Monetary Policy, Labor Income Redistribution and the Credit Channel: Evidence from Matched Employer-Employee and Credit Registers[*]

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Abstract

We document the redistributive effects of monetary policy on labor market outcomes via the credit channel. For identification, we exploit matched administrative datasets in Portugal – employee-employer and credit registers – and monetary policy since the Eurozone creation. We find that softer monetary policy improves wages, hours worked and employment more in small and young firms, which are more financially constrained. Within these firms, the wage effects accrue to incumbent workers, in line with the back-loaded wage mechanism. Consistent with the capital-skill complementarity mechanism, we document an increase in the skill premium and show that financially constrained firms increase both physical and human capital investment the most. Our findings uncover a central role for the firm-balance sheet and the bank lending channels of the monetary policy transmission to labor income inequality, with state-dependent effects that are stronger during crises. Importantly, we do not find any redistributive effects for firms without bank credit.

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In recent years inequality has received a great deal of attention in the monetary policy debate (e.g., Bernanke 2015; BIS 2021; Bullard 2014; Lagarde 2020; Mersch 2014; Powell 2019; Yellen 2014).[1] While monetary policy is not directly intended to redistribute income or wealth in the economy, a growing strand of the macroeconomic literature suggests that it is not immune to redistributive consequences (e.g., Doepke and Schneider 2006; Kaplan et al. 2018). The bulk of the discussion centers on the relationship between monetary policy and wealth through its effects on asset prices.[2] However, earnings heterogeneity also represents a relevant source of redistribution (e.g., Auclert 2019). Yet, the quantification of the distribution of these effects across different types of workers and firms in the economy as well as the underlying mechanisms remain open questions.

The estimation of the redistributive effects of monetary policy on labor market outcomes is challenging as it requires an exploration of its effects across both workers and firms. The increase in the dispersion of average earnings *between* firms is one of the main reasons behind the rise in income inequality (see e.g., Song et al. 2018, for the evidence in the U.S.). In addition, firm financial frictions are crucial in determining how monetary policy transmits to firm-level employment and investment (Cloyne et al. 2018; Gertler and Gilchrist 1994; Ottonello and Winberry 2020) and also contribute to shape wage contracts (Guiso et al. 2013; Michelacci and Quadrini 2009). It follows that, the assessment of the redistributive effects of monetary policy on worker labor market outcomes should consider firms characteristics and financial frictions, in addition to workers characteristics.[3]

This paper provides novel evidence on the heterogeneous effects of monetary policy on worker labor market outcomes, and on the importance of the credit channel. We exploit a unique granular administrative dataset that matches linked employee-employer data and firm loan-level credit registry in Portugal since the Eurozone creation. Softer monetary policy conditions disproportionately increase worker-level wages and hours worked and firm-level employment in small and young firms, which tend to be more financially constrained. We find that, consistent with the back-loaded wage mechanism, monetary policy relaxes financial constrains and allows firms to increase the wage profile of their incumbent workers whose wages were previously back-loaded. Further, we provide

[1] According to the comprehensive overview of central banks' speeches both in advanced and emerging markets in BIS (2021), about 10% of all recent central bankers' communications mentions keywords "inequality" or "distributional consequences/impact of monetary policy". Inequality and the need for monetary policy to take it into account was also among the most debated topics at the listening events of the Federal Reserve and the ECB monetary policy strategy review.

[2] A number of studies have show that softer monetary policy boosts stock prices (Bernanke and Kuttner 2005), corporate bond prices (Gertler and Karadi 2015) and government bond prices (Hanson and Stein 2015). As richer household hold a disproportionate share of stock and bonds, it has been argued that monetary easing fuels capital income and wealth inequality (see e.g., Bernanke et al. 1996; BIS 2021).

[3] To date, the main evidence on monetary policy and income inequality relies on consumer survey data (e.g., Coibion et al. 2017) and, hence, it cannot observe firms or follow workers over time as they move across firms to disentangle to importance of worker and firm characteristics on wages.

new evidence on the effects of monetary policy on the capital-skill complementarity. Following a monetary policy softening, small and young firms are able to increase both their physical and human capital investment the most. In addition, we document a rise in the skill premium by showing that high-skilled workers benefit the most both in terms of wages and hours worked. Our paper highlights the central role played by the credit channel in the transmission of monetary policy to labor income inequality. In particular, both the firm balance-sheet and the bank lending channels are important to explain the heterogeneous effects of monetary policy on labor market outcomes. Finally, we show that these effects are substantially stronger during crisis times, i.e. when financial constraints are the most severe.

Our setting allows us to overcome key data and endogeneity challenges. First, we exploit an unparalleled match of granular longitudinal data on workers, firms, banks and loans in Portugal. The administrative employee-employer data cover all private sector workers over two full monetary policy cycles (1999–2013). The dataset includes rich information on workers (e.g., occupation, education, regular wage, any additional wage supplements, hours worked) as well as employers (e.g., industry, region, age, sales, investment). Hence, it allow us to analyze all critical labor market outcomes (wages, hours worked and employment) and follow workers over many years as they move across firms. Furthermore, a novelty 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.[4] To the best of our knowledge, this is the first paper that makes use of the universal credit registry matched with administrative employee-employer data covering the entirety of the 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 for the redistributive effects of monetary policy on labor market outcomes and uncover the underlying mechanisms associated with the existence of financial frictions at the firm and bank level. Hence, the availability of such a comprehensive and novel dataset enables us to make key contributions to the literature.

Second, the institutional setting helps us overcome potential reverse causality 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. We argue that euro area monetary policy has been mostly exogenous to the state of the Portuguese economy as (i) Portugal accounts to 1.8% of Eurozone GDP, (ii) the Portuguese business cycle has not yet converged to the one of the core euro area economies (Giannone et al. 2011), and (iii)

[4] 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 the loan amounts, the credit register includes information on other key loan characteristics, such as the maturity, currency and loan type.

the Portuguese economy was very sluggish at the Eurozone creation (Blanchard 2007; Reis 2013).[5] Portugal also represents a suitable laboratory to investigate the state-dependent labor market effects of monetary policy. As the country was severely hit by the Global Financial Crisis and the European Sovereign Debt Crisis, this setting allows us to study the importance of the credit channel not only in normal times, but also in crisis times, when credit frictions matter the most.

In this paper, we examine the redistributive effects of monetary policy on a number of labor market outcomes (hourly wages, hours worked and employment) and the role of the credit channel. Our baseline measure of monetary policy conditions is the overnight interbank interest rate for the Eurozone (EONIA) as in Jimenez et al. (2014) but we also show that the results are robust to the use of the shadow rate (Wu and Xia 2016) and monetary policy surprises (Jarocinski and Karadi 2020). Using the administrative employee-employer data, we follow workers over time as they move across firms to disentangle the time effects as well as permanent firm- and worker- component in their labor market outcomes using time, firm and worker fixed effects. This modelling approach is consistent with the seminal contribution by Abowd et al. (1999). We build on this framework and explore heterogeneous responses across different firms and workers. In terms of firm heterogenieties, we start with firm size and age as proxies of financial constraints, and next we introduce micro-level credit data to directly measure firm-level credit sensitivity to monetary policy. In terms of worker heterogeneity, we explore the differences between stayers and new hires as well as the role of the skill premium as measured by each worker educational attainment (e.g., college degree, STEM education).[6]

We establish four findings. First, softer monetary policy conditions improve labor market outcomes more in small and young firms, which tend to be more financially constrained. Following a 1 percentage point (pp) decrease in the monetary policy rate, workers in small (young) firms experience a 1.16 pp (0.4 pp) stronger increase in wages in the following year compared to workers in large (old) firms. These effects also persist in subsequent periods. While the magnitude of the impact is the largest in the first year, the positive and statistically significant effect lasts for at least the next three years. Within small and young firms, we find that the wage effects accrue to

[5] It is also important to note that the ECB raised monetary rates in 2011 when Portugal was in the middle of an economic and financial downturn. Further, the ECB did not conduct quantitative easing during our sample period 1999–2013. The ECB only introduced its expanded asset purchase program in March 2015 (i.e., seven years after the onset of the crisis). In addition, we overcome remaining concerns regarding the endogeneity by showing that our results are consistent and robust to a range of alternative monetary policy measures (e.g., monetary policy surprises or shadow rates) and also for inclusion of macroeconomic and financial control variables, as in line with the Taylor-type interest rate rule logic. This is similar in spirit to the approach in Christiano et al. (1999).

[6] The focus of this analysis is to study the redistributive labor market effects associated with monetary policy. To this end, in our estimations we control for the heterogeneous effects of the domestic business cycle and of the global financial cycle.

existing workers. We argue that, consistent with the back-loaded wage mechanism (Guiso et al. 2013; Michelacci and Quadrini 2009), monetary policy relaxes financial constrains and allows firms to increase wage profiles for their incumbent workers whose wages were previously back-loaded. To this end, we first show that small and young firms indeed tend to offer below-equilibrium wages.[7] Our results are important because they suggest that these firms "pay back" to their existing workers and increase the wage profile of the incumbent workers whose wages were previously back-loaded.[8] A 1 pp decrease in the monetary policy rate reduces the wage gap between small and large firms by approximately 5%, and between young and old firms by about 4.4%. In addition to the wage effects, we show that softer monetary policy also increases employment and hours worked by more in small and young firms. A 1 pp decrease in the monetary policy rate is associated with a 1.73 pp stronger increase in employment in small firms compared to large firms, and a 2.16 pp larger increase in employment in young firms compared to old firms. Taken together, softer monetary policy improves labor market outcomes more in small and young firms and hence reduces inequality between firms in the economy.

Second, we take a step further and explore worker-level heterogeneity with respect to skill. The existing literature has provided substantial evidence that the composition of workers across firms plays a pivotal role in understanding wage dispersion in the economy (Abowd et al. 1999; Card 1999; Card et al. 2013). We show that following a monetary policy softening, high-skilled workers benefit the most both in terms of wages and hours worked. A 1 pp decrease in the monetary policy rate is associated with a 1.14 pp stronger increase in wages and 2.7 pp increase in hours worked for high-skilled workers relative to the outcomes of low-skilled workers. Next, we combine worker and firm heterogeneity and show that the skill-premium effects are concentrated in small (young) firms. As high-skilled and high-wage workers tend to be mostly employed by large and high-wage firms (Engbom and Moser 2017), a monetary policy softening is associated with a labor reallocation of skilled workforce towards smaller firms. Consistent with the capital-skill complementarity mechanism, softer monetary policy allows financially constrained firms to increase both capital investment and employment of skilled workers. In addition, by exploiting the availability of detailed education coding in the micro-level data, we show that the increased employment of skilled workers and the rise in the skill-premium are more pronounced for workers with STEM degrees. Overall, our findings lend further support to the capital-skill complementary mechanism.

