (Bernanke and Blinder, 1988; Jimenez et al., 2012; Amiti and Weinstein, 2018) or lower liquidity (Kashyap and Stein, 2000) have more sensitive credit supply to monetary policy changes. To address this, we include bank-time fixed effects ($\kappa_{b,t}$) to control for time-varying bank-level credit supply.

Another challenge stems from the potential influence of firm-, industry-, or region-specific factors. We address this by saturating the model with industry-time ($\kappa_{i,t}$), region-time ($\kappa_{r,t}$), and firm-level (κ_f) fixed effects. These controls account for any observed and unobserved heterogeneity at the industry-time, region-time and firm level. For example, these fixed effects capture changes in firm demand for credit triggered by local or industry-specific time-varying conditions, such as increased demand for firm goods in response to monetary policy easing, as in standard New Keynesian model. We estimate Equation 3 using quarterly credit registry data for Portuguese firms for the 1999–2013 period.

Columns (1) and (2) of Table 5 present the results. The estimates reveal that monetary policy easing leads to greater increases in bank credit for smaller and younger firms. These findings emphasize the importance of the credit channel in transmitting monetary policy effects to wages. Softer monetary policy relaxes financing constraints, enabling smaller and younger firms to access additional credit, which, in turn, supports wage increases for their employees.

The second piece of evidence examines the effects of monetary policy on wages for firms with and without access to bank credit. To this end, we extend Equation 1 by introducing a triple interaction of monetary policy, firm heterogeneity (size or age), and a variable reflecting the importance of bank credit at the firm level. Since not all firms in Portugal have active bank borrowing relationships, we compare labor market outcomes for workers in small (or young) firms with and without bank credit. Specifically, we define a dummy variable $\text{ExistCredit}_{f,t-1}$ that takes the value of 1 if the firm had an existing bank borrowing relationship in prior periods, and 0 otherwise.

Table 7 summarizes the findings. In Column (1), we observe that the wage effects for workers in small firms are exclusively driven by firms with existing bank borrowing relationships. No redistributive effects are observed for small firms without bank credit. In Column (2), we repeat the analysis for young versus old firms. Similarly, only workers in young firms with active bank credit relationships benefit from monetary policy easing, while the coefficient for young firms without

bank credit is of the opposite (negative) sign.

Alternative mechanism. Our results highlight the importance of financing frictions and the credit channel in the heterogenous transmission of monetary policy to workers' wages. An alternative explanation for why smaller and younger firms increase wages more strongly in response to monetary easing could be that the demand for their products rises disproportionately, leading to higher sales and, consequently, higher wages. For example, if smaller and younger firms are more likely to operate in industries specializing in goods or services with demand that is particularly sensitive to monetary policy, these firms might raise wages for their workers due to increased sales rather than because of relaxed financing constraints. We provide two pieces of evidence to rule out this explanation.

First, we augment Equation 1 by introducing industry- and region-time fixed effects into the wage regression. This adjustment allows us to control for both observed and unobserved heterogeneity at the industry-time and region-time levels, including industry- or region-specific changes in demand for goods or services. Columns (5) and (10) of Table 4) show that our results remain robust: smaller and younger firms continue to increase wages more in response to monetary policy easing, even after accounting for industry- and region-specific time-varying effects. These findings are in line with the credit effects for small and young firms, which were also estimated using industry- and region-time fixed effects, as presented in Table 5.

Second, we analyze firm balance sheet data to examine the response of firm sales to monetary policy easing across firms of different sizes and ages. In this analysis, we again control for potential time-varying demand shifters at the industry and region levels by including industry- and region-time fixed effects. Columns (3) and (4) of Table 5 summarize the results. The insignificant estimates of the interaction between monetary policy shocks and firm size/age indicators suggest that there is no differential effect of monetary policy on firm sales across firms of varying sizes or ages. If anything, the negative (though insignificant) coefficients imply that the effect might even operate in the opposite direction, further contradicting this demand-based alternative mechanism and reinforcing the role of financing constraints in driving the observed results.

Overall, this evidence indicates that our findings are not driven by an alternative mechanism involving differential effects of monetary policy on firms' product demand.

3.2 Firm heterogeneity: credit sensitivity to monetary policy

In the previous section, we have shown that following a monetary policy softening, wages of workers employed in smaller and younger firms improve more than in larger and older firms. Guided by the large body of literature that emphasizes the crucial role played by financial frictions for small firms, we investigate deeper the importance of financing frictions and the credit channel for the transmission of monetary policy to worker wages.

We exploit a novel dataset which links the employee-employer and credit registries. Specifically, we study the role of the firm balance-sheet channel by proposing a novel, agnostic approach that allows us to compute the sensitivity of the individual firm credit to monetary policy. If credit frictions and firm balance sheet channel play an important role in explaining redistributive labor market effects, monetary policy should propagate more strongly to wages in firms with higher credit sensitivity to monetary policy. To this end, we develop a strategy that does not require to take an explicit stance regarding which firm characteristics are the main financing friction proxies and consequently drivers of the firm heterogeneous responses to monetary policy.

Our methodology consists of two steps. First, we use loan-level credit data to estimate the following regression:

$$\log(\text{credit}_{f,b,t}) = \kappa_{b,t} + \kappa_{i,t} + \kappa_{r,t} + \beta_f(-i_t) + \gamma_f \Delta X_{t-1} + \epsilon_{f,b,t}, \tag{4}$$

where the outcome variable $\log(\text{credit}_{f,b,t})$ denotes the log level of total credit that firm f borrows from bank b at time (quarter) t. Our main coefficient of interest β_f denotes the firm-level credit sensitivity to monetary policy in an agnostic manner. That is, using loan-level credit data, we estimate the sensitivity for each firm to monetary policy without taking a stance which observable firm characteristics are the main drivers of the transmission mechanism. Given that a decrease in interest rates on average leads to an increase in credit available to a firm, **a more positive** β_f is associated with a stronger sensitivity of firm level credit to monetary policy. In the rest of the credit analysis, we use this estimated firm-level credit sensitivity to monetary policy as a proxy for the firm-balance sheet channel.

Similarly to specification 3, we augment the regression by including bank-time fixed effects ($\kappa_{b,t}$) to account for time-varying bank-level credit supply, as well as industry-time and region-time fixed effects ($\kappa_{i,t}$ and $\kappa_{r,t}$) to control for heterogeneity at the industry and regional levels over time. This includes capturing changes in firm demand for credit that may be driven by local or industry-specific

time-varying conditions, including fluctuations in product demand. We show that our results are also robust to an alternative specification in which we control for time-varying firm demand shocks with firm-time fixed effects (Khwaja and Mian, 2008). This strategy first estimates the credit sensitivity to monetary policy for the bank-firm loan pair and then aggregates the bank-firm-level estimates to the firm-level estimates using firm credit exposure to different banks as weights.[18].

We estimate Equation 4 using quarterly credit registry data for Portuguese firms for the 1999–2013 period. In order to provide systematic evidence for the external validity of our measure of firm-level credit sensitivity to monetary policy, we investigate whether our agnostic measure is consistent with commonly used proxy measures of the firm balance-sheet channel such as firm size or age (see e.g., Cloyne et al., 2023). According to the existing literature, smaller and younger firms tend to be more financially constrained, and consequently benefit more from softer monetary policy. Table 6 summarizes the results of the range of univariate and multivariate regressions which examine the relationship between the firm's credit sensitivity to monetary policy and its size or/and age. We find that our agnostic firm-level credit sensitivity to the monetary policy rate is correlated with the proxies previously used by the literature. Specifically, younger and smaller firms exhibit stronger sensitivity of their credit to monetary policy. This suggests that financially constrained, smaller and younger firms receive more credit following the monetary policy softening, which is consistent with the credit-channel fo monetary policy.

