CATÓLICA LISBON
BUSINESS & ECONOMICS

# Monetary Policy and Wages – Evidence from the Portuguese Labor Market

Manuel Costa

Dissertation written under the supervision of Professor Hugo Reis.

Dissertation submitted in partial fulfilment of requirements for the MSc in Economics – Major in Banking and Finance, at the Universidade Católica Portuguesa, March 2025.

# Monetary Policy and Wages 3 Evidence from the Portuguese Labor Market

Manuel Filipe Ferreira Costa

## Abstract

This paper examines the impact of monetary policy on wage dynamics in Portugal, focusing on firm heterogeneity, financial constraints, and skill premium effects. Using matched employeremployee and firm financial data from 2004 to 2022, I analyze how monetary easing influences wage distribution across different firms and workers. The sample is divided between conventional monetary policy (2004 3 2013) and unconventional monetary policy (2014 3 2022) to assess differences in transmission mechanisms.

The findings indicate that monetary easing leads to stronger wage growth, particularly in small and young firms, which are typically financially constrained. Furthermore, I document a rise in the skill premium, as wage gains are more pronounced for high-skilled workers than for lowskilled workers. Additionally, I find evidence of a back-loaded wage mechanism, where firms prioritize wage increases for long-term employees during expansionary periods.

These results highlight the central role of financial constraints in shaping wage-setting behavior and the uneven distributional effects of monetary policy. The findings have important policy implications, particularly in balancing support for financially constrained firms with concerns about inflationary pressures on real wages. Importantly, the analysis employs Shadow Rates to capture the effects of both conventional and unconventional monetary policy, providing a robust framework for assessing policy transmission in a heterogeneous firm environment.

Keywords: Monetary Policy, Wages, Shadow Rate, EONIA, Small Firm, Young Firm, Financial Constraints, Skill Premium.

# Política Monetária e Salários 3 Evidência do Mercado de Trabalho Português

Manuel Filipe Ferreira Costa

## Abstrato

Este artigo examina o impacto da política monetária na dinâmica salarial em Portugal, com foco na heterogeneidade das empresas, nas restrições financeiras e nos efeitos do prémio de qualificações. Utilizando dados combinados de empregadores e empregados, bem como registos financeiros das empresas entre 2004 e 2022, analiso de que forma o acomodamento da política monetária influencia a distribuição salarial entre diferentes empresas e trabalhadores, distinguindo política monetária convencional (2004 3 2013) e política monetária não convencional (2014 3 2022) para avaliar as diferenças nos mecanismos de transmissão.

Os resultados indicam que a descida das taxas de juro conduz a um maior crescimento salarial, especialmente em empresas pequenas e jovens, tipicamente com finanças mais restritas. Seguidamente, documento um aumento no prémio de qualificações, uma vez que os ganhos salariais são mais acentuados para trabalhadores altamente qualificados do que para trabalhadores menos qualificados. Além disso, são encontradas evidências de um mecanismo de progressão salarial diferida, no qual as empresas priorizam aumentos salariais para empregados de longo prazo, especialmente durante períodos expansionistas.

Estes resultados destacam o papel central das restrições financeiras na definição dos salários e os efeitos distributivos desiguais da política monetária. As conclusões apresentam importantes implicações políticas, nomeadamente no equilíbrio entre o apoio às empresas financeiramente restringidas e as preocupações com as pressões inflacionistas sobre os salários reais. Importa salientar que a nossa análise recorre a Taxas Sombra para captar os efeitos da política monetária convencional e não convencional, proporcionando um quadro robusto para avaliar a transmissão da política num ambiente empresarial heterogéneo.

Palavras-chave: Política Monetária, Salários, Taxa Sombra, EONIA, Pequenas Empresas, Jovens Empresas, Dificuldades Financeiras, Prémio de Qualificações.

**Acknowledgements**

This thesis is the end result of seven months of work, between reviewing literature, collecting data and analysing results. I would like to express my gratitude to Professor Hugo Reis, my supervisor, who kindly gave me the support I needed to carry out the study, and to Professor Nuno Alves, who enthusiastically taught Monetary Policy every Friday evening during the first semester of my master's degree.

In this section, I would also like to thank my parents, who have worked hard for years, in every way, to ensure that one day I would be happy while achieving my dreams, and my brother, who cares so much about me and for whom I will always want to be an example.

This journey would not have been the same without the daily support of my girlfriend, whom I met on this programme. May we always be able to complement each other in life as we did in this master's programme.

Table of Contents

**Figure Index**



**Table index**



**Table appendix index**

**Figure appendix index**

# 1. Introduction

Monetary policy plays a pivotal role in shaping economic outcomes, particularly by influencing interest rates, liquidity, and labor market dynamics. In recent years, central banks have increasingly relied on unprecedented measures to stabilize economies. From the early 2000s through the Global Financial Crisis (GFC) of 2008 – 2009 and its aftermath, central banks implemented aggressive interventions, including unconventional monetary policies such as quantitative easing (QE), to combat severe economic downturns. While these policies were effective in facilitating recovery, they also raised concerns about their potential unintended consequences, particularly in how they impact different segments of the labor market.

Portugal's economy has undergone significant economic cycles over the past two decades, influenced by both domestic and international factors. Following a period of stable growth in the early 2000s, the country was severely impacted by the European sovereign debt crisis of 2010 – 2014, which led to a deep recession and necessitated a bailout from the International Monetary Fund, European Union and European Commission (Troika). The subsequent years saw a period of economic recovery, supported by structural reforms, an improving labor market, and accommodative monetary policy by the European Central Bank (ECB). However, the COVID-19 pandemic in 2020 brought another sharp contraction, which was met with extensive fiscal and monetary interventions to support firms and households.