[7] By comparing wages of workers in the same region, industry and job title across firms, we find the wage differential to be around 23% between small and large firms and 9% between young and old firms.

[8] The results in support of the back-loaded wage mechanism are also robust to the inclusion of firm-time fixed effects.

Third, we document the importance of the credit channel for the redistributive effects of monetary policy through the labor market. We start by comparing the effect on wages for firms with and without bank credit. We find that monetary policy is associated with economically and statistically significant wage effects in small and young firms only for firms with previous bank-borrowing relationships. On the contrary, the effects are null for workers in firms that do not have any bank borrowing in the previous periods. To further corroborate these findings, we also show a stronger sensitivity of worker wages in small and young firms when these firms are highly levered.

Next, we exploit the richness of the credit registry data and show that both the firm balance-sheet channel and the bank lending channel play an important role in explaining the heterogeneous effects of monetary policy on labor market outcomes.[9] We analyze the firm balance-sheet channel by proposing a novel, agnostic approach that allows us to compute the firm-level credit sensitivity to monetary policy changes. While we validate that our measure relates to commonly used proxies for financial constraints such as size and age (see e.g., Cloyne et al. 2018), the proposed strategy offers a flexible approach that does not require to observe (or take an ex-ante stance on) which firm characteristics are the main drivers of the heterogeneous response to monetary policy.[10] Next, we turn to the analysis of the bank lending channel. We proxy for bank financial constraint by using measures of bank health (Amiti and Weinstein 2018; Bernanke and Gertler 1995; Jimenez et al. 2012) and bank liquidity positions (Kashyap and Stein 2000). Our findings show that by alleviating firm and bank financial constraints, softer monetary policy allows easier access to credit for constrained firms and for firms borrowing from more constrained banks. Most importantly, we show that workers in these firms benefit more in terms of wages, hours worked and employment.[11]

Fourth, we show that the redistributive effects of monetary policy are state dependent. The effects of softer monetary policy on worker labor market outcomes are 2 to 3.5 times stronger in crisis periods than in normal times. Crucially, both the firm balance-sheet and the bank lending channels

[9] According to the firm balance-sheet channel, firms' borrowing ability is directly related to the value of their net worth, which gives rise to an external finance premium. Softer monetary policy increases firms' asset value and consequently decreases the external finance premium improving their capacity to raise external funds (Bernanke et al. 1996; 1999). The bank lending channel predicts that if banks cannot frictionlessly rely on uninsured sources of funds, expansionary monetary policy positively affects the provision of bank credit supply to the economy. The magnitude of this effect depends on the strength of the bank balance channel and its liquidity position (Bernanke and Blinder 1988; Kashyap and Stein 2000).

[10] Importantly, 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, and industry-region-time fixed effects to absorb any heterogeneity at the industry-region-time including changes in the firm demand for credit which could be triggered by local and industry time-varying conditions. Our results are also robust to alternative estimations.

[11] We examine the relative importance of the firm-balance sheet and bank lending channels by augmenting the worker-level regressions to simultaneously include proxies for the two channels. Both remain significant. Thus, our results highlight that the two versions of the credit channel complement each other in the transmission of monetary policy to labor income inequality.

display stronger effects in crisis times. Our results suggest that monetary policy is particularly effective in alleviating bank and firm financial constraints during periods of financial distress, thereby mitigating labor income inequality.

Related literature. Our paper relates to four strands of the academic literature. First, we contribute to the recent and growing literature that studies the redistributive effects of monetary policy (e.g., Auclert 2019; Coibion et al. 2017; Gornemann et al. 2016; Kuhn et al. 2021). While existing papers mainly explore the relationship between monetary policy and wealth inequality (e.g., Andersen et al. 2021; Holm et al. forthcoming), we focus on labor income inequality. Auclert (2019) decomposes aggregate consumption into a number of channels and demonstrates that the earning heterogeneity channel is important for the transmission of monetary policy to consumption. We closely examine all relevant margins (wages, hours worked and employment) and uncover the crucial role of both firms and workers characteristics for the redistributive effects of monetary policy on labor market outcomes. In particular, our results show that the redistributive effects of monetary policy are mainly driven by small and young firms and highlight the importance of the back-loaded wage mechanism (e.g., Guiso et al. 2013; Michelacci and Quadrini 2009) for firm heterogeneity and of the capital-skill complementarity mechanism for worker heterogeneity (e.g., Krusell et al. 2000). We also show that firm and bank financial constraints play a crucial role in propagating the effects of monetary policy to worker labor market outcomes. The assessment of the credit channel (e.g., Bernanke and Gertler 1995; Drechsler et al. 2017; Kashyap and Stein 2000) for the heterogeneous effects of monetary policy on labor market outcomes had been left unexplored and represents one of our novel contributions to the existing literature on the redistributive effects of monetary policy.

Our paper closely relates to Coibion et al. (2017) who, using survey data, show that expansionary monetary policy decreases inequality in the U.S.. The quantification of the redistributive effects of monetary policy on worker labor market outcomes based on the exploration of its effects across both workers and firms distinguishes our analysis from other existing work. Consumer survey data do not allow to observe firms (and measure their financial constraints) or to follow workers over time as they move across firms to disentangle the importance of worker and firm characteristics on wages. Instead, we use linked employee-employer administrative data (covering all private sector firms in Portugal), which allow us to observe workers over time as they move across different firms. This is crucial as it enables us to explore the critical role of firm heterogeneity on worker wages (see e.g., Song et al. 2018).[12] In addition, it also allow us to quantify the importance of the underlying mechanisms associated with firm and bank financial constraints, and hence their implications for

[12] Importantly, Song et al. (2018) finds that the increase in the dispersion of average earnings between firms is one of the main reasons behind the rise in income inequality in the United States.

the effects of monetary policy labor income inequality.

Second, the reliance on the employee-employer data also connects our paper to a large body of literature that investigates the evolution of inequality over time (Card et al. 2015; Alvarez et al. 2018; Song et al. 2018). Our modelling approach is consistent with the framework proposed by Abowd et al. (1999), as we follow individuals over time as they move across firms. Relative to the existing work, this paper is explicit about the source of wage changes over time. In particular, we study how monetary policy affects labor income inequality (while controlling for other macroeconomic and financial conditions). To this end, we analyze how these worker and firm characteristics interact with monetary policy conditions and provide new evidence on how monetary policy propagates to wages and hours worked across various workers of different characteristics.

Third, we complement existing studies on the labor market effects of credit shocks (Barbosa et al. 2019; Berton et al. 2018; Chodorow-Reich 2014; Giroud and Mueller forthcoming; Moser et al. 2021). In particular, Chodorow-Reich (2014) exploits syndicated-loan data to show the heterogeneous effects of the Lehman crisis on U.S. firm-level employment outcomes. By using a rich dataset that matches the credit register loan-level information with employment data for workers, firms and banks, Berton et al. (2018) document the impact of credit supply shocks on employment across firms, workers, and job contracts in the Veneto region of Italy. More recently, Moser et al. (2021) use the ECB's negative interest rate policy as implemented in 2014 to explore the employment and wage effects of a credit supply shock in Germany. A number of distinctive features of our analysis makes our work complementary to other studies. First, our results are not related to a particular credit supply shock, but summarize the impact of monetary policy changes on labor earnings for the universe of Portuguese private sector workers over 14 years. Specifically, our sample includes normal and crisis times and enables us to show the state-dependent effects of the credit channel. Second, our comprehensive datasets allows us to analyze *all* private sector employees in the economy and the *full universe* of loan data.[13] This allows us to contribute to the existing literature by uncovering that workers in small firms benefit the most from a monetary policy softening. Third, we document the importance of back-loaded wage and capital-skill complementarity mechanisms in the monetary policy transmission.[14]

[13] 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.

[14] Our result on the capital-skill complementarity mechanisms also relates to Dolado et al. (2021) who report aggregate and industry-level evidence that monetary policy increases labor income inequality between high- and low-skilled workers. We add to their findings by showing that firm characteristics matter. Specifically, by exploiting granular micro-level data, we can show that the redistributive effects of monetary policy are driven by small and

Fourth, our work relates to the large literature that studies the role of the firm balance-sheet channel (Bernanke and Gertler 1995) and the bank lending channel (Bernanke and Blinder 1992; Drechsler et al. 2017; Kashyap and Stein 2000) for the transmission of monetary policy. We build on the recent studies that use micro-level credit registry data to provide evidence on the impact of monetary policy (e.g., Jimenez et al. 2012; 2014) or other credit supply shocks (e.g., Amiti and Weinstein 2018; Khwaja and Mian 2008; Paravisini 2008; Schnabl 2012) on lending to firms and firm-level real outcomes. Our work also complements recent papers on the effects of monetary policy on firm-level outcomes (e.g., Bahaj et al. 2019; Cloyne et al. 2018). Existing papers focus on the investment and employment effects through the firm balance-sheet channel. We show that monetary policy has also important heterogeneous effects on worker wages and hours worked. Furthermore, both the firm balance sheet and the bank lending channels are important for the monetary policy transmission mechanism and are substantially stronger in crisis times. Finally, we find no effect for firms without bank credit.

The remainder of the paper is organized as follows. Section 1 discusses data and identification challenges and introduces our dataset. We present the results on the redistributive monetary policy on wages in Section 2 and on employment and hours worked in Section 3. Section 4 explores the effects of capital-skill complementarity. Section 5 analyzes the role of the credit channel. Section 6 compares the effects in normal times and in crisis periods. Section 7 presents the robustness analysis. Finally, Section 8 concludes.

1 Identification Challenges and Data

1.1 Identification and data challenges

Our setting allows us to overcome key identification and data challenges. First, the analysis requires granular longitudinal data on firms and workers. The recent literature has highlighted the importance of firm identity on worker wages (see e.g., Alvarez et al. 2018; Card et al. 2013; Engbom and Moser 2017; Song et al. 2018). In particular, Song et al. (2018) show that the increase in the dispersion of average earnings *between* firms is one of the main reasons behind the rise in income inequality in the U.S.. To date, existing evidence has primarily relied on survey data (e.g., Coibion et al. 2017) which cannot identify firms or track the same workers over time as they move in the labor market. On the contrary, our administrative employee-employer dataset enable us to follow workers over time as they move across different firms. This is important because it allows

young firms which are able to disproportionately increase both human and physical capital investment.

us to disentangle the permanent worker and firm component in wages, following the modelling approach of Abowd et al. (1999). Hence, we can examine the effects of the additional variation associated with monetary policy changes.

Second, the analysis of the credit channel and financial frictions in the monetary transmission requires a detailed picture of firm borrowing conditions. To this end, we exploit an unparalleled match of granular employee-employer and credit registries. The Portuguese credit registry provides the *universal* credit coverage and allows us to examine the role of credit across all firms in the economy including SMEs. To the best of our knowledge, this is the first paper that makes use of the universal credit registry matched with administrative employee-employer data covering the entirety of private sector employees.