According to our proposed transmission mechanism, financially constrained firms pay lower wages to their workers (see e.g., Michelacci and Quadrini, 2009; Guiso et al., 2013). Similarly to previous analysis done for firm size and age, we now test whether firms different with respect to our novel agnostic proxy for financing frictions also systematically offer different wages. In Columns (7)–(9) of Table 3, we compute the wage gaps by comparing the wages of workers in the same region, industry, and job title across firms with different credit sensitivity to monetary policy. We find that firms with stronger sensitivity of credit tend to offer lower wages. This result once again confirms that financially constrained firms are lower-wage firms across various proxies for credit frictions. In light of this finding, we examine the heterogeneous effect of monetary policy on worker wages across firms of different size and age.

While we validate that our agnostic measure of firm-level credit sensitivity to monetary policy relates to more explicit proxies (size, age) and provides consistent results with respect to the relationship between financing frictions and firm average wages, our proposed measure offers a

[18]We provide detailed methodology of this alternative approach in Online Appendix B

novel and flexible approach to examine the heterogeneous effects of monetary policy without having access to or taking an ex-ante stance on the role of specific firm-level observables as main drivers of such heterogeneity. Next, we use the estimate of the agnostic firm-level credit sensitivity to monetary policy as a source of heterogeneity in the labor market regressions:

$$\log\left(\text{wage}_{w,f,t}\right) = \alpha_t + \alpha_f + \alpha_w + \theta\Big(\text{CreditSensitMP}_f \times (-i_t)\Big) + \\ + \gamma\Big(\text{CreditSensitMP}_f \times \Delta X_{t-1}\Big) + \zeta C_{w,t-1} + \epsilon_{w,f,t}. \quad (5)$$

If the firm balance-sheet transmission mechanism is at work in shaping the labor market outcomes, we should expect that wages of workers associated with firms with a stronger sensitivity of their credit to monetary policy (high CreditSensitMP_f firms) would increase by more compared to workers associated with firms with a weaker sensitivity (low CreditSensitMP_f firms). Hence, we would expect the coefficient θ to be positive and statistically significant.

Column (3) of Table 7 reports the estimates for the firm-balance sheet channel on worker's wages using the agnostic measure of firm-level credit sensitivity to monetary policy. Consistent with our hypothesis, we find that following an expansionary monetary policy, wages of workers in firms with stronger credit sensitivity to monetary policy increase by more compared to firms with a weaker credit sensitivity. Finally, in Column (4), we present an alternative approach to construct the proxy of firm balance sheet channel by directly controlling for firm demand for credit with firm-time fixed effects as in Khwaja and Mian (2008).[19]

Our findings relate to the long standing empirical macroeconomic literature that studies the importance of the firms' balance sheet strength as a mechanism through which monetary policy interacts with credit market imperfections and affect firms' outcomes (e.g., Gertler and Gilchrist, 1994; Bernanke and Gertler, 1995). Our results show that firms more reliant on banks as their primary source of funding are more responsive to monetary policy. Furthermore, we uncover the importance of this channel for the previously undocumented redistributive effects of monetary policy on labor market outcomes.

3.3 Monetary policy in crisis times

To shed more light on the importance of financing frictions, we explore whether the impact of monetary policy on wages also depends on the state of the economy. In particular, we analyze to

[19] We discuss the details behind this approach in Online Appendix B.

what extent a monetary policy softening affects labor income inequality differently in good times and in times of crisis, i.e. when financial frictions are more pronounced.

In Table 8, we revisit our main findings and augment the analysis by introducing a triple interaction term of monetary policy, firm heterogeneity and the state of the economy. For simplicity, we use the dummy variable Crisis_{t-1} that takes the value of 1 if the Portuguese economy suffered from a negative GDP growth in the previous year. In Columns (1) and (2), we proxy firm financial constraints by size and age. In both cases we find that workers in small and young firms benefit more from softer monetary policy and these effects are amplified in crisis periods. In Column (3), we use our agnostic measure of the firm balance-sheet channel. We find that the benefit of softer monetary policy for workers in firms with higher credit sensitivity are substantially larger in crisis times.

Overall, our results demonstrate that the effects of monetary policy through the credit channel are stronger in crisis periods compared to normal times. This finding provides evidence in support of the effectiveness of monetary policy in alleviating financing constraints especially when they are needed the most.

Our findings contribute to the recent and growing literature on the effects of monetary policy on firm-level outcomes (e.g., Bahaj et al., 2020; Cloyne et al., 2023) by showing important heterogeneous effects of monetary policy changes on worker-level wages and hours worked though the credit channel. In addition, we also complement recent work that documents positive firm-level employment effects of monetary policy though the credit channel (see e.g., Luck and Zimmermann, 2020; Jasova et al., 2021), by showing that the same channel is also important for the transmission of a monetary policy to labor income inequality across workers in the economy. Finally, we provide novel evidence on the state-dependent effects of the credit channel of the transmission of monetary policy to labor income.

4 Within-firm Inequality and Capital-Skill Complementarity

Our findings on firm heterogeneity highlight that workers in low-wage , financially-constrained firms benefit the most from a monetary policy softening which leads to a decline in overall labor income inequality across workers. However, we also find that softer monetary policy leads to an increase in within-firm inequality. To understand this result, we analyze worker-level heterogeneity with respect to skill. Higher-educated, skilled workers earn on average higher wages leading to a skill

premium. We investigate the effects of monetary policy on worker-level heterogeneity by comparing high- vs. low- skilled workers. The focus on the skill premium is motivated by the large body of labor literature that has investigated the link between educational attainment (skill) and labor market outcomes (e.g., Autor et al., 2008; Card, 2001; Mincer et al., 1974) and the importance of the capital-skill complementarity (e.g., Acemoglu, 1998; Krusell et al., 2000). Recently, the finance literature has also documented the effects of financial frictions on firm-level employment (Berton et al., 2018), and labor and capital reallocation (Bai et al., 2018; Fonseca and Van Doornik, 2022). In what follows, we contribute to the above literature by analyzing the interaction of monetary policy, firm financial frictions and the worker skill premium.

4.1 Monetary policy and skill premium

First, we revisit the empirical specification described in Equation 1 which we use to analyze the heterogeneous effects of monetary policy on wages. We replace the firm heterogeneity with the worker heterogeneity. Specifically, we proxy for skill with education attainment and we define a dummy variable College_w which takes the value of 1 if the maximum educational attainment of worker w is at least a college degree, and 0 otherwise.[20] Table 9 Column (1) shows that following a monetary policy softening, the wages of high-skilled (college educated) workers increase by more than the wages of low-skilled workers. A one standard deviation expansionary monetary policy shock is associated with a 0.88 pp larger increase in wages for high-skilled workers relative to the outcomes of low-skilled workers.

The richness of our administrative employee-employer data allows to further differentiate the skill premium across workers. While college graduates might on average have higher skills, new technologies might be more complementary to specific fields and workers performing non-routine cognitive tasks (Acemoglu and Autor, 2011; Fonseca and Van Doornik, 2022). To this end, we differentiate the educational attainment into the college degree obtained in the STEM fields or other (non-STEM) fields.[21] The results are reported in Column (2) of Table 9. We find that while monetary policy increases the college premium for all high-skilled workers, the benefit is concentrated in the wages of STEM-degree high-skilled workers. In Column (3) we show that our results are robust to the use of the time-varying college measure $\text{College}_{w,t-1}$ that takes the value

[20] In the baseline, we define the variable College as an invariant (maximum) educational attainment. Our results are robust to the time-varying definition, i.e. the degree of education of worker w in year $t-1$.