Using detailed data spanning 2004 – 2022, this thesis examines how monetary policy influences wage dynamics, focusing on the mediating role of firm heterogeneity based on size, age, and financial constraints. The analysis is conducted using a rich dataset combining employeremployee records with firm-level financial information from Portugal. This allows for a granular exploration of the interactions between firms' financial characteristics and workerlevel outcomes, offering a holistic perspective on the wage effects of monetary policy. Furthermore, this thesis subdivides the dataset into two distinct economic periods: first, the period of conventional monetary policy (2004 – 2013) and second, the period of unconventional monetary policy (2014 – 2022), providing a comprehensive view of the different effects of both types of monetary policy on wages. This distinction is one of the strengths of this work, as it captures the dynamics of wage formation during periods of economic instability and recovery.

Previous studies, such as Jasova et al. (2021), emphasise the importance of firm size and age in shaping wage responses to monetary policy. This thesis builds on that foundation, delving deeper into the mechanisms through which financial constraints amplify small and young firms'

sensitivity to monetary changes. Furthermore, a key strength of this research is the inclusion of Shadow Rates — a tool that captures both unconventional and conventional monetary policy. Alongside Shadow Rates, for robustness, this study utilises the EONIA rate (applied in Jasova et al. (2021)), which captures only traditional monetary policy. Unlike conventional rates, the Shadow Rate accounts for the impact of non-standard measures like QE, offering a fuller understanding of monetary policy effects, which is particularly relevant in the post-2014 period, when central banks increasingly relied on unconventional measures.

The findings of this research reveal several key insights. First, monetary policy has a significant influence on wage dynamics, with small and young firms being particularly sensitive to changes in interest rates. Small firms, for example, experience greater wage increases in response to monetary easing compared to larger firms, while young firms show similar but less pronounced patterns. Second, unconventional monetary policy measures such as QE, as captured through Shadow Rates, exhibited distinct effects on wages compared to traditional interest rate tools, benefiting disproportionately, on average, small and young firms. Third, this study does not find sufficient evidence to state that highly indebted small and young firms are more affected by monetary policy than less indebted small and young firms. Fourth, the coefficients associated with the Shadow Rate in each regression analysis are lower than those of the EONIA rate, which is likely due to the Shadow Rate capturing a more moderate and realistic effect.

Moreover, the analysis demonstrates that monetary policy differentially affects high and lowskilled workers. Following a reduction in interest rates, college-educated workers experience larger wage gains compared to workers with lower education.

This thesis contributes to the literature by extending the analysis of Jasova et al. (2021) to include the period spanning 2014 – 2022, capturing the unique monetary environment dominated by unconventional policies. Furthermore, it introduces firm indebtedness as a mediating variable, shedding light on how financial constraints affect wage responses to monetary shocks. By interacting firm size and age with financial ratios such as Obtained Financing / Assets and Liabilities / Assets, the analysis offers new insights into the mechanisms through which monetary policy influences wages in different types of firms.

This thesis also accounts for the COVID-19 impact, showing that the results remain robust even after removing the years 2020, 2021, and 2022 from the analysis.

In summary, this study provides novel insights into the distributional effects of monetary policy on wages, highlighting the crucial role of firm heterogeneity and financial constraints. By

capturing both conventional and unconventional monetary environments, it offers a comprehensive perspective on how monetary policy shapes wage dynamics and inequality.

The thesis will proceed as follows: I start with a summary of the main related-literature articles in chapter 2, followed by an explain the process of collection and treatment of the data in chapter 3. Then, I describe the main variables of interest in chapter 4 and analyze the macroeconomic context in chapter 5. The results are presented in chapters 6 – 10: chapter 6 – analysis of the baseline effect of monetary policy on wages, chapter 7: analysis of the interaction between firm heterogeneity and monetary policy on wages, chapter 8: analysis of the mediating role of firm indebtedness, chapter 9: analysis of the interaction of monetary policy with skill premium and chapter 10: analysis of the back-loaded wage mechanism. Finally, I conclude in chapter 11.

# 2. Literature Review

## 2.1. Monetary policy and wage formation

The relationship between monetary policy and wage formation has been explored extensively in economic literature. A significant body of work focuses on the interaction between monetary policy and wage-setting processes. Detken and Gärtner (1992) employ a game-theory approach to examine the strategic interaction between labor unions and governments. Their analysis reveals that labor unions adjust wages in response to inflationary pressures, which can influence both unemployment and output. This adjustment process, while sometimes limiting the effectiveness of monetary policy, does not entirely nullify its effects.

Gylfason and Lindbeck (1992) further developed this line of inquiry by focusing on the interaction between monetary policy and wage formation in economies with strong labor unions. Using game theory, they demonstrated that labor unions, as utility-maximizers, adjust nominal wages in response to changes in prices following monetary policy shifts. They found that the effectiveness of monetary policy is often circumscribed by the unions' optimal wage responses, although it is not necessarily nullified. The authors also highlighted how the interplay between governments and labor unions can create persistent inflation and unemployment. This strategic interaction between unions and monetary authorities has important implications for how real wages respond to monetary expansions or contractions, especially in economies with robust collective bargaining frameworks.

Guiso, Pistaferri, and Schivardi (2012) contribute to this body of work by examining how firms' productivity shocks influence wage-setting processes. They argue that idiosyncratic productivity shocks at the firm level are a significant determinant of wage heterogeneity, as firms with higher productivity levels tend to offer higher wages. Their analysis also highlights how firm-level characteristics interact with broader macroeconomic factors, such as monetary policy, to shape wage dynamics. This finding complements existing research on how labor unions and governments interact by introducing a microeconomic lens, emphasizing the role of firm-level shocks in shaping aggregate wage outcomes.