Third, the focus on Portugal also helps us address potential concerns regarding reverse causality issues, as monetary policy can react to labor market dynamics.[15] 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). Furthermore, it is also important to highlight that the ECB raised monetary rates in 2011 when Portugal was in the middle of an economic and financial downturn. Further, the ECB only started to conduct quantitative easing in 2015 (outside of our 1999–2013 sample period). As a result, we argue that euro area monetary policy has been rather exogenous to the state of the Portuguese economy. To further address this issue, in our regression analysis we control for business cycle and financial sensitivity using the Portuguese GDP growth and VIX. In addition, we further address any potential remaining endogeneity challenges by replacing the overnight interest rate measure (EONIA) with the high-frequency monetary policy surprises (as measured by Jarocinski and Karadi (2020)) and we show that all our results are robust to the use of unexpected monetary policy surprises as an alternative measure of monetary policy. As labor market outcome are only observed at the annual frequency, changes in the monetary policy rate are more appropriate for our benchmark analysis. Nevertheless, in Section 7, we show that our results are robust to alternative monetary policy measures including monetary policy surprises.

Fourth, Portugal also represents a suitable laboratory to investigate the state-dependent labor market effects of monetary policy. Portugal was severely hit by the Global Financial Crisis and the European Sovereign Debt Crisis. This allows us to study the importance of the credit channel

[15]This challenge is particularly salient in the U.S. where full employment is part of the Federal reserve dual mandate. On the contrary, in the Eurozone, the ECB follows a single (price-stability) target.

not only in normal times, but also during crisis times, when financial frictions matter the most. The focus on Portugal presents a valuable novel setting complementary to other contemporaneous evidence using data from Norway (Holm et al. forthcoming) or Germany (Moser et al. 2021), i.e. economies that were not as adversely affected by the crisis.

1.2 Data

We build a novel granular dataset that matches the employee-employer and credit registers in Portugal. It allows us to fully track the transmission of monetary policy via banks and firms to worker labor market outcomes. We focus on the period since the creation of the Eurozone 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 constructed by the Portuguese Ministry of Labor, Solidarity and Social Security. Private sector firms in Portugal with at least one paid employee are required to submit information on their entire workforce on a yearly basis. The dataset includes information on employee's occupation, education, regular monthly salary, any additional wage supplements, hours worked, etc. On the employer's side, we observe the firm's industry, region, founding year 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.[16]

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 match of QP with the credit registry - *Central de Responsabilidades de Credito* (CRC) - collected and managed by the Bank of Portugal. CRC reports monthly level data on all loans above the reporting threshold of 50 EUR that firms receive from credit institutions supervised by the Bank of Portugal. The dataset includes information on loan amounts and key loan characteristics, such

[16] 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 (approximately 20% of the Portuguese workforce). Second, QP provides a snapshot of labor market outcomes as of the reference month (October). Individuals who happen to be unemployed or out of the labor force at the time of the census have no labor market record for that year. We address these challenges by checking for significant discrepancies in the coverage of the QP dataset. We match the QP data with the aggregate quarterly labor statistics and we do not identify any potential concerns for our analysis. In particular, we do not observe substantial flows of workers between the private and public sector over the sample period. In addition, the annual data collection occurs in late October and therefore, it 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 any major challenge as wages are generally renegotiated only once per year. It is common in the literature to focus on annual data even if higher frequency data is available (see e.g., Patterson 2019; Sorkin 2018).

as maturity, currency, type of the loan, and guarantee/collateral used to secure the loan, if any. In this paper, we utilize the credit registry data on total credit (drawn credit as well as unused credit lines) between private NFCs and banks. We restrict the focus to domestic banks and domestic subsidiaries of foreign banks.

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

Monetary policy. Finally, we measure ECB monetary policy conditions using the overnight interbank interest rate, i.e. the Euro Overnight Index Average (EONIA). EONIA signals ECB monetary policy conditions and is analogous to the U.S. Fed funds rate. Overnight rates are commonly used in the literature to capture monetary policy conditions (e.g., Kashyap and Stein 2000; Jimenez et al. 2014). For robustness, we also use alternative monetary policy measures, namely the shadow rates constructed by Wu and Xia (2016) and the annualized monetary policy surprises provided by Jarocinski and Karadi (2020).

Table 1 summarizes the data. Our sample covers the 1999–2013 period.[17] We focus on worker's primary occupation in year t.[18] In total, we observe more than 5.5 million prime age workers employed for a total of almost 800,000 firms. 33% of all workers are employed in firms with fewer than 50 employees and we denote these firms as small.[19] 11% of the workforce is employed in young firms, i.e. firms with an age below five years.[20] The average worker in our dataset is 38 years old. The fraction of workers above the age of 35 years 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 workforce are women.

[17] Due to restrictions to match the employee-employer and the credit registries, the analysis cannot be extended the analysis beyond 2013.

[18] If the worker has multiple occupations in year t, we define the primary occupation based on the years employed in the firm and the salary size.

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

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

2 Redistributive Wage Effects

2.1 Empirical strategy

We start the analysis by studying the heterogeneous effects of monetary policy conditions on wages across different types of firms in the economy as summarized by the following regression:

$$\log\left(\text{wageHr}_{w,f,t}\right) = \alpha_t + \alpha_w + \alpha_f + \beta(R_{t-1} \times H_f) + \gamma(X_{t-1} \times H_f) + \zeta C_{w,t-1} + \epsilon_{w,f,t}. \quad (1)$$

Our outcome variable is the log of the hourly wage of worker w in firm 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.[21] The lagged level of the interest rate (R_{t-1}) captures monetary policy conditions. Our baseline measure is the effective overnight reference rate (EONIA), as in Jimenez et al. (2014). The results are robust to alternative monetary policy measures, such as the shadow rate by Wu and Xia (2016) and monetary policy surprises as constructed by Jarocinski and Karadi (2020).[22] Firm heterogeneity is denoted by H_f.[23] The estimate of β on the interaction between the monetary policy rate and firm characteristics is our main coefficient of interest. It measures by how much more wages for workers in firms of a certain type ($\mathrm{H}_{f,t-1}$) react to monetary rate changes compared to a reference group of workers. Next, we also control for the heterogeneous effects on wages of the domestic business cycle and the global financial cycle. Specifically X_{t-1} denotes the lagged real GDP growth for Portugal and the lagged log level of the U.S. VIX.[24] This setting allows us to control for the heterogeneous firm effects driven by business cycle dynamics and financial distress, and to focus on the effects associated with monetary policy.[25]

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-component in wages using fixed effects. This modelling approach is consistent with the seminal framework proposed by Abowd et al. (1999). We progressively saturate our specification with fixed

[21] 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 monthly wages. Moreover, in Section 3 we also analyze hours worked and employment.

[22] The robustness results are reported in Section 7.

[23] When applicable, we consider both a time-varying ($H_{f,t-1}$) and a time-invariant (H_f) versions.

[24] We also show robustness to the additional inclusion of euro area macro controls in Section 7. In line with the standard Taylor (1993) rule logic, we include Eurozone GDP growth and inflation.

[25] In Online Appendix Table A1, we present the results on the relationship between monetary policy, economic conditions and wage dynamics in Portugal. In all specifications, the relationship of wages and the monetary policy rate is negative, whereas it is positive with the Portuguese GDP growth.

effects until we reach the benchmark specification (Equation 1). To absorb time variation as well as the unobserved permanent worker and firm components of the individual's annual wage, we use time, firm and worker fixed effects denoted as α_t, α_w and α_f, respectively. We also add controls for worker characteristics ($\mathrm{C}_{w,t-1}$), namely a quadratic polynomial in worker age. We cluster standard errors at the firm and worker level.

2.2 Results

In this section, we report the heterogeneous effect of monetary policy on worker wages across firms of different 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., Bernanke and Gertler 1989; 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. 2018; Bahaj et al. 2019).

Firm size. Table 2 Columns (1)–(4) present the estimates of Equation 1 where we interact the monetary policy rate with the firm size. A dummy variable $\mathrm{SmallFirm}_f$ 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 1 percentage point (pp) decrease in the monetary policy rate is associated with a 1.16 pp stronger increase in wages of workers in small firms compared to large firms.[26] Our results are robust to the coefficient stability and omitted variable bias test proposed by Oster (2019).[27]

The effect is quantitatively very similar also when we account for additional industry/region time-varying fixed effects (see Online Appendix Table A2 Columns (2)–(4)). The results are not driven by the presence of micro firms in which all workers might have close ties to the owner and/or

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

[27] We compute lower bound of the size estimate using the coefficients and R-squared 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.

mobility patters 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 A3).

Figure 1 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 2, workers in the bottom quintile of the firm size distribution (smallest 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. 2018). This result has often been interpreted as supporting evidence on the importance of the credit channel. We explore these implications more formally in Section 5. 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. forthcoming).

Firm age. Table 2 Columns (5)–(8) show that following a monetary policy softening, young firms increase wages by more than old firms. Using Equation 1, we interact the monetary policy rate with a dummy variable $\text{YoungFirm}_{f,t-1}$ that takes value of 1 if the firm is younger than five years, and 0 otherwise. The baseline estimate in Column (8) show that a 1 pp reduction in the monetary policy rate is associated with an approximately 0.4 pp larger increase in wages for workers in young firms compared to workers in old firms. This relationship does not attenuate when we introduce additional time-varying region and/or industry fixed effects (see Online Appendix Table A2 Columns (5)–(7)).

Figure 1 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. (2019) 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 effected in terms of wages.

Finally, in Online Appendix Table A2, we show that both the firm size and the age margin are economically relevant. In Column (1), 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.

Existing literature has highlighted that workers in small or young firms tend to earn lower wages (see e.g., Brown and Medoff 1989; Oi and Idson 1999). In Appendix Table A4, we compute the wage gaps by comparing 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, 9% for young vs. old firms. Taken together, our findings highlight that softer monetary policy contributes to a decrease in the wage dispersion across firms in the economy. In terms of magnitudes, a 1 pp decrease in the monetary policy rate reduces the wage gap between small and large firms by approximately 5%, and between young and old firms by 4.4%. In Figure 1 Panel (c), we further corroborate this finding by splitting firms into qualities according to their position in the wage distribution in year $t-1$. We find that following a monetary policy softening, the wages of workers in low-wage firms increase more than the wages of workers in high-wage firms. Therefore, our results highlight that softer monetary policy reduces income inequality between firms.

Persistence. Finally, in Appendix Table A5 we show that the heterogeneous firm size and age effects of monetary policy on wages are persistent over time. We find that softer monetary policy conditions increase wages more in small and young firms not only in the following year but also in the subsequent three years. While the magnitude of the effects decreases after the first year, the effects remains stable, economically and statistically significant at least for the next three years.