[21] We denote as STEM the degrees in Natural Sciences, Technology, Engineering, Economics and Math. Our results are robust to the exclusion of the Economics/Business degrees.

of 1 when the last year's educational attainment is at least a college degree, and 0 otherwise.

Finally, in Columns (4)–(6) we report the effects of monetary policy on skill premium *within firm* by saturating the regression analysis with firm-time fixed effects. Importantly, we find that even within the firm monetary policy softening is associated with a stronger increase in wages of skilled workers leading to a rise in skill premium. These results suggests that the rise in within-firm inequality is directly related to the rise in skill-premium.

4.2 Employment of skilled workers, firm heterogeneity and capital-skill complementarity

Why is the skill premium rising following softer monetary policy and how is it related to firm heterogeneity? We conjecture that the mechanism behind this result is related to capital-skill complementarity. According to the capital-skill complementarity mechanism, investment in human capital is complementary to investment in physical capital (Fonseca and Van Doornik, 2022, e.g.). As a results, if softer monetary policy leads to a physical capital investment expansion, firms should also invest in human capital by hiring skilled workers to operate newly acquired physical capital. The stronger demand for high skilled workers would lead to higher skill premium. According to the literature on the credit channel of monetary policy (Gertler and Gilchrist, 1994, e.g), smaller, financially constrained firms tend to increase the physical capital investment more following the expansionary monetary policy. Combining the insights from the credit channel and capital-skill complementarity mechanisms, we would also expect financially constrained firms to hire more skilled workers when monetary policy softens.

To test this mechanism, we examine how monetary policy affects the employment of skilled workers and their allocation across firms as well as capital investment. To this end, we proceed in three steps. First, we investigate the impact of monetary policy on average employment opportunities of skilled workers. Second, we estimate the differential effect of monetary policy on worker's employment across workers of different skill and firms of different size. Finally, to establish the relevance of capital-skill complementarity mechanisms we test whether firms that invest more in human capital by hiring more skilled workers also invest more in physical capital.

To estimate the impact of monetary policy on employment of college educated workers, we revisit the empirical specification described in Equation 1 which we use to analyze the heterogeneous effects of monetary policy on wages. We replace the outcome variable with the worker-level employment dummy which takes the value of 1 if the worker is employed in firm f in year t, and 0 if the worker is

unemployed. We still consider the worker heterogeneity with respect to college attainment. Table 9 Column (7)–(8) shows that monetary policy softening increases employment of skilled, college educated workers and this effect is the strongest for STEM college-educated workers. This result is robust to estimating the effect at the firm-level. For that purpose, we aggregate worker-level data to firm $\times$ worker-type (j) data, where the worker-type is either college-educated or non-college educated worker. Then, we compute the total number of college-educated and non-college educated workers within firm f at time t and we consider the logarithm of it as our new outcome variable.[22] Columns (5) and (6) of Table 9 confirm that following the monetary policy softening firms increase demand for skilled, STEM-educated workers most.

As a next step, we estimate the heterogeneous effects of monetary policy on the employment of college- and non-college-educated workers across firms of different size, which is our proxy for financing constraints. In In Panel (a) of Figure 4, we report the estimates of the triple interaction of firm size, worker skill and monetary policy. We examine the heterogeneous effects of monetary policy on worker employment using the college educated workers in large firms as a reference category. We find that while the employment of college-educated workers rises by more both in large and small firms, the effect is most pronounced for high-skilled workers in small firms. As high-skilled (high-wage) workers tend to be mostly employed by large (high-wage) firms (Engbom and Moser, 2017), monetary easing is associated with a labor reallocation of skilled workforce towards smaller firms. Low-skilled workers in small firms benefit disproportionately more than their low-skilled peers in large firms. Interestingly, the effect for low-skilled workers in small firms is statistically similar to high-skilled workers in large firms (our reference category). Finally, low-skilled workers in large firms benefit the least. In Panel (b), we repeat the same exercise but now additionally splitting skilled workers into STEM-educated ones and those with other, non-STEM degree. We find that the employment of STEM-educated workers increases the most and this effect is the strongest for small, financially constrained firms.

In Table 5 Columns (5)–(6), we focus on the final missing piece of the capital-skill complementarity channel: the effect of monetary policy on firm capital investment. Using firm balance sheet data, we construct the outcome variable as the year-on-year change in capital scaled to the lagged value of firm's total assets. In line with the previous analysis, we explore the heterogeneous effect of monetary policy by firm size and age and find that expansionary monetary policy is also associated

[22] In Column (8), we additionally split college-educated workers into two additional types: STEM-college-educated and non-STEM-college-educated ones.

with a stronger increase in investment in small and young firms. We complete the analysis by examining the effects of monetary policy on the firm-level employment across firms of different size and age. Columns (7)–(8) show that in addition to increased physical capital investment, smaller and younger firms also increase total employment more than larger and older firms. As shown in Figure 4, the employment effect is concentrated in the skilled workers.

Overall, we provide new evidence on the effects of monetary policy on capital-skill complementarity at the most granular firm- and worker-level. Our findings relate to Dolado et al. (2021) who using aggregate and industry level document that a monetary policy easing exacerbates labor income inequality between high- and low-skilled workers, and that the increase in high-skill employment encourages capital investment. We complement the literature by stressing the importance of the firm identity on inequality (see e.g., Card et al., 2013; Song et al., 2018). In particular, we show that the redistributive effects of monetary policy are primarily driven by small and young firms. Following a monetary policy softening, small and young firms are able to disproportionately increase their capital investment as well as wages and hours worked of their high-skilled workers. Furthermore, in the next section we directly connect our evidence to the credit channel, and show that credit plays a critical role in the transmission of monetary policy towards small and young firms and it affects the dispersion of the labor market outcomes of workers.

5 Robustness to alternative monetary policy measures and clustering methods

In what follows we show that our results are robust to the use of different measures of monetary policy conditions. To this end, we re-estimate key heterogeneities using alternative monetary policy measures and report the results for the wage heterogeneity in Table C1 of the Online Appendix C.

First, we present the results using Euro Overnight Index Average (EONIA) as in Kashyap and Stein (2000) and Jimenez et al. (2014). Euro area monetary policy has been rather exogenous to the state of the Portuguese economy. Specifically, Portugal joined the Eurozone in 1999 and monetary policy is jointly set for all of its member states by the ECB. Portuguese GDP constitutes on average only 1.8% of the euro area GDP. Importantly, the Portuguese economy was very sluggish following the Eurozone creation (Blanchard, 2007; Reis, 2013) and its business cycle has not converged to that of the core countries (Giannone et al., 2011). It is important to highlight while the onset of the Sovereign Debt Crisis could potentially impact the endogeneity in the final two years of our

sample (2010–2013). In fact, the ECB *raised* monetary rates in 2011 when Portugal was in the middle of an economic and financial downturn and did not introduce quantitative easing.

Second, we augment the EONIA measure with additional macroeconomic controls for the euro area. The macroeconomic literature largely summarizes the conduct of monetary policy with the Taylor rule, according to which the policy interest rate is set as a function of contemporaneous deviations in inflation and activity (see e.g., Christiano et al., 1999). In line with the standard Taylor (1993) rule logic, we complement the baseline macro controls (GDP growth in Portugal and VIX) with additional terms and interact the firm heterogeneity with the lagged values of euro area GDP growth and inflation, respectively.