In a more contemporary analysis, Auclert (2019) contributes to this discussion by highlighting the importance of the redistribution channel of monetary policy. Auclert argues that monetary policy affects not only aggregate demand but also the redistribution of income between borrowers and savers, particularly through changes in interest payments. This redistribution can amplify or dampen the consumption responses of different economic agents, thereby

influencing broader economic outcomes, including wage dynamics. For instance, low-wage earners who are more likely to be net borrowers might benefit temporarily from lower interest rates, but this effect could be offset if higher asset prices disproportionately benefit wealthier households.

Jiménez et al. (2012) provide additional insights into the interaction between monetary policy and firm behavior, particularly through the risk-taking channel. They demonstrate that a reduction in short-term interest rates incentivizes low-capitalized banks to extend credit to riskier borrowers, particularly firms with weaker credit histories. This behavior increases both the volume of credit extended and the likelihood of default, highlighting the compositional shifts in credit supply induced by monetary easing. These findings introduce a critical perspective on how monetary policy can influence firm-level decisions, which in turn, indirectly affect labor markets and wage outcomes.

### 2.2. Wage rigidity and timing

Research has also explored the timing of wage adjustments in response to monetary shocks. Jasova et al. (2021) examine wage-setting patterns across different economies and highlight how these patterns influence the transmission of monetary policy shocks. In countries like Japan, where wage negotiations are synchronized (as in the annual "Shunto" negotiations), wage rigidity is pronounced at certain times of the year. This temporal rigidity can affect the economy's response to monetary shocks depending on when they occur. In contrast, countries like France and Germany, where wage decisions are spread throughout the year, exhibit more consistent responses to monetary policy changes.

These studies suggest that the structure of wage negotiations and the timing of wage adjustments are critical in determining the impact of monetary policy on wages and employment.

### 2.3. Firm balance sheets and wage responses

While much of the literature has concentrated on the timing of wage-setting or the strategic interaction between labor and government, this study adopts a different approach by examining how firms' heterogeneity – based on financial health, size and age – mediates the effects of monetary policy on wages. Following this, Ippolito et al. (2018) proved that firms with higher debt-to-asset ratios are likely to be more sensitive to changes in interest rates, as lower borrowing costs could free up resources that could be allocated to wage increases. On the other hand, highly levered firms may choose to use interest savings to strengthen their balance sheets rather than increase wages.

Guiso, Pistaferri, and Schivardi (2012) also provide relevant insights here by showing that firms with greater financial flexibility tend to pass productivity gains to workers in the form of higher wages. In contrast, firms facing financial constraints may prioritize strengthening their balance sheets or meeting debt obligations, limiting the scope for wage increases. This dynamic is particularly relevant in understanding how monetary policy-induced changes in interest rates influence wage-setting, especially in firms with varying levels of financial leverage.

Building on this, Jiménez et al. (2012) emphasize how changes in credit risk-taking by banks during periods of monetary easing can disproportionately affect riskier firms. As we have seen before, the study reveals that monetary policy-induced reductions in short-term interest rates increase both loan approvals and credit volumes for riskier firms, particularly those serviced by lowly capitalized banks. While this does not directly address wages, the expanded credit supply to riskier firms has implications for firm-level employment decisions and resource allocation, potentially influencing wage dynamics indirectly.

Similarly, Jasova et al. (2021) focus on the credit channel and found that expansionary monetary policy tends to benefit younger workers and small firms, increasing wages and hours worked. To finalize, one cannot fully understand wage dynamics in any environment without comprehending the concept of back-loaded wage mechanisms. Analyzing data from 1999 to 2013, the authors confirm that through their lifetime, firms indirectly borrow from workers by delaying compensation acts for workers that stay in the firm, which is consistent with their finding that size and wages are positively correlated.

### 2.4. Income inequality and expansionary monetary policy

While expansionary monetary policies, characterized by low interest rates and increased liquidity, are often designed to stimulate economic growth, they are not immune to redistributive consequences. According to the Bank for International Settlements (BIS, 2021), maintaining low interest rates over extended periods has led to asset price inflation, disproportionately benefiting wealthier households who hold financial assets. In contrast, lower-income wage earners often experience slower wage growth due to wage rigidity, which exacerbates income inequality.

Auclert's (2019) study further contributes to this debate by proposing that the redistribution effects of monetary policy are crucial in understanding its full impact on income inequality.

Auclert highlights how households with different financial profiles – borrowers versus savers – respond differently to changes in interest rates. Borrowers, who tend to have lower incomes,

may benefit from lower interest payments, but this benefit may be outweighed by the inflationary impact on essential goods and stagnant wages. Conversely, savers, who are generally wealthier, benefit from rising asset prices during periods of expansionary monetary policy, contributing to the widening of income inequality.

Jiménez et al. (2012) further add to this understanding by emphasizing how monetary policy shapes the composition of credit supply, disproportionately benefitting riskier firms. This compositional shift not only has implications for financial stability but also for income distribution, as riskier firms are more likely to employ low-wage workers or workers in precarious positions.

# 3. Data

I utilize a granular dataset that combines employer-employee information with firm-level financial data for Portugal. This integrated dataset allows us to examine the interplay between firms' financial characteristics and worker-level outcomes. The analysis focuses on the period spanning 2004 and 2022, which encompasses key economic and monetary cycles in Portugal. As previously mentioned, I will subdivide the sample in two periods (2004 to 2013 and 2014 to 2022) and remove the COVID-19 effect (2020, 2021 and 2022) from the second period, for robustness. The table A1 in the appendix describes all the variables that composed my dataset.

### 3.1. Employer – employee Data

The **Quadros de Pessoal (QP)** dataset, collected by the Portuguese Ministry of Labor, Social Solidarity, and Social Security, provides a detailed account of all private sector employees in Portugal. It includes firms with at least one paid employee and offers rich information on both the employer and employee sides. Its key worker-level variables include education, gender, regular monthly salary, wage supplements, hours worked, length of service in the firm and age. On the firm side, we observe industry classification, geographic region, founding year, number of employees and annual sales.