2.3 Back-loaded wage mechanism

Our findings highlight that workers in small and young firms benefit more from a decrease in the monetary policy rate. This suggests that softer monetary policy narrows the wage gap across firms in the economy. In light of these findings a question naturally emerges: Why do workers in small and young firms benefit more?

A large body of the labor literature has provided ample evidence that young and small firms tend to offer lower wages to their workers and the wage differential is mainly associated with firms' financial constraints. Michelacci and Quadrini (2009) and Guiso et al. (2013) show that financially constrained firms tend to offer back-loaded wages. In particular, Michelacci and Quadrini (2009) develop a labor market equilibrium model which documents that financially constrained firms offer an increasing wage profile, i.e. they pay (below frictionless market) entry wages with a promise of a steeper wage profile in the future once the firms become unconstrained. The mechanism has also been empirically examined by Guiso et al. (2013) who exploit the heterogeneity in credit market developments across Italian provinces and show that firms operating in less developed local markets implicitly borrow from their workers by paying back-loaded entry wages but offer a faster wage growth as the local credit markets converge. Recently, Howell and Brown (2020) also document the importance of the back-loaded wage mechanism across small high-tech firms in the US which receive a sudden positive cash flow shock by winning R&D grants. According to this mechanism, a softening in monetary policy conditions should benefit the most the incumbent workers in financially constrained firms whose wages were originally back-loaded.

In Table 3 we explore how small vs. large firms share rents with their workers following a monetary policy softening. We show that stayers in small firms drive the aggregate effects and benefit the most from an accommodative monetary policy. This holds for the baseline specification controlling for worker, firm and time fixed effects in Column (1), as well as for the within-firm analysis using firm-time fixed effects in Column (2). In Columns (3) and (4), we compare the wage dynamics of stayers and new hires in the sample of large firms and we find the opposite (positive) effect in favor of new hires. Finally, Columns (5) and (6) present the analysis for the entire universe of all firms in Portugal. Column (5) shows that while on average, all workers in small firms gain disproportionately more than workers in large firms, stayers in small firms are by and large the main beneficiaries of a monetary policy softening. The positive effect for stayers in small firms remains strong also when we introduce firm-time fixed effects in Column (6).

Overall, these results lend support to the back-loaded wage contract mechanism. As small firms tend to be more financially constrained, they offer lower entry wages. Softer monetary policy leads to a relaxation of financial constraints and enables small firms to increase the wage profile for existing workers whose wages were previously back-loaded.[28] As a result, softer monetary policy narrows the wage differential across workers in small and large firms in the economy and narrows down the between firm inequality.

3 Redistributive Employment Effects and Hours Worked

So far, we have showed that softer monetary policy conditions reduce workers wage differentials across firms and workers in the economy. In this section, we investigate the redistributive effects of monetary policy across different types of firms with a focus on employment and hours worked.

[28]In Section 5, we provide additional evidence of firm financial constraint by means of a credit registry analysis and explore its relation to firm size.

3.1 Empirical strategy

First, we analyze the heterogeneous effect of monetary policy on workers' total hours worked by estimating the following regression:

$$\log\left(1 + \text{HrsWorked}_{w,f,t}\right) = \alpha_t + \alpha_w + \alpha_f + \beta(R_{t-1} \times H_f) + \gamma(X_{t-1} \times H_f) + \zeta C_{w,t-1} + \epsilon_{w,f,t}. \quad (2)$$

Our outcome variable is total hours worked by worker w in firm f in year t. Equation 2 tracks the hours worked of individuals as they move over time across different firms. This allow us to disentangle hours worked into a firm and a worker component. Total hours worked takes the value 0 if the worker is unemployed, and the reported hours worked if the worker is employed.[29] The rest of the coefficients in Equation 2 are consistent with the wage analysis (see Equation 1 in Section 2). The standard errors are two-way clustered at the firm and worker level.

Second, we focus on employment at the firm level. We analyze heterogeneity in the employment effects of different types of firms in response to softer monetary policy using the following set-up:

$$\log\left(\text{Employment}_{f,t}\right) = \alpha_t + \alpha_f + \beta(R_{t-1} \times H_f) + \gamma(X_{t-1} \times H_f) + \epsilon_{f,t}, \quad (3)$$

where $\log\left(\text{Employment}_{f,t}\right)$ denotes log of the number of workers employed in firm f at time t. As in our previous analysis, R_{t-1} captures monetary policy conditions and H_f denotes firms characteristics. The estimate of β on the interaction between the monetary policy rate and firms' characteristics is our main coefficient of interest. We further saturate the specification with firm and year fixed effects. The standard errors are clustered at the firm level.

3.2 Results

Table 4 presents the results of the interaction of the monetary policy rate with the firm size and age. Columns (1) and (2) report the effects for worker-level hours worked following Equation 2. A monetary policy softening implies a larger increase in hours worked for workers in small (young)

[29]For employed workers, the estimation is straightforward as we observe firm characteristics and firm identity to implement firm fixed effects. For unemployed workers, we impute firm observables and firm fixed effects as follows. If the worker is unemployed only for one period, we assign hours worked to 0 and use the information on worker's last employer to impute her firm fixed effects and firm observables. If the worker is unemployed for two periods, we follow the same procedure for the first year of unemployment. For the second year of unemployment, we assign hours worked to 0 and we match the worker with the next firm that hires her in the subsequent period to impute firm fixed effects and firm observables. Finally, if the worker is unemployed for three or more periods, we impute firm characteristics for the first and the last year as above and we exclude the remaining middle periods.

firms compared to large (old) firms. In Columns (3) and (4), we report the effects on firm-level employment following the specification in Equation 3. A 1 pp decrease in the monetary policy rate is associated with a 1.05 pp stronger increase in employment in small firms compared to large firms, and a 2.11 pp stronger increase in employment in young firms compared to old firms. In Column (5) and (6), we introduce additional time-varying industry and region fixed effects and find similar (slightly larger) coefficients.

4 Capital-Skill Complementarity

Our findings on firm heterogeneity highlight that workers in low-wage (small and young) firms benefit the most from a monetary policy softening. In this section, we investigate the effects of monetary policy on worker-level heterogeneity based on 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 friction on firm-level employment (Berton et al. 2018), and labor and capital reallocation (Bai et al. 2018; Fonseca and Van Doornik 2021). 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 specifications described in Equations 1 and 2 which we use to analyze the heterogeneous effects of monetary policy on wages and hours worked. We replace the firm heterogeneity with the worker heterogeneity. Specifically, we proxy for skill with education 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.[30] Table 5 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. Similarly, Column (3) shows that high-skilled workers also benefit in terms of hours worked.[31] A 1 pp decrease in the monetary policy rate is associated with

[30] 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 $t-1$ (see Online Appendix Table A6).

[31] The main results are reported across firms using worker, firm and time fixed effects as in Equations 1 and 2. In Online Appendix Table A6, we show that there results also hold by saturating the regression analysis with firm-time fixed effects.

a 1.14 pp larger increase in wages and 2.7 pp larger increase in hours worked.

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 2021). To this end, we differentiate the educational attainment into the college degree obtained in the STEM fields or other (non-STEM) fields.[32] The results are reported in Columns (2) and (4) of Table 5. We find that while monetary policy exacerbates the effect college premium for all high-skilled workers, the benefit is concentrated in the wages and hours worked of STEM-degree high-skilled workers.

4.2 Firm heterogeneity and capital-skill complementarity

How is the rise in skill premium related to firm heterogeneity? In Figure 2, we report the estimates of the interaction of firm size and worker skill premium. We examine the heterogeneous effects of monetary policy on hours worked using the college educated workers in large firms as a reference category. We find that while college premium rises both in large and small firms, the effect on hours worked is most pronounced for high-skilled workers in small firms. This is consistent with our findings in Section 3 which highlight a stronger employment response to monetary policy for small firms. In fact, the estimates in Figure 2 show that both high- and low- skilled workers in small firms benefit more than the reference category while low-skilled workers in large firms benefit the least. Furthermore, as high-skilled (high-wage) workers tend to be mostly employed by large (high-wage) firms (Engbom and Moser 2017), a monetary policy softening is associated with a labor reallocation of skilled workforce towards smaller firms.

In Table 6, we focus on the final missing piece of the capital-skill complementarity: 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 with a stronger increase in investment in small and young firms.

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

[32] 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.

encourages capital investment. Our results stress 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 Credit Channel

In the previous sections, we have shown that following a monetary policy softening, labor market outcomes of workers employed in smaller and younger firms improve more than in larger and older firms. A natural next step is to examine the channel through which monetary policy changes heterogeneously affect wages and employment across firms in the economy. Guided by the large body of literature that emphasizes the crucial role played by financial frictions for small firms, we investigate the importance of the credit channel. Balance sheet positions and credit frictions are key elements in the heterogeneous transmission of monetary policy across firms and banks (e.g., Gertler and Gilchrist 1994; Kashyap and Stein 2000; Jimenez et al. 2012; Drechsler et al. 2017). Furthermore, financial market imperfections contribute to shape wage contracts (e.g., Michelacci and Quadrini 2009; Guiso et al. 2013). Still, the literature is lacking a systematic empirical investigation of the importance of the effects of the credit channel for the transmission of monetary policy to worker-level labor market outcomes.

In this section, we exploit a novel dataset which links the employee-employer and credit registries to investigate the role of credit in the transmission mechanism of monetary policy to worker-level wages and hours worked and firm-level employment. We examine the effect of the firm balance-sheet and bank lending channels and show that both versions of the credit channel play a important role in explaining the redistribute labor income effects of monetary policy.

We start by showing the overall importance of bank credit. To this purpose, we augment Equation 1 with a triple interaction of monetary policy, firm heterogeneity (size or age) and variable capturing the importance of bank credit at the firm level. We measure the latter in two ways. First, since not all firms in Portugal have active bank borrowing relationship, we compare the labor market outcomes for workers in small (young) firm with and without bank credit. To this end, 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 previous periods, and 0 otherwise. Second, we turn to the use of a continuous variable - leverage - which is a commonly used as an empirical proxy to measure financial conditions (e.g., Ippolito et al. 2018; Ottonello and Winberry 2020). $\text{Leverage}_{f,t-1}$ denotes the leverage ratio computed as a share of firm's bank debt to total assets in time $t-1$.[33]

Table 7 reports the results. The estimates in Column (1) show that the wage effects for workers in small firms is fully driven by firms with existing bank borrowing relationship. Instead, the coefficient estimate for small firms without bank credit has the opposite (positive) sign and it is not statistically significant. In Column (2), we replace the categorical variable with a continuous measure of firm leverage and we find stronger response for workers in small firms especially if these firms are highly levered. Following the same approach, we repeat the estimation for young vs. old firms and we report consistent results in Columns (3) and (4).