Third, to take into account the overall stance of monetary policy beyond what is strictly observed through the change in policy interest rates, we use the euro area shadow rate computed by Wu and Xia (2016). The shadow rate is a measure of monetary policy conditions that also summarizes the use of unconventional policy measures. Thus, unlike EONIA, it also accounts for additional monetary expansions associated with for instance fixed-rate full allotment or LTRO liquidity operations.[23]

To summarize, Online Appendix C reports that all our key findings are robust to the use of EONIA, additional macro controls or shadow rates.[24]

In our baseline regressions, we report estimates with standard errors that are two-way clustered at the firm and worker levels. In Table C2 of Online Appendix C, we present results using two alternative clustering approaches: (i) four-way clustering at the firm, worker, industry-time, and region-time levels, and (ii) three-way clustering at the firm, worker, and industry-region-time levels. Across all specifications, our results remain robust.

6 Conclusion

We analyze how monetary policy affects labor income inequality across both workers and firms via the credit channel. We show that a monetary policy expansion is associated with improved labor market outcomes and higher capital investment, especially in financially constrained firms. As these

[23] It is important to note that the most important unconventional monetary policy measures (negative rates and quantitative easing) did not occur during our sample period 1999–2013. The ECB reduced the deposit facility rate into negative territory for the first time only in June 2014 and it launched expanded asset purchase program only in March 2015.

[24] Online Appendix C reports the robustness to macro controls, shadow rates and monetary policy surprises for the baseline wage outcomes with respect to firm and worker heterogeneities. The results for all other margins are also robust to these alternative measures of monetary policy and are available upon request.

firms tend to offer lower wages, softer monetary policy narrows the wage differential between firms in the economy. In addition, financially constrained firms are able to increase their investment in both physical capital and human capital, in line with the capital-skill complementarity mechanism, which, however, increases wage inequality within a firm.

We find that monetary policy is associated with strong effects only for small and young firms with existing borrowing relationships. By exploiting the richness of the credit registry data, we show the key role of the credit channel for the heterogeneous effects of monetary policy on labor market outcomes. To analyze the importance of the credit channel, we develop a novel approach that estimates the firm-level credit sensitivity to monetary policy.

Our paper has several important implications. We show that the overall labor income inequality effects of monetary policy are mainly driven by between-form financial constraints. Within firms, labor inequality rises, accompanied by a capital-skill complementarity. Our findings also have relevant implications for the growing heterogeneous agent literature (e.g., Auclert, 2019; Kaplan et al., 2018). We show the importance of the heterogeneous effects of monetary policy on labor market outcomes and the central role played by the credit channel. By highlighting the critical role of firms and workers characteristics for the heterogeneous effects of monetary policy on labor market outcomes, our empirical evidence suggests that heterogeneous agents models should not neglect the impact of monetary policy across both workers and firms when studying the redistributive effects of monetary policy. Our results also advocate that the modeling of firm and bank financial constraints is vital to understanding the heterogeneous effects of monetary policy on labor market outcomes. Furthermore, our paper increases awareness of the key margins of the distributional consequences of central banking actions and are, thus, informative for the future conduct of monetary policy.

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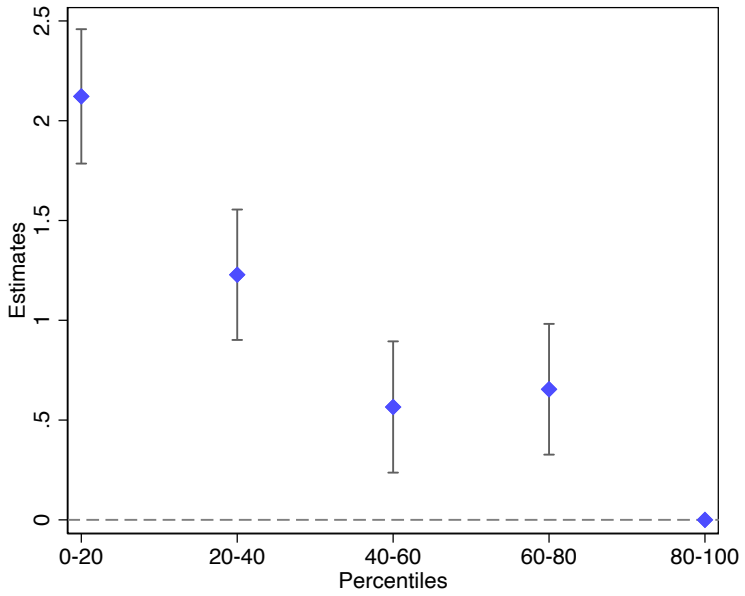
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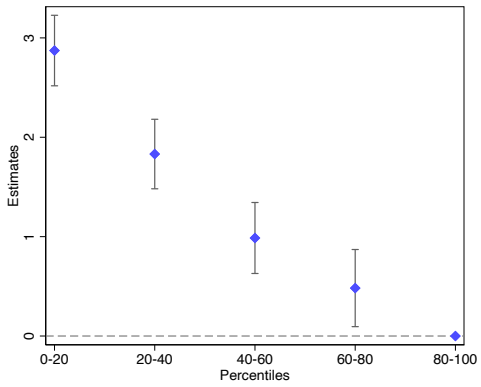
Figure 1: The effect of expansionary monetary policy on overall wage inequality



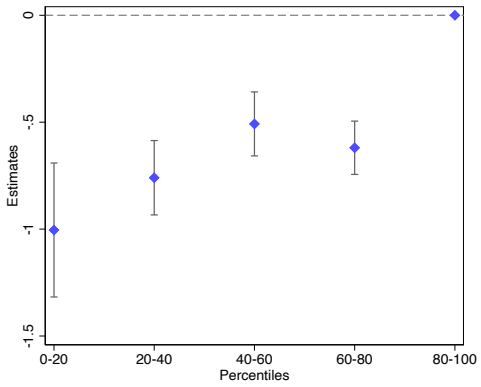
Notes: This figure presents the coefficients for the analysis of the effect of expansionary monetary policy on overall labor income inequality. Each point represents a coefficient estimate β_j from Equation 2 for a separate independent variables for each bin (quintile) of the distribution of ordered worker positions $(t-1)$ in the overall income distribution within the economy. In this classification, the bottom quintile represents the lowest earners, while the top quintile signifies the highest earners. The top quintile (p80–100) serves as the reference category and is omitted. Standard errors are two-way clustered at the firm and worker level. Vertical lines denote 95% confidence intervals.

Figure 2: The effect of expansionary monetary policy on between- vs. within-firm inequality