This dataset enables the tracking of workers over time as they transition between firms and sectors, providing a dynamic view of labor market movements.

### 3.2. Firm financial data

To supplement the employer-employee data, I incorporate firm-level financial data from the **IES** dataset, which includes annual financial statements for firms in Portugal. This dataset offers detailed information on balance sheet and income statement variables such as total assets, total liabilities, revenue, and obtained financing.

The two datasets QP and IES were linked using common identifiers, specifically Year and Firm ID, to construct the combined employer-employee dataset.

### 3.3. Macroeconomic data

To complement the QP and IES datasets, macroeconomic indicators were incorporated from external sources. These include the Euro Overnight Index Average (**EONIA**) rate from the European Central Bank (ECB), the **Shadow Rate** from Jing Cynthia Wu's website, Portugal economy GDP and GDP growth rates from the Portuguese National Institute of Statistics (INE), and the Index of Volatility (VIX) for the U.S. economy, sourced from the World Bank.

## 4. *Descriptive statistics*

The descriptive statistics presented on Table 1 for the period between 2004 and 2022 allow us to define the macroeconomic context of Portugal, contextualized within the broader global economy, in the period of analysis.

| Table 1 - Descriptive statistics | *2004 – 2022*[1] | | *2004 – 2013*[2] | | *2014 – 2022*[3] | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| **Dependent variable:** | | | | | | |
| Log (Real Hourly Wage) (euros) | 1.34 | 0.56 | 1.30 | 0.59 | 1.39 | 0.53 |
| **Monetary policy variables:** | | | | | | |
| EONIA Rate (%) | 0.78 | 1.44 | 1.78 | 1.45 | -0.26 | 0.22 |
| Shadow Rate (%) | -1.45 | 3.66 | 1.47 | 1.68 | -4.69 | 2.14 |
| **Macroeconomic variables:** | | | | | | |
| Real GDP growth (%) | 0.86 | 3.44 | -0.12 | 2.26 | 1.96 | 4.28 |
| Volatility Index – US economy | 19.26 | 6.53 | 20.16 | 7.34 | 18.26 | 5.75 |
| **Firm level heterogeneity:** | | | | | | |
| Firm age (years) | 23.91 | 23.08 | 22.20 | 22.83 | 25.70 | 23.20 |
| Obtained Financing (million euros) | 37.3 | 348 | 42.8 | 416 | 35.1 | 317 |
| Liabilities (million euros) | 106 | 581 | 102 | 548 | 111 | 613 |
| Assets (euros) | 151 | 849 | 173 | 1090 | 141 | 732 |
| Obtained Financing / Assets (%) | 19.18 | - | 17.59 | - | 19.81 | - |
| Liabilities / Assets (%) | 95.65 | - | 89.42 | - | 98.16 | - |
| Small Firm (%) | 40.74 | - | 38.06 | - | 43.56 | - |
| Young Firm (%) | 14.37 | - | 16.31 | - | 12.34 | - |
| **Worker level heterogeneity:** | | | | | | |
| Employee age (years) | 39.60 | 10.84 | 38.49 | 10.62 | 40.77 | 10.95 |
| College education (%) | 17.38 | - | 13.79 | - | 21.16 | - |
| Stayer (%) | 75.28 | - | 71.74 | - | 79.01 | - |
| Female (%) | 44.91 | - | 43.84 | - | 46.03 | - |
| **Other variables of interest:** | | | | | | |
| Daily Hours Worked[a] (hours) | 7.73 | 0.68 | 7.72 | 0.66 | 7.74 | 0.71 |
| Real Wage (euros)[b] | 793.04 | 1276.16 | 767.99 | 1347.23 | 819.37 | 1196.36 |

a – Assuming an average of 22 working days a month. | b – Assuming 1995 prices. | This table presents the descriptive statistics of each variable of interest in the study. | [1] The number of observations for the sample period 2004 – 2022 was 41,506,650 for every variable except Obtained Financing (23,670,899), Liabilities (34,151,438), Assets (23,670,899), Liabilities / Assets (23,666,237) and Obtained Financing / Assets (23,666,237).

### 4.1. Dependent variable

The average log of Real Hourly Wage increased from 1.30 euros in the first period to 1.39 euros in the second period, reflecting overall real wage growth over time. The standard deviation decreased from 0.59 to 0.53, suggesting a reduction in wage dispersion in the post-crisis period.

To further represent the evolution of the purchasing power of the Portuguese across the sample period, I will describe the Real Wage, without any Log or Hours Worked normalization, even though it is not the dependent variable of my study. The real wage, whose annual series are shown on Figure 1, averaging €793.04, reflects the impact of inflation-adjusted earnings, suggesting relatively modest wage levels that align with Portugal's economic position during this period. However, this figure masks notable dynamics when decomposing the timeframe into two sub-periods. Between 2004 and 2013, the average real wage was €767.99, while in the subsequent period, 2014 – 2022, it increased 6.7% to €819.37. This upward trend highlights improved purchasing power in the latter period, driven by economic recovery and wage growth policies. The inflation index, based on 1995 prices, explains why these values fall below the current minimum wage of €820.

*Figure 1 – Mean Real Wage by Year*


This figure presents the mean real wage by year, across the sample period, discounted according to 1995 prices.

**Wage differences in small and young firms**

Expanding on the discussion of real wages, it is essential to analyze the differences in mean wages between small and young firms across the full sample period (2004 – 2022) and its two subperiods (2004 – 2013 and 2014 – 2022). The findings indicate that wages in smaller and younger firms tend to be consistently lower than those in larger and older firms, suggesting that firm characteristics play a crucial role in wage determination. These wage disparities highlight

the importance of firm size and age not only in shaping wage outcomes but also in influencing the overall dynamics of the firm population.