5.1 Firm balance-sheet channel

In this section, 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. According the the firm-balance sheet channel, softer monetary policy increases firms' asset value and net worth, and thus extends firms' capacity to raise external funds (Bernanke and Gertler 1995). If this channel is also associated with the redistributive labor market effects, monetary policy should propagate more strongly to wages and hours worked in firms with higher credit sensitivity to monetary policy. To test this hypothesis, we a strategy that does not require to take an explicit stance regarding which firm characteristics are the main 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:

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

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 on which observable

[33] While in most cases the two measures capture a previous firm reliance on bank credit in a consistent way ($\text{ExistCredit}_{f,t-1}$ as a dummy and $\text{Leverage}_{f,t-1}$ as a continuous variable), some differences might occur. Namely, if a firm reports a previous bank borrowing relationship but it was fully repaid by $t-1$, the value of 1 while would be assigned to $\text{ExistCredit}_{f,t-1}$ while the variable $\text{Leverage}_{f,t-1}$ would not signal any credit outstanding.

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 negative 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 and we denote it as FBC_f.

Estimating the effect of monetary policy through the credit transmission mechanism poses two important identification challenges. First, in addition to the firm-level credit sensitivity, individual firms are connected to different banks which can respond heterogeneously to monetary policy in terms of their credit supply effects. For instance, an ample body of the bank-lending channel literature has shown that banks with worse balance sheet health (Bernanke and Blinder 1988; Jimenez et al. 2012; Amiti and Weinstein 2018) or less liquid banks (Kashyap and Stein 2000) tend to be have more sensitive credit supply response to monetary policy. In Equation 4, we address this concern by introducing bank-firm fixed effects ($\kappa_{b,t}$) to control for the time-varying bank-level credit supply.

Second, in addition to monetary policy, firm-level credit sensitivity can also be driven by other firm, industry or region specific changes that could confound the results. We address this concern in a number of ways. In the baseline specification (Equation 4), we saturate our model with industry-region-time fixed effects ($\kappa_{s,r,t}$) to control for any heterogeneity at the industry-region-time including changes in the firm demand for credit which could be triggered by local and industry time-varying conditions. As detailed in Online Appendix B, we show that our results are also robust to alternative specifications in which we control for time-varying demand shocks by first estimating the credit sensitivity to monetary policy for the bank-firm loan pair and then aggregating it on the firm level.

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 FBC_f 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. 2018). According to the existing literature, smaller and younger firms tend to be more financially constrained, and consequently benefit more from softer monetary policy. Table 8 summarizes the results of the range of univariate and multivariate regressions which examine the relationship between FBC_f and firm 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 (i.e., more negative FBC_f).

These results further corroborate the importance of the back-loaded wage mechanism highlighted in Section 2.3. In particular, we show that small and young firms tend to offer back-loaded wages to their workers and softer monetary policy conditions allow these firms to increase wages by more, thus narrowing the wage dispersion across firms. The matched employee-employer and credit registry data allow us to further elaborate on the actual credit sensitivity of firms to monetary policy. These findings also support the capital-skill complementarity mechanism by showing that in response to softer monetary policy, financially constrained firms increase both physical and human capital investment.

While we validate that this agnostic measure of firm-level credit sensitivity to monetary policy relates to more explicit proxies (size, age), our proposed measure offers a 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. As a result, we use the estimate of the agnostic firm-level credit sensitivity to monetary policy as a source of heterogeneity in the labor market regressions:

$$y_{w,f,t} = \alpha_t + \alpha_w + \alpha_f + \theta(R_{t-1} \times FBC_f) + \gamma(X_{t-1} \times FBC_f) + \zeta \mathrm{C}_{w,t-1} + \epsilon_{w,f,t}. \tag{5}$$

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

5.2 Bank lending channel

The empirical banking literature has extensively shown that contractionary monetary policy reduces bank credit supply and has negative effects on firm credit and real economic activity (Bernanke and Blinder 1992; Kashyap and Stein 2000; Jimenez et al. 2012). In this section, we present the methodology that we use to test the hypothesis that monetary policy propagates more strongly to workers' wages in firms borrowing from banks with worse balance sheet health (Bernanke and Gertler 1995; Ashcraft 2005; Jimenez et al. 2012; Amiti and Weinstein 2018) and lower liquid assets holdings (Kashyap and Stein 2000).

First, we match the credit registry and bank balance sheet data and construct two measures of strength of the bank lending channel: (i) bank health and (ii) bank liquidity. Similarly to Amiti and Weinstein (2018), we use loan-level credit data to estimate bank credit supply shocks as a measure of bank health and financial constraint. Formally, we decompose the credit of an individual firm f with a bank b at time t into the time-varying firm shocks and bank shocks:[34]

$$\log(\text{credit}_{f,b,t}) = \alpha_{b,t} + \alpha_{f,t} + \epsilon_{f,b,t}, \tag{6}$$

where $\alpha_{b,t}$ denotes bank health (captured with bank-time fixed effects). For bank liquidity, we construct $LiqAss_{b,t}$ as a ratio of the sum of all bank liquid assets (i.e., cash holdings, bond holdings and short-term loans to other monetary financial institutions) to total assets following Kashyap and Stein (2000).

Second, we compute the firm-level exposure to the bank lending channel ($BLC_{f,t}$) as the lagged credit weighted average of a bank-level measure of the bank lending channel. Formally, we define it as

$$BLC_{f,t} = \sum_b BLC_{b,t} \times Credit_{b,f,t-1},$$

where $BLC_{b,t} \in \{Health_{b,t}, LiqAss_{b,t}\}$ represents one of the proxies for bank lending channel.

Finally, we plug our measures of firm exposure to the bank lending channel ($BLC_{f,t-1}$) into the worker-level labor market regressions as the key source of heterogeneity:

$$y_{w,f,t} = \alpha_t + \alpha_w + \alpha_f + \vartheta(R_{t-1} \times BLC_{f,t-1}) + \gamma(X_{t-1} \times BLC_{f,t-1}) + \zeta \mathrm{C}_{w,t-1} + \epsilon_{w,f,t}. \tag{7}$$

If the bank lending channel is at work, we would expect wages, hours worked and employment of workers in firms borrowing from banks with more financially constrained banks increase by more in response to softer monetary policy conditions. Consequently, the estimate of ϑ would be positive and statistically significant.

5.3 Results

In this section, we present the results of the analysis on the credit channel of monetary policy on a range on labor market outcomes. Table 9 summarizes the effect on worker-level wages. Column (1) reports the estimates for the firm-balance sheet channel. Consistent with our hypothesis, we find that following a decrease in the monetary policy rate, wages of workers in firms with stronger credit sensitivity to monetary policy increase by more compared to firms with a weaker credit sensitivity. Columns (2) and (3) present the results for the bank lending channel using bank health

[34] This analysis is similar in spirit to Amiti and Weinstein (2018). Given that our labor market analysis is performed on levels, we also estimate bank-supply shocks using credit levels rather that credit differences.

and liquidity, respectively. We find that firms borrowing from more financially constrained banks propagate monetary policy changes to wages more strongly.

In Table 10, we examine the effect on the credit channel on worker-level hours worked and firm-level employment. Similarly to the wage analysis, we report positive and statistically significant coefficients across all specifications. This suggests that the credit channel plays an important role in the transmission of monetary policy also in the extensive margin, using employment and hours worked.

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 confirm 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.

As a final step, we include both the firm balance-sheet and the bank lending channel in the same regression. Hence, we augment the worker-level wage regression (Equation 5) to simultaneously include our agnostic measure of firm balance-sheet channel and one of the two proxies of the bank lending channel. In addition, we also horse-race the two versions of the proxy for the bank-lending channel, i.e. we use both bank health and bank liquidity measure in the same regression. Finally, we run a regression which include all three measures. The results are presented in Online Appendix Table B2. We find that all proxies for the credit channel continue to be statistically and economically significant. Hence, our findings demonstrate that the credit channels captured by our proxies complement one another in the heterogeneous transmission of monetary policy to wages across firms in the economy.

6 Monetary policy in crisis times

So far, we have discussed the average effects of monetary policy on labor income redistribution. In this section, we explore whether the impact of monetary policy on wages also depends on the state of the economy. In particular, we analyze to what extend 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 11, 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 measure the state of the economy with domestic GDP growth.[35] Columns (1)–(4) focus on the wage effects. The estimates suggest that workers in constrained firms benefit more from softer monetary policy conditions especially in times of crisis when firms face more severe financial constraints. 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 periods of low GDP growth (positive triple interaction term). 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. In Column (4), we further show that the effects propagated through the bank lending channel are also stronger in times of crisis. Columns (5)–(8) find similar results using the hours worked as an outcome variable.

Overall, our results demonstrate that the effects of monetary policy through the credit channel are 2–3.5 times stronger in crisis periods compared to normal times.[36] We provide evidence in support of the effectiveness of monetary policy in alleviating bank and firm constraints especially when they are most needed, i.e. in crisis periods, contributing to labor income redistribution via both hourly wages and hours worked.

Our findings contribute to the recent and growing literature on the effects of monetary policy on firm-level outcomes (e.g., Bahaj et al. 2019; Cloyne et al. 2018) 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 bank lending 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.

7 Robustness to alternative monetary policy measures

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 both the wage and hours worked analyses and report the results for the wage heterogeneity in the Online Appendix Table C1 and for the credit channel

[35] Our results are robust to alternative proxies such as a crisis dummy.

[36] Crisis times are defined as periods of GDP growth of -2.0% which is the average GDP growth in the 2008–2009 and 2011–2013 periods. The average GDP growth in normal times is about 1.8% and covers the 1999–2007 period and year 2010. In the latter year, GDP growth was about 1.9%.

in the Online Appendix Table C2.

First, we augment our baseline specifications 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.

Second, 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 the observed overnight interbank interest rate (EONIA), it also accounts for additional monetary expansions associated with for instance fixed-rate full allotment, LTRO liquidity operations or the announcement of Outright Monetary Transactions.[37]

Third, we connect to the growing literature on monetary policy surprises (Gertler and Karadi 2015; Nakamura and Steinsson 2018; Jarocinski and Karadi 2020). Specifically, we use the index of monetary policy surprises computed by Jarocinski and Karadi (2020). We aggregate the surprises at the yearly level (by summing them) as in Ottonello and Winberry (2020). The use of monetary policy surprises allows us to further mitigate the remaining potential endogeneity concerns discussed in Section 1. 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. To summarize, Online Appendix Tables C1 and C2 report that all our key findings are robust to the use of additional macro controls, shadow rates or unexpected monetary policy surprises.[38]

[37]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.

[38]The baseline results estimates have similar magnitudes to specifications using additional Taylor-rule macro controls and shadow rates. By construction monetary policy surprises have smaller values and as a result the reported estimates are by a magnitude larger. In terms of standard deviations, all effects are quantitatively similar.