(a) Between-firm inequality



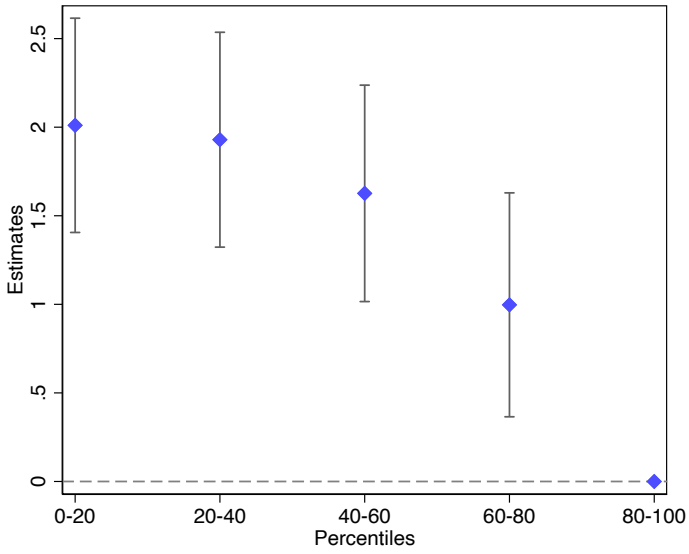
(b) Within-firm inequality



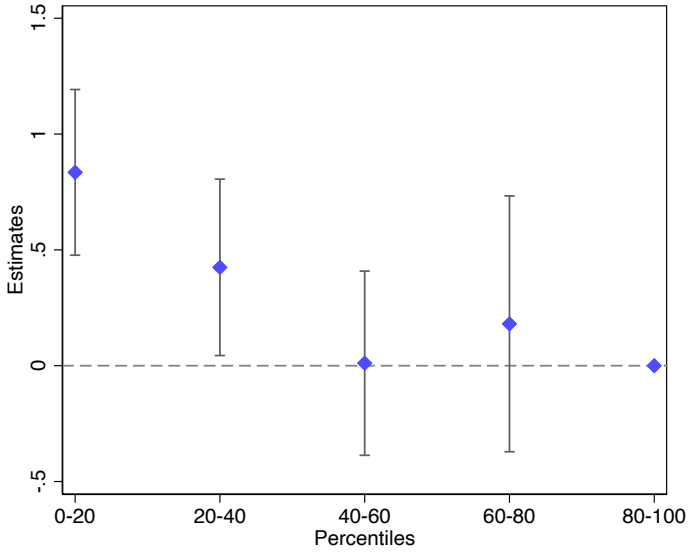
Notes: This figure presents the coefficients for the analysis of the effect of expansionary monetary policy on between- and within-firm labor income inequality. Each point represents a coefficient estimate β_j from Equation 2. In panel (a), we categorize workers into quintile bins based on the average wages offered by their firms in the previous period $(t-1)$, i.e. workers affiliated with high-wage vs. low-wage firms. In panel (b), we split workers into quintile bins based on their wage position within the firm in the previous period. The top quintile (80–100) serves as the reference category and is omitted. Standard errors are two-way clustered at the firm and worker level. Vertical lines denote 95% confidence intervals.

Figure 3: The effect of expansionary monetary policy across firm size and age quintiles

(a) Firm size



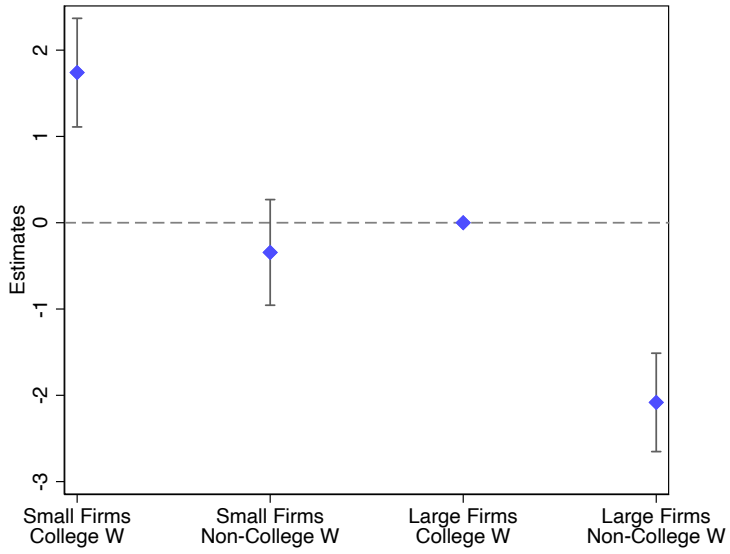
(b) Firm age



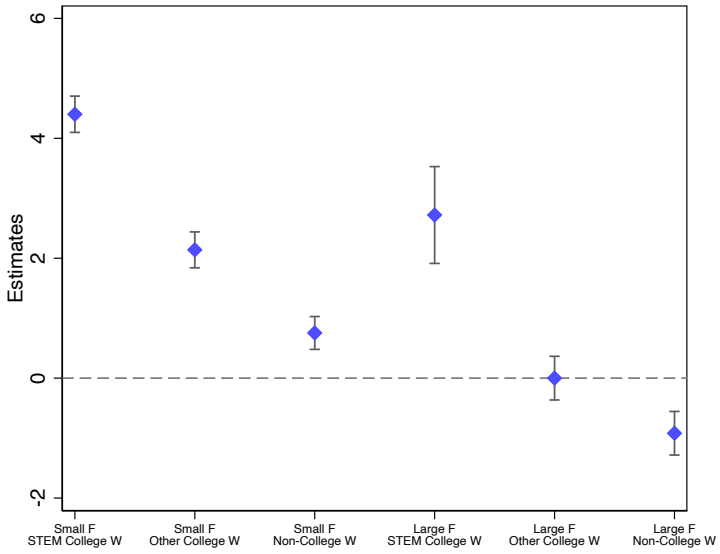
Notes: This figure presents the heterogeneous wage effects of a one standard deviation expansionary monetary policy shock using firm size and age. Each point represents a coefficient estimate from the Equation 1 with separate independent variables for each bin (quintile) of distribution ordered by firm size in Panel (a) and firm age in Panel (b). The top quintile (80–100) is the reference (omitted) category. Standard errors are two-way clustered at the firm and worker level. Vertical lines denote 95% confidence intervals.

Figure 4: The effect of expansionary monetary policy on worker-level employment by firm and worker heterogeneity

(a) Interaction of firm size and worker skill



(b) Additional heterogeneity using worker college type



Notes: This figure presents the effects of a one standard deviation expansionary monetary policy shock ($-i_t$) using a combination of firm and worker heterogeneity, as described in Equation 5. We use cumulative identified monetary policy shocks for the Eurozone based on Jarocinski and Karadi (2020). The outcome variable is worker-level employment dummy which takes the value of 1 if the worker is employed in year t, and 0 otherwise. Firms with fewer than 50 employees are denoted as Small Firms, and as Large Firms otherwise. In Panel (a), workers are denoted as College W if their highest educational attainment is at least a college degree, and Non-College W otherwise. College educated workers in large firm are taken as the reference (omitted) category. In Panel (b), we further split college education into two subcategories. Workers are denoted as STEM College W if they received a degree in STEM fields, and Other College W denotes non-STEM college degrees. Standard errors are two-way clustered at the firm and worker level. Vertical lines denote 95% confidence intervals.

Table 1: Descriptive statistics

Firms:	
Fraction of workers in small firms	0.3321
Fraction of workers in young firms	0.1101
Mean share of college educated workers in a firm	0.1250
Workers:	
Mean age	38.16
Fraction $>$ 35 years old	0.5712
Fraction with high school degree	0.6152
Fraction with college degree	0.2295
Fraction females	0.4469
Mean weekly hours	38.8134
Std. weekly hours	4.1300
Mean log hourly wage	2.9935
Std. log hourly wage	0.6484
Number of workers	5,587,862
Number of firms	795,369

Notes: The sample consists of yearly data from 1999 to 2013.

Table 2: Monetary policy, average wage dynamics and income inequality

	$\log(\text{wage}_{w,f,t})$					
				Overall	Between-firms	Within-firm
	(1)	(2)	(3)	(4)	(5)	(6)
$(-i_t)$	5.50***	4.04***	4.79***			
	(0.184)	(0.090)	(0.077)			
$(-i_t)\times$ Pct(0-20)				2.12***	2.87***	-1.00***
				(0.172)	(0.181)	(0.160)
$(-i_t)\times$ Pct(20-40)				1.23***	1.83***	-0.76***
				(0.167)	(0.178)	(0.089)
$(-i_t)\times$ Pct(40-60)				0.57***	0.99***	-0.51***
				(0.168)	(0.182)	(0.076)
$(-i_t)\times$ Pct(60-80)				0.65***	0.48***	-0.62***
				(0.167)	(0.198)	(0.064)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes	Yes	-
Firm FE	No	Yes	Yes	Yes	Yes	-
Firm-Time FE	No	No	No	No	No	Yes
Worker FE	No	No	Yes	Yes	Yes	Yes
N	28,778,666	28,701,026	27,906,048	27,677,148	27,677,148	26,861,750
R2	0.0092	0.5139	0.8058	0.8202	0.8197	0.9063