Although the number of firms in Portugal has been increasing during the period of analysis, the composition of firms by size and age reveals notable shifts. The share of small and young firms has declined, with the share of small firms decreasing from 36% to less than 33% (a 3pp variation) and the share of young firms declining by 4pp, from nearly 13% to 9%. This trend might reflect the effects of competition and economies of scale, where firms with more robust balance sheets tend to survive longer, while more indebted or fragile firms are more likely to exit the market.

Adding the evolution of the total number of small and young firms to the analysis further reinforces this interpretation. The number of small firms fluctuated around 1 million during the entire period, reaching a maximum of nearly 1.1 million and a minimum of around 0.9 million. In contrast, the number of young firms declined sharply from 400,000 to 250,000 in the first period (2004 – 2013) and has remained relatively stable between 250,000 and 300,000 firms since then. This indicates that fewer new firms have been created compared to 2004, which may suggest that the early years of firm survival have become more challenging or that Portuguese preferences have shifted away from entrepreneurship.

**Full Sample Period (2004 – 2022)**

For the full sample, the mean real wage in small firms was €645.22, significantly lower than the €894.68 observed in larger firms[1]. Similarly, young firms exhibited a mean real wage of €700.88, compared to €808.51 in older firms[2]. These wage gaps underscore the constraints faced by smaller and younger firms, potentially due to differences in productivity, access to financial resources, and labor market segmentation.

**First Period (2004 – 2013)**

When analyzing the first period (2004 – 2013), the wage gap remains evident. The mean real wage for small firms stood at €613.37, compared to €863.00 for larger firms[3]. Meanwhile, young firms had a mean wage of €678.33, whereas older firms offered a higher average of

[1] See figure A1 in the appendix.
[2] See figure A2 in the appendix.
[3] See figure A3 in the appendix.

€785.46[4]. These figures suggest that smaller and younger firms had even greater wage disadvantages in this period, possibly reflecting economic stagnation and limited firm growth opportunities before the broader economic recovery in the following years.

**Second Period (2014 – 2022)**

In the second period (2014 – 2022), the mean real wage in small firms increased to €674.47, although still trailing behind the €931.22 observed in larger firms5. Likewise, young firms experienced wage growth, with a mean real wage of €732.19 compared to €831.64 in older firms[6]. This improvement aligns with the general trend of rising wages in the post-2013 period, as economic recovery and wage policies contributed to higher earnings across firm sizes and ages. However, the persistence of wage differentials suggests that structural barriers continue to limit wage convergence between smaller / younger firms and their larger / older counterparts.

Overall, while wages in small and young firms have increased over time, their gap with larger and older firms remains significant. This trend highlights the continued importance of firm characteristics in wage determination, something that decision-makers should account for.

### 4.2. Monetary policy variables

The EONIA rate, averaging 0.78% across the sample period, illustrates the prolonged period of low interest rates in the Eurozone, particularly during the post-2008 financial crisis and subsequent european sovereign debt crisis. During the first subperiod (2004 – 2013), the average EONIA rate was significantly higher (1.78%) compared to -0.26% in 2014 – 2022, which illustrates the shift toward negative interest rates and accommodative monetary policy in response to the Eurozone crisis.

The Shadow Rate, with a mean of -1.45%, highlights the use of unconventional monetary policy measures, such as QE, when conventional tools reached their limits. The mean Shadow Rate was much higher in 2004 – 2013 (1.47%) than in 2014 – 2022 (-4.69%), illustrating the extent of monetary easing and negative rates during the latter period. The higher standard deviation for the Shadow Rate (3.66) underscores the substantial shifts in monetary conditions during this period.

Given that Portugal's GDP accounts for only 1.8% of Eurozone GDP, I consider the monetary policy effect to be exogenous. This assumption is supported by Jasova et al. (2021), who made

[4] See figure A4 in the appendix.
[5] See figure A5 in the appendix.
[6] See figure A6 in the appendix.

a similar argument, reinforcing the idea that Portugal's economic influence on Eurozone-wide monetary policy decisions is minimal.

### 4.3. Macroeconomic variables

Portugal's real GDP variation, averaging 0.86% per year, reflects slow economic growth over the sample period, influenced by the financial crisis and subsequent recessions. GDP growth was negative on average in 2004 – 2013 (-0.12%), but turned positive in 2014 – 2022 (1.96%), marking a recovery phase for the portuguese economy.

The Volatility Index (VIX) for the US economy mean of 19.26 benchmarks the moderate level of uncertainty in the global financial markets and the standard deviation (6.53) indicates periods of heightened volatility. The VIX was higher on average during 2004 – 2013 (20.16) compared to 2014 – 2022 (18.26), indicating reduced global financial market uncertainty in the latter period.

### 4.4. Firm – level heterogeneity

The average firm age is 23.91 years, and comparing the two subperiods, firm age increased from an average of 22.20 years in 2004 – 2013 to 25.70 years in 2014 – 2022.

The presence of small firms (40.74%) and young firms (14.37%) indicates a notable proportion of newer and smaller enterprises. The share of small firms rose from 38.06% in the first subperiod to 43.56% in the second[7] while conversely, in the second subperiod, the proportion of young firms declined from 16.31% to 12.34%, reflecting a slowdown in new firm formation[8].

The average of the ratios Obtained Financing / Assets (19.18%) and Liabilities/Assets (95.65%) reflect high levels of corporate debt, aligning with Portugal's dependence on external financing during the financial crisis. OF/A ratio increased from an average of 17.59% in 2004 – 2013 to 19.81% in 2014 – 2022, indicating greater access to bank financing in the latter period. Similarly, the L/A ratios increased from 89.42% to 98.16%, highlighting rising leverage among firms. Both ratios reflect that firms increased debt in the second period, perhaps motivated by the increasing liquidity in the banking system and subsequent loan supply.