8 Conclusion

We analyze how monetary policy affects labor income redistribution across both workers and firms via the credit channel. We show that a monetary policy softening is associated with improved labor market outcomes and higher capital investment, especially in small and young firms. By relaxing financial constraints, softer monetary policy allows these types of firms to increase the wage profile of their incumbent workers, as consistent with the back-loaded mechanism. Hence, since small and young firms tend to offer lower wages, softer monetary policy narrows the wage differential between firms in the economy. In addition, small and young firms are able to increase their investment in both physical capital and human capital, in line with the capital-skill complementarity mechanism.

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 firm balance-sheet channel, we develop a novel approach that estimates the firm-level credit sensitivity to monetary policy. Further, we show that the bank-lending channel is also relevant for the redistributive effects of monetary policy.

Our paper has several important implications. We show that the redistributive effects of monetary policy are mainly driven by small and young firms. Our results suggest that the back-loaded wage mechanism (e.g., Michelacci and Quadrini 2009; Guiso et al. 2013) is also at work in response to a monetary policy softening, as well as the capital-skill complementarity mechanism (e.g., Krusell et al. 2000). By showing that firm and bank financial constraints play a critical role for the redistributive effects of monetary policy, and especially so in crisis times, we also uncover new insights into the importance of the credit channel.

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 redistributive 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 modelling of firm and bank financial constraints is vital to understand the heterogenous 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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Graphs and Tables

Table 1: Descriptive statistics

Firms:	
Fraction of workers in small firms	0.3321
Fraction of workers in young firms	0.1101
Mean bank leverage	0.2081
Mean share of college educated workers in 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 worker-year obs.	28,779,857
Number of workers	5,587,862
Number of firms	795,369

Notes: The sample consists of yearly data from 1999 to 2013. All statistics are calculated across worker-year observations

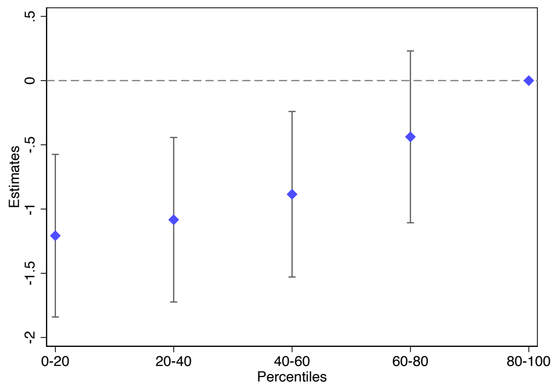
Table 2: Monetary policy, wages and firm heterogeneity

	$\log(\text{wageHr}_{w,f,t})$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{SmallFirm}_f \times \text{R}_{t-1}$	-2.75***	-2.87***	-1.88***	-1.16***				
	(0.398)	(0.395)	(0.201)	(0.163)				
$\text{YoungFirm}_{f,t-1} \times \text{R}_{t-1}$					-0.56	-0.36	-0.40***	-0.40***
					(0.68)	(0.701)	(0.137)	(0.118)
R_{t-1}	-3.67***				-5.11***			
	(0.396)				(0.177)			
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE		Yes	Yes	Yes		Yes	Yes	Yes
Firm FE			Yes	Yes			Yes	Yes
Worker FE				Yes				Yes
N	23,441,331	23,441,331	23,408,044	22,584,310	28,449,288	28,449,288	28,372,955	27,578,607
R^2	0.10	0.11	0.54	0.83	0.02	0.03	0.52	0.81

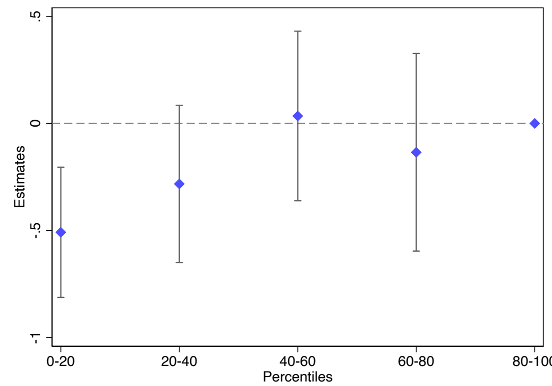
Notes: This table shows the worker-level wage effects of 1 pp increase in the monetary policy rate, as described in Equation 1. R_{t-1} is a lagged value of EONIA rate. SmallFirm_f is a dummy variable that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. $\text{YoungFirm}_{f,t-1}$ 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 1: Firm heterogeneities by quintiles

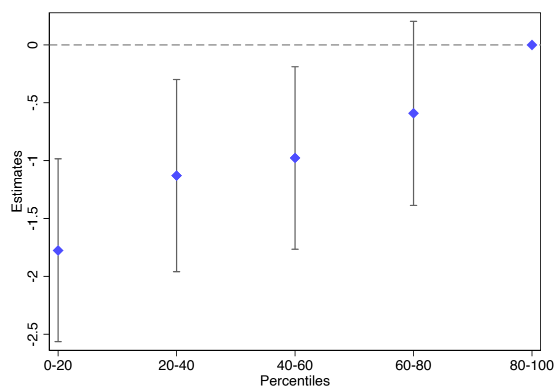
(a) Firm size



(b) Firm age



(c) Firm wage



Notes: This figure presents the redistributive wage effects of 1 pp increase in the monetary policy rate using firm heterogeneities. Each point represents a coefficient estimate from the Equation 1 with separate independent variables for each bin (quintile) of distribution ordered by firm size (Panel (a)), firm age (Panel (b)) and firm wages in $t-1$ (Panel (c)). The top quintile (p80–p100) is the reference (omitted) category. Standard errors are two-way clustered at the firm and worker level. Vertical lines denote 95% confidence intervals.

Table 3: Back-loaded wage mechanism and monetary policy

	log(wageHr$_{w,f,t}$)					
	Small Firms		Large Firms		Full sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Stayer$_{w,t-1}$ × R_{t-1}	-0.21***	-0.15*	0.17	0.45***	0.07	0.32*
	(0.068)	(0.077)	(0.263)	(0.170)	(0.256)	(0.170)
SmallFirm$_f$ × R_{t-1}					-0.71***	
					(0.269)	
SmallFirm$_f$× Stayer$_{w,t-1}$ × R_{t-1}					-0.45*	-0.58***
					(0.268)	(0.190)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	-	Yes	-	Yes	-
Firm FE	Yes	-	Yes	-	Yes	-
Firm-Time FE		Yes		Yes		Yes
N	9,462,425	8,560,216	7,503,550	7,503,269	17,146,584	16,247,310
R^2	0.82	0.88	0.86	0.88	0.85	0.88

Notes: This table shows how firms of different size share rents with their workers following a 1 pp increase in the monetary policy rate. R_{t-1} is a lagged value of EONIA rate. SmallFirm$_f$ is a dummy variable that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. Stayer$_{w,t-1}$ takes the value of 1 if the worker did not change the firm in the past year, and 0 otherwise. Controls denote additional variation of small firm and GDP and VIX, as well as the polynomial of worker's age (in line with Equation 1). 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, employment and hours worked

	$\log(1+\text{HrsWorked}_{w,f,t})$		$\log(\text{Employment}_{f,t})$			
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{SmallFirm}_f \times R_{t-1}$	-7.03***		-1.05***		-1.73***	
	(0.61)		(0.18)		(0.20)	
$\text{YoungFirm}_{f,t-1} \times R_{t-1}$		-2.87***		-2.11***		-2.16***
		(0.79)		(0.06)		(0.06)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	-	-
Worker FE	Yes	Yes	n/a	n/a	n/a	n/a
Industry-Time FE					Yes	Yes
Region-Time FE					Yes	Yes
N	26,919,089	36,078,494	3,349,200	3,421,880	3,349,189	3,421,856
R^2	0.27	0.25	0.87	0.88	0.87	0.89

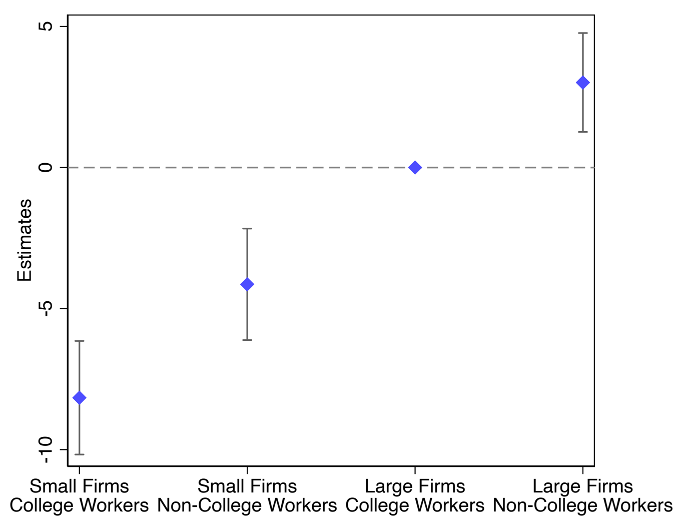
Notes: This table shows the worker-level hours worked effects (Equation 2) and firm-level employment effects (Equation 3) of 1 pp increase in the monetary policy rate. The outcome variable in Columns (1)–(2) denoted as log(1+HrsWorked) measures total hours worked by worker w in firm f in year t. It takes the value of 0 if the worker is unemployed and the reported hours if the worker is employed. The outcome variable in Columns (3)–(6) is $\log(\text{Employment}_{f,t})$ which denotes the log of the number of workers employed in firm f at time t. R_{t-1} is a lagged value of EONIA rate. 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, and in Columns (1)–(2) also the polynomial of worker's age. n/a stands for not applicable. Standard errors two-way clustered at the firm and worker level in Columns (1)–(2) and at the firm level in Columns (3)–(6). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Monetary policy and skill premium

	$\log(\text{wageHr}_{w,f,t})$		$\log(1 + \text{HrsWorked}_{w,f,t})$	
	(1)	(2)	(3)	(4)
$\text{College}_w \times \text{R}_{t-1}$	-1.14***		-2.70***	
	(0.103)		(0.353)	
$\text{STEM College}_w \times \text{R}_{t-1}$		-1.66***		-4.64***
		(0.113)		(0.351)
$\text{Other College}_w \times \text{R}_{t-1}$		-0.60***		-1.39***
		(0.087)		(0.474)
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes
N	22,452,141	22,452,141	30,433,138	30,433,138
R^2	0.82	0.82	0.25	0.25

Notes: This table shows the estimates of worker-level heterogeneity on wages and hours worked of 1 pp increase in the monetary policy rate, as described in Equations 1 and 2, respectively. R_{t-1} is a lagged value of EONIA rate. College_w 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 to 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. Controls denote additional variation of college variable(s) and GDP and VIX, as well as the polynomial of worker's age. Standard errors two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 2: Firm and worker heterogeneity



Notes: This figure presents the redistributive wage effects of 1 pp increase in the monetary policy rate using a combination of firm and worker heterogeneity. The outcome variable is log hours worked. Firms with fewer than 50 employees are denoted as Small Firms, and as Large Firms otherwise. Workers are denoted as College Workers if their highest educational attainment is at least a college degree. College educated workers in large firm are taken as the reference (omitted) category. Standard errors are two-way clustered at the firm and worker level. Vertical lines denote 95% confidence intervals.