Notes: This table shows the worker-level wage effects of a one standard deviation expansionary monetary policy shock $(-i_t)$. We use cumulative identified monetary policy shocks for the Eurozone based on Jarocinski and Karadi (2020). In Columns (1) – (3), we examine the impact of expansionary monetary policy on average wages across all workers. Columns (4) – (6) present the coefficients for the heterogeneity analysis of the effect of expansionary monetary policy on labor income inequality across all workers, between firms and within firm, respectively. Coefficients represented estimated parameters β_j from Equation 2. In Column (4), we split workers into quintile bins based on their last year wage position in the overall income distribution within the economy. In this classification, the bottom quintile represents the lowest earners, while the top quintile signifies the highest earners. In Column (5), we categorize workers into quintile bins based on the average wages offered by their firms in the previous period $(t-1)$, i.e. workers affiliated with high-wage vs. low-wage firms. In Column (6), we split workers into quintile bins based on their wage position within the firm in the previous period. In all cases, the top quintile (80–100) serves as the reference category and is omitted. Controls denote lagged values of the Portuguese GDP growth GDP and VIX, as well as the polynomial of worker's age. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Wage gap between firms

	$\log(\text{wage}_{w,f,t})$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SmallFirm_f	-0.265***	-0.233***	-0.233***						
	(0.090)	(0.006)	(0.006)						
$\text{YoungFirm}_{f,t-1}$				-0.103***	-0.091***	-0.090***			
				(0.005)	(0.003)	(0.003)			
CreditSensitMP_f							-0.017**	-0.016***	-0.016***
							(0.007)	(0.004)	(0.004)
Industry-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Job Title FE	No	Yes	-	No	Yes	-	No	Yes	-
Job Title-Time FE	No	No	Yes	No	No	Yes	No	No	Yes
N	23,441,303	23,441,263	23,440,268	28,449,265	28,449,230	28,448,302	19,361,371	19,361,315	19,360,363
R^2	0.31	0.51	0.51	0.27	0.48	0.48	0.20	0.42	0.42

Notes: This table shows the coefficients of the wage gap for workers in small vs. large firms in Columns (1)–(3), and young vs. old firms in Columns (4)–(6). SmallFirm_f is is a dummy variable that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. $\text{YoungFirm}_{f,t-1}$ is a dummy variable that takes a value of 1 if the firm is younger than five years, and 0 otherwise. Dash (-) symbol refers to the fact that the fixed effects are not applicable as they are nested in different (higher-order) fixed effects. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Monetary policy, wages and firm heterogeneity

	$\log(\text{wage}_{w,f,t})$										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\text{SmallFirm}_f \times (-i_t)$	2.34***	2.44***	2.27***	1.61***	1.35***						1.56***
	(0.375)	(0.383)	(0.186)	(0.160)	(0.156)						(0.158)
$\text{YoungFirm}_{f,t-1} \times (-i_t)$						1.48**	2.04***	0.83***	0.65***	0.55***	0.30**
						(0.669)	(0.647)	(0.164)	(0.136)	(0.108)	(0.122)
$(-i_t)$	2.85***					3.98***					
	(0.379)					(0.174)					
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	Yes	Yes	Yes	-	No	Yes	Yes	Yes	-	Yes
Firm FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Worker FE	No	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes
Industry-Time FE	No	No	No	No	Yes	No	No	No	No	Yes	No
Region-Time FE	No	No	No	No	Yes	No	No	No	No	Yes	No
N	23,440,467	23,440,467	23,407,226	22,583,567	22,583,547	28,448,100	28,448,100	28,371,823	27,577,576	27,577,557	22,325,223
R^2	0.11	0.12	0.55	0.83	0.83	0.03	0.04	0.53	0.82	0.82	0.83

Notes: This table shows the heterogeneous worker-level wage effects of a one standard deviation expansionary monetary policy shock $(-i_t)$, as described in Equation 1. We use cumulative identified monetary policy shocks for the Eurozone based on Jarocinski and Karadi (2020). SmallFirm_f is a dummy variable that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. $\text{YoungFirm}_{f,t-1}$ is a dummy variable that takes a value of 1 if the firm is younger than five years, and 0 otherwise. Controls denote additional variation of small (young) firm and GDP and VIX, as well as the polynomial of worker's age. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Monetary policy, credit, sales, investment and employment: firm heterogeneity

	$\log(credit_{f,b,t})$		$\frac{Sales_{f,t}}{TA_{f,t-1}}$		$\frac{\Delta Capital_{f,t}}{TA_{t-1}}$		$\log(\text{Employment}_{f,t})$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{SmallFirm}_f \times (-i_t)$	2.51***		-1544.86		2.20***		0.04***	
	(0.670)		(1157.52)		(0.200)		(0.020)	
$\text{YoungFirm}_{f,t-1} \times (-i_t)$		2.35***		-3067.71		1.57***		0.23***
		(0.613)		(2290.94)		(0.155)		(0.006)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	-	-	-	-	-	-
N	17,328,097	16,620,299	1,840,797	1,896,849	620,875	619,845	3,794,154	3,875,384
R^2	0.541	0.519	0.184	0.200	0.030	0.052	0.8963	0.902

Notes: This table shows the heterogeneous effects of a one standard deviation expansionary monetary policy shock $(-i_t)$ on firm credit, sales, investment and employment. Credit effects are estimated using credit registry data at the bank, firm and month level using the following specification:

$$\log\left(\text{credit}_{f,b,t}\right) = \kappa_{b,t} + \kappa_{i,t} + \kappa_{r,t} + \kappa_f + \beta(H_f \times (-i_t)) + \gamma(H_f \times \Delta X_{t-1}) + \epsilon_{w,f,t}.$$

The impact of monetary policy on firm-level sales, investment and employment is estimated using the following equation:

$$\log\left(\text{y}_{f,t}\right) = \kappa_{i,t} + \kappa_{r,t} + \kappa_f + \beta(H_f \times (-i_t)) + \gamma(H_f \times \Delta X_{t-1}) + \epsilon_{f,t}.$$

We use cumulative identified monetary policy shocks for the Eurozone based on Jarocinski and Karadi (2020). The outcome variable in Columns (1)–(2) measures the logarithmic value of credit received by firm f from bank b at time t. The outcome variable in Columns (3)–(4) measures firm sales normalized by the lagged value of firm's total assets. The outcome variable in Columns (5)–(6) measures the year-on-year change in capital scaled to the lagged value of firm's total assets. The outcome variable in Columns (7)–(8) denotes the log of the number of workers employed in firm f at time t. We study firm-level heterogeneity, H_f, with respect to firm size and age. SmallFirm_f is a dummy variable that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. $\text{YoungFirm}_{f,t-1}$ is a dummy variable that takes a value of 1 if the firm is younger than five years, and 0 otherwise. Controls denote additional variation of small (young) firm and GDP and VIX. Standard errors are two-way clustered at the firm level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Relationship between firm credit sensitivity to monetary policy rate and proxy variables

	CreditSensitMP$_f$					
	(1)	(2)	(3)	(4)	(5)	(6)
Age$_f$	-0.17***					
	(0.008)					
log(TotalAssets$_f$)		-0.27***				
		(0.061)				
log(Employment$_f$)			-0.23***			
			(0.097)			
YoungFirm$_f$				5.99***		6.03***
				(0.002)		(0.003)
SmallFirm$_f$					7.04***	5.47***
					(0.877)	(0.993)
N	272,042	284,881	272,645	272,042	257,783	257,232
R^2	0.0015	0.0002	0.0002	0.0022	0.0002	0.0024