### 4.5. Worker – level heterogeneity

The average employee age (39.60 years) and increased from 38.49 years in 2004 – 2013 to 40.77 years in 2014 – 2022, reflecting an aging workforce.

[7] Series of the share of small firms in figure A7 in the appendix.
[8] Series of the share of young firms in figure A8 in the appendix.

The college premium increased from 13.79% in 2004 – 2013 to 21.16% in 2014 – 2022 which reflects an increase in the valuation of highly skilled workers.

Additionally, the stayer dummy (75.28%) indicates significant workforce stability. The percentage of stayers rose from 71.74% in the first subperiod to 79.01% in the second, suggesting greater employee retention in the latter years.

The female share (44.91%) highlights gender representation in the labor market. It increased from 43.84% in 2004 – 2013 to 46.03% in 2014 – 2022, reflecting steady progress in gender inclusion.

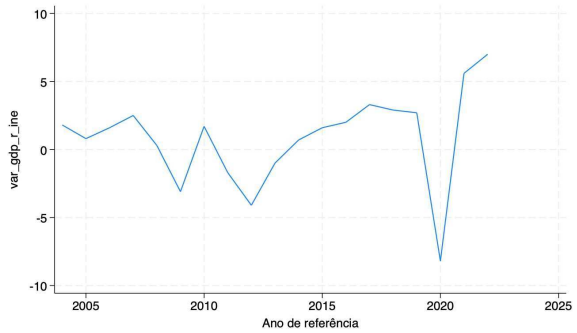
# 5. *Macroeconomic context*

I will now do a brief description of the macroeconomic context of the Portuguese economy covering the period of analysis.

## 5.1. GDP

The real rates of growth of the Portuguese GDP, shown in Figure 2, showed that output increased from 2004 to 2008, decreased until 2015 and since then is recovering.

*Figure 2 – Real GDP growth*




This figure presents the real annual rates of growth of GDP for the Portuguese economy across the sample period.

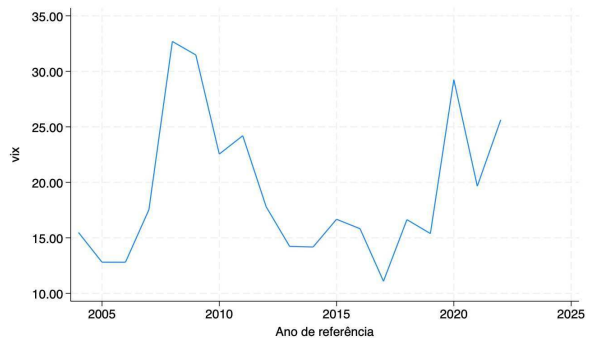
Between 2004 and 2008, the real annual rates of real GDP growth were between 0.3% and 2.5%, reflecting a relatively stable trend of growth in the Portuguese economy. The 2009 – 2013 period reflects the negative effects of the GFC in Portugal, as in four of these five years there was a contraction of the output, exposed by negative real annual rates of growth (particularly in 2012, with a significant decrease of the real GDP of 4.1%). In the last subperiod (2014 – 2022), Portugal had a period of sustainable GDP growth, that was reflected on wages as we will see in the next topic. The only exception was in 2020 (with a contraction of -8.2%) caused by COVID-19, but the economy showed resilience with a recovery of 5,6% in the following year of 2021. Until then, the higher rate of growth was 3.3% in 2018 and the lower was still positive (0.7%), in 2014.

Comparing the analysis of the business cycle with interest rates, we can infer that the first period (2004 – 2013) was characterized by a higher volatility of interest rates compared to the second period, until 2022. In Table 1, we can observe that the standard deviation of the EONIA rate in the first period was 1.45, much higher than in the second period: 0.22. Furthermore, the mean interest rate in the first period (1.56) was much higher than in the second (-0.26), when monetary policy was consistently dovish. The data from the second period goes in accordance with Carstens from BIS, that defended in 2021 that stable and predictable monetary policy are the best contribute that central banks can make to sustainable economic growth.

### 5.2. VIX

The Volatility Index for the USA economy, whose series are shown in Figure 3, was used in this study to capture the feeling of uncertainty felt by economic agents across the years, following Jasova et al. (2021). To better understand the dynamics behind this index, I will start computing its mean: 19.26. This will serve as an anchor for us to understand if in each year VIX was below or above the mean. We can observe that VIX is clearly cyclical, as from 2004 to 2007 its levels were below the mean, above from 2008 to 2011 (reflecting the unpredictability caused by the GFC), again below the mean for the long period between 2012 and 2019 and, finally, above the mean, firstly due to COVID and after because of the war in Ukraine and the instability in the Middle East. In the larger cycle here presented (from 2012 to 2019) Portugal experienced a sustained economic recovery, a sharp decrease in the unemployment (see Figure 7) and a continuous increase in the real wages.

*Figure 3 – VIX series*




This figure presents the volatility index for the US economy across the sample period.