Table 6: Monetary policy and investment

	Δ Capital$_{f,t}$/TA$_{f,t-1}$			
	(1)	(2)	(3)	(4)
SmallFirm$_f \times \Delta R_{t-1}$	-2.20***	-1.59***		
	(0.18)	(0.18)		
YoungFirm$_{f,t-1} \times \Delta R_{t-1}$			-1.20***	-1.10***
			(0.12)	(0.11)
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Firm FE		Yes		Yes
N	597,877	558,559	619,856	577,022
R^2	0.01	0.41	0.03	0.42

Notes: This table shows the estimates of the heterogeneous effects on monetary policy on firm-level investment of 1 pp increase in the monetary policy rate. The outcome variable as the year-on-year change in capital scaled to the lagged value of firm's total assets. SmallFirm$_f$ is a dummy that takes a value of 1 if the firm has fewer than 50 employees, and 0 otherwise. YoungFirm$_{f,t-1}$ is a dummy 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 clustered at the firm level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Importance of the credit channel

	log($\text{wageHr}_{w,f,t}$)			
	(1)	(2)	(3)	(4)
$\text{SmallFirm}_f\times \text{R}_{t-1}$	0.38	-0.97***		
	(0.69)	(0.22)		
$\text{SmallFirm}_f\times \text{R}_{t-1}\times \text{ExistCredit}_{f,t-1}$	-1.63***			
	(0.62)			
$\text{SmallFirm}_f\times \text{R}_{t-1}\times \text{Leverage}_{f,t-1}$		-1.34**		
		(0.66)		
$\text{YoungFirm}_{f,t-1}\times \text{R}_{t-1}$			1.70	-0.22**
			(1.12)	(0.11)
$\text{YoungFirm}_{f,t-1}\times \text{R}_{t-1}\times \text{ExistCredit}_{f,t-1}$			-2.10**	
			(0.88)	
$\text{YoungFirm}_{f,t-1}\times \text{R}_{t-1}\times \text{Leverage}_{f,t-1}$				-0.45**
				(0.19)
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
N	22,584,310	22,584,310	27,578,607	27,578,607
R^2	0.83	0.83	0.81	0.81

Notes: This table shows the worker-level wage effects of 1 pp increase in the monetary policy rate. We expand Equation 1 with additional interaction capturing the importance of bank credit. $\text{ExistCredit}_{f,t-1}$ takes the value of 1 if the firm has ever had an existing bank borrowing relationship, and 0 otherwise. Leverage denotes the ratio of firm bank debt to total assets in $t-1$. R_{t-1} is a lagged value of EONIA rate. 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. 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: Relationship between firm credit sensitivity to monetary policy rate and proxy variables

	FBC_f					
	(1)	(2)	(3)	(4)	(5)	(6)
Age_f	0.17***					
	(0.008)					
$\log(\text{TotalAssets}_f)$		0.27***				
		(0.061)				
$\log(\text{Employment}_f)$			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 $\text{FBC}_f = \alpha + \phi X_f + \epsilon_f$, where FBC_f denotes firm-balance sheet channel which is estimated as a 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 9: Labor income heterogeneity and credit channel

	$\log(\text{wageHr}_{w,f,t})$		
	(1)	(2)	(3)
$\text{FBC}_f \times R_{t-1}$	0.73***		
	(0.166)		
$\text{BLC}_{f,t-1}^{Health_{b,t}} \times R_{t-1}$		0.63***	
		(0.224)	
$\text{BLC}_{f,t-1}^{LiqAss_{b,t}} \times R_{t-1}$			2.03**
			(0.898)
Controls	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes
N	18,616,412	16,839,851	20,368,059
R^2	0.79	0.80	0.81

Notes: This table shows the coefficients from the credit channel analysis on wages following a 1 pp increase in the monetary policy rate. Column (1) reports the coefficients from the firm balance-sheet channel regression, as described in Equation 5. Columns (2) and (3) report the coefficients from bank lending channel regression, as described in Equation 7, using the credit-weighted firm-level exposure to the bank lending channel proxied by bank health and bank liquidity, respectively. R_{t-1} is a lagged value of EONIA rate. Controls denote additional variation of FBC/BLC measure with 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 10: Credit channel: employment and hours worked

	$\log(1 + \text{HrsWorked}_{w,f,t})$			$\log(\text{Employment}_{f,t})$		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{FBC}_f \times R_{t-1}$	2.39***			4.24***		
	(0.70)			(0.11)		
$\text{BLC}^{Health_{b,t}}_{f,t-1} \times R_{t-1}$		2.05***			0.48***	
		(0.64)			(0.14)	
$\text{BLC}^{LiqAss_{b,t}}_{f,t-1} \times R_{t-1}$			17.16***			3.31***
			(5.42)			(0.93)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes.	-	-	-
Worker FE	Yes	Yes	Yes	n/a	n/a	n/a
Industry-Time FE				Yes	Yes	Yes
Region-Time FE				Yes	Yes	Yes
N	22,066,437	19,809,002	23,982,931	1,085,741	1,121,503	1,562,454
R^2	0.26	0.27	0.27	0.91	0.90	0.89

Notes: This table shows the coefficients from the credit channel analysis on hours worked and employment following a 1 pp increase in the monetary policy rate. Column (1) reports the coefficients from the firm balance-sheet channel regression, as described in Equation 5. Columns (2) and (3) report the coefficients from bank lending channel regression,as described in Equation 7, using the credit-weighted firm-level exposure to the bank lending channel proxied by bank health and liquidity, respectively. Columns (4)–(6) repeat the estimation on firm-level employment. R_{t-1} is a lagged value of EONIA rate. Controls denote additional variation of FBC/BLC measure with GDP and VIX, as well as the polynomial of worker's age. n/a stands for not applicable. Standard errors are two-way clustered at the firm and worker level in Columns (1)–(3), and at firm level in Columns (4)–(6). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Heterogeneity of monetary policy in crisis times

	$\log(\text{wageHr}_{w,f,t})$				$\log(1 + \text{HrsWorked}_{w,f,t})$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{SmallFirm}_f \times R_{t-1}$	-1.56***				-1.07***			
	(0.210)				(0.81)			
$\text{SmallFirm}_f \times R_{t-1} \times \Delta\text{GDP}_{t-1}$	27.55***				262.58***			
	(4.96)				(24.27)			
$\text{YoungFirm}_{f,t-1} \times R_{t-1}$		-0.73***				-7.00***		
		(0.138)				(1.06)		
$\text{YoungFirm}_{f,t-1} \times R_{t-1} \times \Delta\text{GDP}_{t-1}$		19.00***				255.38***		
		(3.81)				(28.06)		
$\text{FBC}_f \times R_{t-1}$			0.78***				3.34***	
			(0.202)				(0.953)	
$\text{FBC}_f \times R_{t-1} \times \Delta\text{GDP}_{t-1}$			-7.83**				-64.25**	
			(3.80)				(30.951)	
$\text{BLC}^{Health_b}_{f,t-1} \times R_{t-1}$				0.61***				3.51***
				(0.18)				(0.09)
$\text{BLC}^{Health_b}_{f,t-1} \times R_{t-1} \times \Delta\text{GDP}_{t-1}$				-10.34***				-115.32***
				(5.01)				(8.52)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,584,310	27,578,607	18,608,550	15,486,418	26,919,135	36,078,494	22,066,437	19,809,002
R^2	0.83	0.82	0.79	0.83	0.27	0.25	0.26	0.26

Notes: This table summarized the state-dependent effects of 1 pp increase in the monetary policy rate on labor income redistribution. SmalFirm_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. FBC_f denotes the firm balance-sheet channel measure, as described in Equation 5. We proxy for the state of the economy with domestic GDP growth denoted as ΔGDP_{t-1}. R_{t-1} is a lagged value of EONIA rate. 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Online Appendix

Monetary Policy, Labor Income Redistribution and the Credit Channel: Evidence from Matched Employer-Employee and Credit Registers

A Additional Figures and Tables

Table A1: Monetary policy, economic conditions and wage dynamics

	$\log(\text{wageHr}_{w,f,t})$			$\log(1{+}\text{HrsWorked}_{w,f,t})$		
	(1)	(2)	(3)	(4)	(5)	(6)
R_{t-1}	-5.51***	-4.44***	-4.68***	-3.70***	-4.00***	-3.00***
	(0.166)	(0.089)	(0.072)	(0.218)	(0.214)	(0.223)
ΔGDP_{t-1}	0.51***	0.46***	0.40***	3.69***	3.87***	3.76***
	(0.043)	(0.026)	(0.024)	(0.126)	(0.127)	(0.123)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes		Yes	Yes
Worker FE			Yes			Yes
N	28,779,857	28,702,159	27,907,080	36,834,680	36,815,735	36,776,921
R^2	0.01	0.52	0.81	0.001	0.11	0.24

Notes: This table shows the coefficients from worker-level wage and hours worked sensitivity of wages to a 1 pp increase in the monetary policy rate. R_{t-1} is a lagged value of EONIA rate. ΔGDP_{t-1} denotes lagged values of the Portuguese GDP growth. Controls denote the polynomial of worker's age. Standard errors are two-way clustered at the firm and worker level. *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A2: Firm heterogeneity robustness: small and young firms

	log(wageHr)$_{w,f,t}$						
		Baseline			Baseline		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SmallFirm$_f \times$ R$_{t-1}$	-1.11***	-1.16***	-1.15***	-1.08***			
	(0.163)	(0.163)	(0.149)	(0.118)			
YoungFirm$_{f,t-1} \times$ R$_{t-1}$	-0.25**				-0.40***	-0.36***	-0.32***
	(0.113)				(0.118)	(0.109)	(0.094)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	-	-	Yes	-	-
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-Time FE			Yes	-		Yes	-
Region-Time FE			Yes	-		Yes	-
Sector-Region-Time FE				Yes			Yes
N	22,325,965	22,584,310	22,584,272	22,583,423	27,578,607	27,578,577	27,577,770
R^2	0.83	0.83	0.83	0.83	0.81	0.82	0.82

Notes: This table shows the robustness to the worker-level wage effects of 1 pp increase in the monetary policy rate, as described in Equation 1. R_{t-1} is a lagged value of EONIA rate. 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. 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 A3: Firm heterogeneity: small vs large firms and sample cutoffs