Notes: This table presents coefficients from firm-level univariate regressions CreditSensitMP$_f$ $= \alpha + \phi X_f + \epsilon_f$, where CreditSensitMP$_f$ denotes the firm-level credit sensitivity to monetary policy conditions from loan-level regression following Equation 4. X_f represents average size or age of firm f over the sample period. YoungFirm$_f$ is a dummy that takes a value of 1 if the firm is younger than five years, and 0 otherwise. SmallFirm$_f$ is a dummy that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Importance of credit

	log(wage$_{w,f,t}$)			
	(1)	(2)	(3)	(4)
SmallFirm$_f \times (-i_t)$	-0.43			
	(0.796)			
SmallFirm$_f \times (-i_t) \times$ ExistCredit$_{f,t-1}$	2.42***			
	(0.819)			
YoungFirm$_f \times (-i_t)$		-1.65**		
		(0.643)		
YoungFirm$_f \times (-i_t) \times$ ExistCredit$_{f,t-1}$		2.33***		
		(0.687)		
CreditSensitMP$_f \times (-i_t)$			0.68***	
			(0.185)	
$\overline{\text{CreditSensitMP}}_f \times (-i_t)$				0.30**
				(0.134)
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes
N	14,661,241	18,351,663	18,616,018	12,625,774
R^2	0.82	0.80	0.79	0.80

Notes: This table shows the heterogeneous worker-level wage effects of a one standard deviation expansionary monetary policy shock ($-i_t$), as described in Equation 5. We use cumulative identified monetary policy shocks for the Eurozone based on Jarocinski and Karadi (2020). SmallFirm$_f$ is a dummy variable that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. YoungFirm$_{f,t-1}$ is a dummy variable that takes a value of 1 if the firm is younger than five years, and 0 otherwise. ExistCredit$_{f,t-1}$ takes the value of 1 if the firm has ever had an existing bank borrowing relationship, and 0 otherwise. CreditSensitMP$_f$ denotes the baseline measure of firm-level credit sensitivity to monetary policy conditions from loan-level regression following Equation 4. $\overline{\text{CreditSensitMP}}_f$ denotes an alternative measure of of firm-level credit sensitivity to monetary policy conditions as descibed by Online Appendix B. Controls denote interaction terms of small (young) firms and the respective credit proxy, triple interaction of small (young) firms, credit proxy and GDP/VIX, double interactions of credit proxy and GDP / VIX / monetary policy rate, double interaction of small (young) firms and GDP / VIX, as well as the polynomial of worker's age. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Heterogeneity of monetary policy in crisis times: importance of financial constraints

	$\log(\text{wage}_{w,f,t})$		
	(1)	(2)	(3)
$\text{SmallFirm}_f \times (-i_t)$	1.43***		
	(0.140)		
$\text{SmallFirm}_f \times (-i_t) \times \text{Crisis}_{t-1}$	0.60***		
	(0.208)		
$\text{YoungFirm}_{f,t-1} \times (-i_t)$		0.56***	
		(0.149)	
$\text{YoungFirm}_{f,t-1} \times (-i_t) \times \text{Crisis}_{t-1}$		0.69***	
		(0.168)	
$\text{CreditSensitMP}_f \times (-i_t)$			0.47***
			(0.182)
$\text{CreditSensitMP}_f \times (-i_t) \times \text{Crisis}_{t-1}$			0.42*
			(0.240)
Controls	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes
N	22,583,567	27,577,576	18,616,018
R^2	0.83	0.814	0.7911

Notes: This table summarized the state-dependent effects of a one standard deviation expansionary monetary policy shock $(-i_t)$ on labor income inequality, using Equation 5 augmented with a triple interaction of monetary policy, firm heterogeneity and the state of the economy. We use cumulative identified monetary policy shocks for the Eurozone based on Jarocinski and Karadi (2020). SmallFirm_f is a dummy that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. $\text{YoungFirm}_{f,t-1}$ is a dummy that takes a value of 1 if the firm is younger than five years, and 0 otherwise. CreditSensitMP_f denotes the firm balance-sheet channel measure, as described in Equation 5. Crisis_{t-1} is a dummy variable if the economy suffered from a negative GDP growth in the previous year. Controls denote additional variation of the respective key firm characteristic and GDP and VIX, as well as the polynomial of worker's age. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Monetary policy, skill premium and employment of skilled workers

	$\log(\text{wage}_{w,f,t})$						$\text{Employed}_{w,f,t}$		$\log(\text{Employment}_{j,f,t})$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{College}_w \times(-i_t)$	0.88***			1.09***			3.65***		4.29***	
	(0.106)			(0.062)			(0.127)		(0.095)	
STEM $\text{College}_w \times (-i_t)$		1.49***			1.60***			6.11***		4.87***
		(0.131)			(0.072)			(0.144)		(0.097)
Other $\text{College}_w \times (-i_t)$		0.41***			0.66***			1.93***		4.10***
		(0.110)			(0.064)			(0.156)		(0.118)
$\text{College}_{w,t-1} \times(-i_t)$			1.22***			1.57***				
			(0.126)			(0.080)				
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	-	-	-	Yes	Yes	-	-
Firm FE	Yes	Yes	Yes	-	-	-	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-
Firm-Time FE	No	No	No	Yes	Yes	Yes	No	No	-	-
Industry-Time FE	No	No	No	No	No	No	No	No	Yes	Yes
Region-Time FE	No	No	No	No	No	No	No	No	Yes	Yes
N	22,451,149	22,451,149	22,451,149	22,451,149	22,451,149	22,451,149	30,433,138	30,433,138	4,434,542	4,434,542
R^2	0.8165	0.8166	0.8166	0.8167	0.8168	0.8168	0.245	0.245	0.742	0.743

Notes: This table shows the worker-level heterogeneity analysis on wages and employment outcomes following a 25 bp expansionary monetary policy shock ($-i_t$), as described in Equation 5. We use cumulative identified monetary policy shocks for the Eurozone based on Jarocinski and Karadi (2020). In the baseline, we define College_w as a time-invariant dummy variable that takes the value of 1 if the highest educational attainment of worker w is at least a college degree, and 0 otherwise. We further split College into two subcategories STEM College_w takes the value of 1 if a worker received a degree in STEM fields and Other College_w denotes non-STEM degrees. We use time-varying college measure $\text{College}_{w,t-1}$ that takes the value of 1 when the last year's educational attainment is at least a college degree, and 0 otherwise. We consider three different outcome variables. Columns (1)–(4) uses logarithm of worker hourly wage ($\log(\text{wage}_{w,f,t})$ as a dependent variable. In Columns (5)–(6), we replace the outcome variable with the worker-level employment dummy ($\text{Employed}_{w,f,t}$) which takes the value of 1 if the worker is employed in firm f in year t, and 0 if the worker is unemployed. In Column (7), the outcome variable is the logarithm of the the total number of college-educated (worker-type $j = 1$) and non-college educated (worker-type $j = 0$) workers within firm f at time t. In Column (8), the outcome variable is the logarithm of the total number of workers of type j in firm f at time t, where worker-type takes value of 1 for college-educated workers and 0 for non-college educated workers. In Column (9), the outcome variable is the logarithm of the total number of workers of type j in firm f at time t, where worker-type takes value of 2 for STEM college-educated workers, 1 for non-STEM college-educated workers and 0 for non-college educated workers. Controls denote additional variation of the respective college measure and GDP and VIX, as well as the polynomial of worker's age. Dash (-) symbol refers to the fact that the fixed effects are not applicable as they are nested in different (higher-order) fixed effects. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Online Appendix

A Additional Figures and Tables

Table A1: Firm heterogeneity: small vs large firms and sample cutoffs

	$\log(\text{wage}_{w,f,t})$		
	Baseline	p10 cutoff	p25 cutoff
	(1)	(2)	(3)
$\text{SmallFirm}_f \times (-i_t)$	1.61***	1.60***	1.55***
	(0.160)	(0.160)	(0.159)
Controls	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes
N	22,583,567	21,151,016	18,568,775
R^2	0.83	0.83	0.83