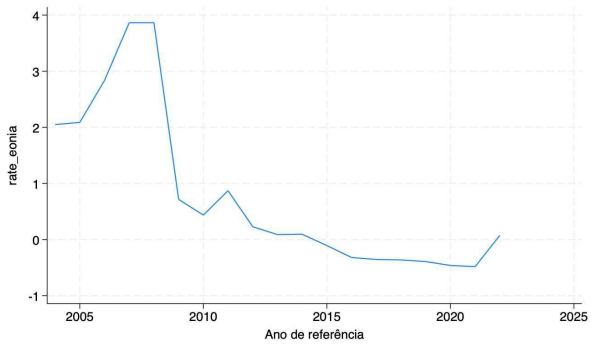
### 5.3. EONIA

As I mentioned previously, my study will be decomposed into 2 periods: 2004 to 2013 and 2014 to 2022. These two periods were almost opposite in the behavior of interest rates, represented by EONIA. If in the first period the mean EONIA was 1.78% and the standard deviation was 1.45, in the second was -0.26 and the standard deviation 0.22. The mean of the entire sample was 0.78 and the respective standard deviation 1.44[9]. The general idea is that in the first period rates were always above 0%, reaching almost 4% in 2007 and 2008 and in the second period interest rates were below the zero-low-bound until 2021 and much less volatile than in the first period.

[9] See the EONIA descriptive statistics in Table 1 and their series in Figure 4.

Interest rates increased substantially in 2023, to the mean level of 3.29. However, I will not include this year on the analysis for the following two reasons: first, we do not have data from Quadros de Pessoal and IES for 2023 and second, even if we had information of workers and firms, for 2023, we would not be able to retrieve robust findings because economic agents take time to adjust to variations of this nature. Investors may take time to adapt their investment / disinvestment strategies, State policies may be decided only in the discussion of the annual budget, firms do not increase wages immediately to employees and many more. However, I encourage future researchers to extend my analysis to the next decade, and maybe create a third period that captured the reaction of the economy to the geopolitical challenges imposed in the decade of 2020.

*Figure 4 – EONIA series*




This figure presents the series of the EONIA rate in the Euro Area for the entire sample period.

### 5.4. Shadow Rates

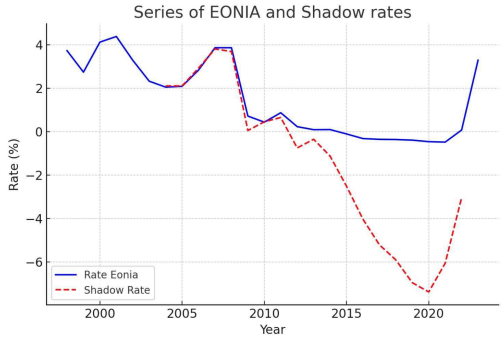
To better understand the role of both types of monetary policy in the Portuguese economy during the period of analysis (2004 – 2022), I focus on the Shadow Rate, introduced by Wu and Xia (2016). The Shadow Rate is a monetary policy indicator developed to account for central bank actions under the zero lower bound (ZLB), where traditional interest rate metrics like the EONIA rate fail to capture the full extent of policy easing.

During the first subperiod (2004 – 2013), Portugal, like the Eurozone, experienced relatively high interest rate volatility and fluctuations in monetary policy. The Shadow Rate was closely aligned with the EONIA rate during this time, as the European Central Bank (ECB) primarily relied on conventional tools, and rates remained above the ZLB. However, from 2014 on, Shadow Rates diverged significantly from the EONIA rate, as we can see in Figure 5. While the ECB implemented expansive QE programs, Shadow Rates dropped deep into negative territory, reaching levels as low as -7% during periods of aggressive bond purchases. This stark contrast

highlights how Shadow Rates reflect the additional easing impact of unconventional measures, a feature absent in the EONIA rate.

By 2020, Shadow Rates spiked briefly during the onset of the COVID-19 pandemic, corresponding to heightened policy intervention, before gradually normalizing as the economy recovered. Figure 5 presents the Shadow Rate dynamics for the entire period, showcasing the periods of deep monetary easing and their alignment with economic shocks and recoveries.

*Figure 5 – Series of EONIA and Shadow Rates*




This figure presents the series of the EONIA and Shadow Rates in the Euro Area for the entire sample period.

### 5.5. Differences between Shadow and EONIA rates

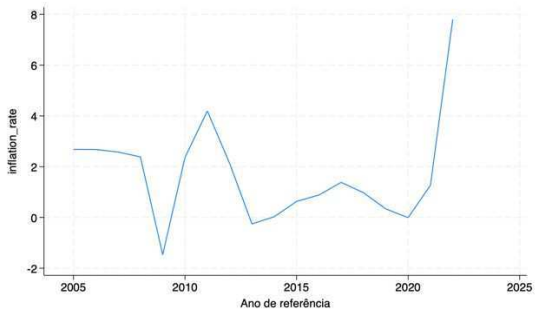
While both the Shadow Rate and EONIA aim to represent monetary policy stance, their methodologies and implications differ fundamentally:

1. **Range of values:** EONIA is bounded by the ZLB and, despite slight negative values in the second subperiod, does not adequately reflect the depth of monetary easing through QE. Shadow Rates, in contrast, capture the implicit negative rates resulting from unconventional monetary policies. Thus, the use of QE is represented by the years where the Shadow Rate differes from the EONIA.
2. **Sensitivity to QE:** EONIA rates are unaffected by the scale of central bank asset purchases, whereas Shadow Rates directly incorporate these policies, allowing for a nuanced understanding of their macroeconomic impact.
3. **Volatility:** Shadow Rates are less volatile in the first period (2004 – 2013) due to the reliance on conventional policies. In the second period (2014 – 2022), their movements closely follow the intensity of QE programs, diverging significantly from EONIA's nearzero stability.

## 5.6. Inflation

The average inflation was 1.7%, a value below but close to the 2% medium-long target of the ECB, which reflects its effectiveness in meeting its goals to inflation. The standard deviation was 0.20, minimum of -0.15% in 2009 and maximum of 7.80% in 2022. The outlier of this series is clearly the year 2022, due to the reasons previously mentioned. The main idea that I highlight from the series that we can observe in Figure 6 is that despite several years in the second period of analysis with rates below 0%, that practically means that the ECB flooded the market with liquidity to promote economic growth, inflation in Portugal was controlled, near 0, with maximum of 1.4% in 2017 and minimum of -0.3% in 2013.