	$\log(\text{wageHr}_{w,f,t})$		
	Baseline	p10 cutoff	p25 cutoff
	(1)	(2)	(3)
$\text{SmallFirm}_f \times R_{t-1}$	-1.16***	-1.10***	-1.04***
	(0.163)	(0.169)	(0.169)
Controls	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes
N	22,584,310	21,151,715	18,569,410
R^2	0.83	0.83	0.83

Notes: This table shows the robustness to the worker-level wage effects of 1 pp increase in the monetary policy rate, as described in Equation 1. From the baseline sample in Column (1), we eliminate firms below the 10th and 25th percentile of employment, respectively. R_{t-1} is a lagged value of EONIA rate. 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 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 A4: Wage gap between firms

	$\log(\text{wageHr}_{w,f,t})$					
	(1)	(2)	(3)	(4)	(5)	(6)
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)
Sector-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Region-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Job Title FE		Yes	-		Yes	-
Job Title-Time FE			Yes			Yes
N	23,441,303	23,441,263	23,440,268	28,449,265	28,449,230	28,448,302
R^2	0.31	0.51	0.51	0.27	0.48	0.48

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. Standard errors are two-way clustered at the firm and worker level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Monetary policy, wages and firm heterogeneity: persistence over time

	$\log(\text{wageHr}_{w,f,\ldots})$							
	t	t+1	t+2	t+3	t	t+1	t+2	t+3
	Baseline				Baseline			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{SmallFirm}_f \times R_{t-1}$	-1.16***	-0.57***	-0.51***	-0.31**				
	(0.163)	(0.134)	(0.117)	(0.128)				
$\text{YoungFirm}_{f,t-1} \times R_{t-1}$					-0.40***	-0.16***	-0.13***	-0.22**
					(0.118)	(0.091)	(0.085)	(0.097)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,584,310	22,584,310	22,584,310	22,584,310	27,578,607	27,578,607	27,578,607	27,578,607
R^2	0.83	0.83	0.83	0.83	0.81	0.81	0.81	0.81

Notes: This table shows the persistence of the worker-level wage effects of 1 pp increase in the monetary policy rate, expanding Equation 1 with additional lags. R_{t-1} is a lagged value of EONIA rate. 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 A6: Monetary policy and skill premium: Robustness

	$\log(\text{wageHr}_{w,f,t})$		
	Baseline		
	(1)	(2)	(3)
$\text{College}_w \times \text{R}_{t-1}$	-1.14***		-1.16***
	(0.103)		(0.053)
$\text{College}_{w,t-1} \times \text{R}_{t-1}$		-1.16***	
		(0.103)	
Controls	Yes	Yes	Yes
Time FE	Yes	Yes	-
Firm FE	Yes	Yes	-
Worker FE	Yes	Yes	-
Firm-Time FE			Yes
N	22,452,141	22,452,141	21,401,785
R^2	0.82	0.82	0.85

Notes: This table shows the robustness to worker-level heterogeneity analysis on wages following a 1 pp increase in the monetary policy rate. R_{t-1} is a lagged value of EONIA rate. 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. In the robustness, 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. Controls denote additional variation of the respective college measure and GDP and VIX, as well as the polynomial of worker's age. Standard errors 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 5.1 of the paper, 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:

$$\log(\text{credit}_{f,b,t}) = \kappa_{b,t} + \kappa_{f,t} + \beta_{f,b} R_{t-1} + \gamma_{f,b} GDP_{t-1} + \epsilon_{f,b,t}. \tag{B1}$$

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

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

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 sector-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:

$$\log(\text{wage}_{w,f,t}) = \alpha_t + \alpha_w + \alpha_f + \theta(\overline{\text{FBC}}_f \times R_{t-1}) + \zeta \text{C}_{w,t-1} + \epsilon_{w,f,t}. \tag{B3}$$

The results are presented in Online Appendix Table B1. 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.

Table B1: Firm-balance sheet credit channel robustness

	$\log(\text{wageHr}_{w,f,t})$	
	Baseline	Robustness
	(1)	(2)
$\text{FBC}_f \times R_{t-1}$	0.73***	
	(0.166)	
$\overline{\text{FBC}}_f \times R_{t-1}$		0.35***
		(0.123)
Controls	Yes	Yes
Time FE	Yes	Yes
Firm FE	Yes	Yes
Worker FE	Yes	Yes
N	18,616,412	12,625,965
R^2	0.79	0.80

Notes: This table shows the robustness to the firm balance-sheet channel analysis on wages following a 1 pp increase in the monetary policy rate. Column (1) reports the firm-balance sheet channel coefficients from the baseline estimates regression, as described in Equation 5. Column (2) reports estimates using the alternative approach presented in Online Appendix B. R_{t-1} is a lagged value of EONIA rate. Controls denote additional variation of the respective FBC measure 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 B2: Credit channel robustness

	log(wageHr$_{w,f,t}$)			
	(1)	(2)	(3)	(4)
$FBC_f \times R_{t-1}$	0.68***	0.77***		0.73***
	(0.196)	(0.175)		(0.196)
$BLC_{f,t-1}^{Health_{b,t}} \times R_{t-1}$	0.68***		0.66***	0.68***
	(0.220)		(0.224)	(0.220)
$BLC_{f,t-1}^{LiqAss_{b,t}} \times R_{t-1}$		1.91**	1.77*	1.71*
		(0.819)	(0.966)	(0.954)
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes
N	15,995,108	17,721,545	15,896,614	15,756,204
R^2	0.80	0.80	0.80	0.80

Notes: This table shows the robustness to the the credit channel analysis on wages following a 1 pp increase in the monetary policy rate. FBC$_f$ denotes the firm balance-sheet channel measure, as described in Equation 5. BLC$_{f,t-1}$ denote the bank lending channel measures (as described in Equation 7) using the credit-weighted firm-level exposure to the bank lending channel proxied by bank health and liquidity, respectively. R_{t-1} is a lagged value of EONIA rate. Controls denote additional variation of the FBC/BLC measure 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C Robustness to different measures of monetary policy

As detailed in Section 7, this Appendix demonstrates that our results are robust alternative measures of monetary policy conditions. We re-estimate both the wage and hours worked analyses and report the results for small/young firm heterogeneity and credit channel in Tables C1 and C2, respectively.

Table C1: Firm heterogeneity and its robustness to different measures of monetary policy

Panel (a): Wages	log(wageHr$_{w,f,t}$)					
	Macro controls		Shadow rates		MP surprises	
	(1)	(2)	(3)	(4)	(5)	(6)
SmallFirm$_f$ $\times$ R_{t-1}	-1.00***		-1.12***		-15.96***	
	(0.153)		(0.147)		(1.582)	
YoungFirm$_{f,t-1}$ $\times$ R_{t-1}		-0.37***		-0.42***		-7.09***
		(0.116)		(0.099)		(1.358)
Controls	Yes‡	Yes‡	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	22,584,310	27,578,607	22,584,310	27,578,607	22,584,310	27,578,607
R^2	0.83	0.82	0.83	0.82	0.83	0.82

Panel (b): Total hours worked	log(1 + HrsWorked$_{w,f,t}$)					
	Macro controls		Shadow rates		MP surprises	
	(1)	(2)	(3)	(4)	(5)	(6)
SmallFirm$_f$ $\times$ R_{t-1}	-8.47***		-7.63***		-53.66***	
	(0.672)		(0.564)		(5.831)	
YoungFirm$_{f,t-1}$ $\times$ R_{t-1}		-4.12***		-4.36***		-47.79***
		(0.755)		(0.662)		(9.183)
Controls	Yes‡	Yes‡	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	26,919,089	36,078,494	26,919,089	36,078,494	26,919,089	36,078,494
R^2	0.27	0.25	0.27	0.25	0.27	0.25

Notes: This table shows the robustness to the the worker-level wage analysis of 1 pp increase in the monetary policy rate, as described in Equations 1 and 2 for Panel (a) and (b), respectively. R_{t-1} denotes different measures of monetary policy: Columns (1) and (2) use the baseline EONIA rate but in addition to our baseline macro controls (GDP growth in Portugal and the VIX), we also controls for lagged values of EA GDP growth and inflation (denoted with ‡). Columns (3) and (4) use shadow rate computed by Wu and Xia (2016), and Columns (5) and (6) rely on the index of monetary policy surprises computed by 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. Young Firm$_{f,t-1}$ is a dummy 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 C2: Credit channel and its robustness to different measures of monetary policy

Panel (a): Wages

	$\log(\text{wageHr}_{w,f,t})$					
	Macro controls		Shadow rates		MP surprises	
	(1)	(2)	(3)	(4)	(5)	(6)
$FBC_f \times R_{t-1}$	0.70***		0.68***		6.79***	
	(0.16)		(0.15)		(1.85)	
$BLC^{Health}_{f,t-1} \times R_{t-1}$		0.59**		0.56***		5.43**
		(0.21)		(0.19)		(2.55)
Controls	Yes‡	Yes‡	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	18,616,412	16,839,851	18,616,412	16,839,851	18,616,412	16,839,851
R^2	0.79	0.80	0.79	0.80	0.79	0.80

Panel (b): Total hours worked

	$\log(1+ \text{HrsWorked}_{w,f,t})$					
	Macro controls		Shadow rates		MP surprises	
	(1)	(2)	(3)	(4)	(5)	(6)
$FBC_f \times R_{t-1}$	2.91***		2.62***		19.82***	
	(0.08)		(0.66)		(7.52)	
$BLC^{Health_b}_{f,t-1} \times R_{t-1}$		3.61***		2.71***		23.12**
		(0.16)		(0.88)		(11.19)
Controls	Yes‡	Yes‡	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	22,066,437	19,809,002	22,066,437	19,809,002	22,066,437	19,809,002
R^2	0.26	0.27	0.26	0.27	0.26	0.27

Notes: This table shows the robustness to the the worker-level wage analysis of 1 pp increase in the monetary policy rate, as described in Equations 1 and 2 for Panel (a) and (b), respectively. R_{t-1} denotes different measures of monetary policy: Columns (1) and (2) use the baseline EONIA rate but in addition to our baseline macro controls (GDP growth in Portugal and the VIX), we also controls for lagged values of EA GDP growth and inflation (denoted with ‡). Columns (3) and (4) use shadow rate computed by Wu and Xia (2016), and Columns (5) and (6) rely on the index of monetary policy surprises computed by Jarocinski and Karadi (2020). FBC_f denotes the firm balance-sheet channel measure, as described in Equation 5. $\text{BLC}^{Health_b}_{f,t-1}$ denotes the bank lending channel measure, as described in Equation 7, using the credit-weighted firm-level exposure to the bank lending channel proxied by bank health. Controls denote additional variation of the FBC/BLC measure 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.