Notes: This table shows the worker-level wage effects of a one standard deviation expansionary monetary policy shock, as described in Equation 1. From the baseline sample in Column (1), we eliminate firms below the 10th and 25th percentile of employment, respectively. Δi_t denotes monetary policy surprises as in Jarocinski and Karadi (2020). SmallFirm_f is a dummy variable that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. Controls denote additional variation of small (young) firm and GDP and VIX, as well as the polynomial of worker's age. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

B Firm balance sheet channel: Robustness

As a robustness for the firm balance-sheet channel methodology presented in Section 3.2 of the manuscript, we consider an alternative specification of Equation 4 that estimates the firm-level credit sensitivity to monetary policy using the following regression that controls for additional firm-time variation of credit:

$$\log(\text{credit}_{f,b,t}) = \kappa_{b,t} + \kappa_{f,t} + \beta_{f,b}(-i_t) + \gamma_{f,b}\Delta GDP_t + \epsilon_{f,b,t}. \tag{B1}$$

We estimate the sensitivity to monetary policy for each bank-firm pair ($\beta_{f,b}$). Next, we compute a credit weighted average of these estimates to obtain sensitivity to monetary policy at the firm level where

$$\overline{\text{CreditSensitMP}}_f = \sum_b \frac{\hat{\beta}_{f,b} \times credit_{b,f,t-1}}{credit_{b,f,t-1}}. \tag{B2}$$

Equation B1 allows us to introduce firm-time fixed effects to further control for time-varying firm-level variation (that could have potentially remained unaddressed by previously used industry-region-time fixed effects in Equation 4 in the main text). Using firm-time fixed effects, we cannot estimate the credit sensitivity to monetary policy at the firm level. Instead, we identify the credit sensitivity $\beta_{f,b}$ for each bank-firm pair and then aggregate the sensitivity at the firm level (Equation B2). The implementation of firm-time fixed effects requires the existence of multiple borrowing relationships for firm f at time t (for details see e.g., Khwaja and Mian, 2008). The broad coverage of Portuguese credit registry (reporting threshold of 50 EUR) allows us to introduce firm-time fixed effects without any significant loss of generality. Note that on average, firms in Portugal have credit relationship with two banks.

Finally, following the same approach as in the main text, we estimate of the worker-level wage heterogeneity:

$$\begin{aligned}\log(\text{wage}_{w,f,t}) = \alpha_t + \alpha_w + \alpha_f + \theta\Big(\overline{\text{CreditSensitMP}}_f \times (-i_t)\Big) + \\ + \gamma\Big(\overline{\text{CreditSensitMP}_f} \times \Delta X_{t-1}\Big) + \zeta \text{C}_{w,t-1} + \epsilon_{w,f,t}.\end{aligned} \tag{B3}$$

The results are presented in Column (4) of Table 7. With softer monetary policy, wages of workers in firms with a stronger credit sensitivity to monetary policy at the bank-firm level increase by more compared to wages in firms with weaker credit sensitivity. This suggests that even after controlling for time-varying credit demand and supply in the loan regression, the firm balance sheet channel is important in shaping the responses of wages to monetary policy changes.

C Robustness to different measures of monetary policy and clustering

Table C1: Robustness to different measures of monetary policy

	$\log(\text{wage}_{w,f,t})$											
	EONIA				EONIA + Macro controls				Shadow rates			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\text{SmallFirm}_f \times (-R_{t-1})$	1.16***				1.00***				1.12***			
	(0.163)				(0.153)				(0.147)			
$\text{YoungFirm}_{f,t-1} \times (-R_{t-1})$		0.40***				0.37***				0.42***		
		(0.118)				(0.116)				(0.099)		
$\text{CreditSensitMP}_f \times (-R_{t-1})$			0.73***				0.70***				0.68***	
			(0.16)				(0.16)				(0.15)	
$\text{College}_w \times (-R_{t-1})$				1.13***				1.29***				1.16***
				(0.10)				(0.09)				(0.08)
Controls	Yes	Yes	Yes	Yes	Yes‡	Yes‡	Yes‡	Yes‡	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,584,310	27,578,607	18,616,412	22,452,141	22,584,310	27,578,607	18,616,412	22,452,141	22,584,310	27,578,607	18,616,412	22,452,141
R^2	0.83	0.82	0.79	0.82	0.83	0.82	0.79	0.82	0.83	0.82	0.79	0.82

Notes: This table shows the robustness to the worker-level wage analysis of 1 pp decrease in the monetary policy rate, as described in Equations 1. R_{t-1} denotes different measures of monetary policy: Columns (1)–(4) use the EONIA rate, Columns (5)–(8) use the EONIA rate with additional macro controls, and Columns (9)–(12) use shadow rate computed by Wu and Xia (2016). SmallFirm_f is a dummy that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. Young $\text{Firm}_{f,t-1}$ is a dummy that takes a value of 1 if the firm is younger than five years, and 0 otherwise. CreditSensitMP_f denotes the firm-level credit sensitivity to monetary policy measure, as described in Equation 5. College_w as a time-invariant dummy variable that takes the value of 1 if the highest educational attainment of worker w is at least a college degree, and 0 otherwise. Controls denote additional variation of small (young) firm and GDP and VIX, as well as the polynomial of worker's age. In addition, Columns (5)–(8) further control for lagged values of EA GDP growth and inflation (denoted with ‡). Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C2: Robustness to different clustering methods

	$\log(\text{wage}_{w,f,t})$											
	Firm and Worker				Firm, Worker, Industry-Time and Region-Time				Firm, Worker and Industry-Region-Time			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\text{SmallFirm}_f \times (-i_{t-1})$	1.61***				1.61***				1.61***			
	(0.160)				(0.206)				(0.182)			
$\text{YoungFirm}_{f,t-1} \times (-i_{t-1})$		0.65***				0.65***				0.65***		
		(0.136)				(0.169)				(0.148)		
$\text{CreditSensitMP}_f \times (-i_{t-1})$			0.68***				0.68***				0.68***	
			(0.185)				(0.226)				(0.204)	
$\text{College}_w \times (-i_{t-1})$				0.88***				0.88***				0.88***
				(0.106)				(0.340)				(0.136)
Controls	Yes	Yes	Yes	Yes	Yes‡	Yes‡	Yes‡	Yes‡	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,583,567	27,577,576	18,616,018	22,451,149	22,583,567	27,577,576	18,616,018	22,451,149	22,583,567	27,577,576	18,616,018	22,451,149
R^2	0.83	0.82	0.79	0.82	0.83	0.82	0.79	0.82	0.83	0.82	0.79	0.82

Notes: This table shows the robustness of the worker-level wage analysis of 1 pp decrease in the monetary policy rate, as described in Equations 1, to different versions of standard error clustering. Columns (1)–(4) present the baseline standard errors that are two-way clustered at the firm and worker level, Columns (5)–(8) use four-way clustering at the firm, worker, industry-time and region-time level, and Columns (9)–(12) use three-way clustering at the firm, worker, industry-region-time level. SmallFirm_f is a dummy that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. Young $\text{Firm}_{f,t-1}$ is a dummy that takes a value of 1 if the firm is younger than five years, and 0 otherwise. CreditSensitMP_f denotes the firm-level credit sensitivity to monetary policy measure, as described in Equation 5. College_w as a time-invariant dummy variable that takes the value of 1 if the highest educational attainment of worker w is at least a college degree, and 0 otherwise. Controls denote additional variation of small (young) firm and GDP and VIX, as well as the polynomial of worker's age. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.