*Figure 6 – Inflation series*




This figure presents the series of the Portuguese economy inflation for the entire sample period.

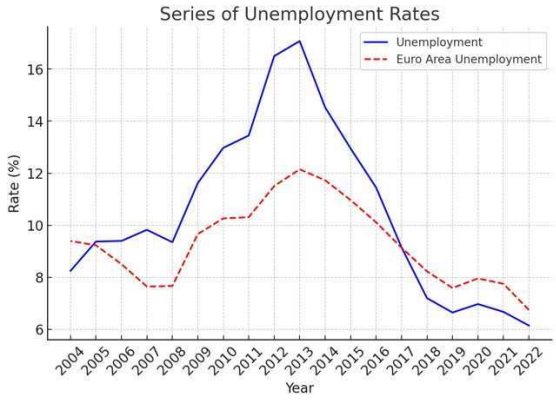
## 5.7. Unemployment

We can observe in Figure 7 that the behavior of Portuguese unemployment has shown significant resilience over the last decade. From 2004 to 2013, a period marked by increasing VIX in the USA, the Portuguese unemployment increased from nearly 8% to 16.4%. Interestingly, as we will observe later, this period was characterized by the continuous decline in both small and young firms in Portugal (from 1.1 million in 2006 to 0.9 million in 2013[10] and from 400 to 258 thousand[11], respectively). The decline in these types of firms, typically with financial constraints according to the literature, is correlated with an increase unemployment. Accordingly, in the following 5 years, until 2018, when the trend was the opposite – unemployment fell to 6.6% in 2018 – small firms increased by nearly 100 000 and young firms by nearly 35 000. Unemployment will not be the focus of this study, but this correlation confirms literature like Moscarini (2012), that concluded that the number of small

[10] See figure A9 in the appendix.
[11] See figure A10 in the appendix.

and young firms tend to decline during recessions, because they are, on average, the ones more financially constrained.

*Figure 7 – Series of Unemployment*




This figure presents the series of the Portuguese economy Unemployment for the entire sample period.

## 6. Baseline monetary policy effect on wages

To primarily analyze the impact of monetary policy on wages, I estimate the following baseline model:

$$(1)\ \log(RHW_{w,f,t})=\alpha+\beta_1(MP_{t-1})+\beta_2(GDP_{t-1})+\beta_3(\log(VIX_{t-1}))+\beta_4(Age_{w,t})+\beta_5(Age2_{w,t})+\epsilon_{w,f,t}$$

,where $\log(RHW_{w,f,t})$ represents the logarithm of the real hourly wage for a worker (w) in a specific firm (f) at a given time (t). The primary variable of interest is $MP_{t-1}$, which denotes the lagged monetary policy measure, captured by the Shadow Rate (SR) or the EONIA rate. The model also includes $GDP_{t-1}$, the lagged real GDP growth rate and the lagged volatility index for the US economy, to account for macroeconomic conditions and worker-specific characteristics captured through age quadratic terms, allowing for non-linear effect. The error term ($\epsilon_{w,f,t}$) accounts for unobservable characteristics.

### Shadow Rate analysis

To capture the full scope of monetary policy, including unconventional measures such as Quantitative Easing (QE), the analysis begins with the Shadow Rate. The results, presented in Table 2, indicate clear differences between the two periods under review.

Table 2 - Impact of Shadow Rates on wages

| Log (Real Hourly Wage) | 2004 – 2013 | 2014 – 2022 | 2014 – 2019 | 2004 – 2022 |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Shadow Rate$_{t-1}$ | 0.71*** | -2.10*** | -2.57*** | -1.34*** |
| | (0.01) | (0.01) | (0.02) | (0.00) |
| Observations | 19,234,912 | 20,238,496 | 13,182,955 | 39,473,408 |
| R-squared | 0.04 | 0.04 | 0.03 | 0.04 |

All the regressions include the lagged variation of GDP of the Portuguese economy, the lagged VIX for the US economy and the polynomial of age (Age and Age$^2$) | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured through Shadow Rates) on the log of Real Hourly Wages for the periods 2004 – 2013, 2014 – 2022, 2014 – 2019 (to ensure robustness to COVID-19 effects) and 2004 – 2022.

During the first period, from 2004 to 2013 (see column 1), the Shadow Rate exhibits a significant positive relationship with wages. Specifically, a 1 percentage point (pp) decrease in the Shadow Rate corresponds to a 0.71% decrease in real hourly wages. This period was characterized by larger lower swings in monetary policy (both traditional and unconventional), as reflected in a lower standard deviation of the Shadow Rate (1.68). These results suggest that monetary tightening during this time had a mild positive effect on wage growth.

In contrast, during the second period, from 2014 to 2022 (see column 2), the Shadow Rate shows a negative relationship with wages. A 1pp decrease in the Shadow Rate results in a 2.10% increase in real hourly wages. This period was marked by a higher standard deviation of the Shadow Rate (2.14), indicative of the unprecedented measures of monetary policy undertaken. The pronounced negative effect suggests that contractionary monetary policies had a stronger downward impact on wages during this time.

To further assess the robustness of these findings, an additional analysis was conducted for the sub-period 2014 to 2019 (see column 3), removing the potential distortions caused by the COVID-19 years (2020 – 2022). The results confirm the previous trend, with a 1pp decrease in the Shadow Rate leading to a 2.57% increase in real hourly wages, an even stronger effect than in the full 2014 – 2022 subperiod. This suggests that the relationship between monetary policy and wages remained consistent before the pandemic and was not solely driven by the extraordinary economic conditions of 2020 – 2022.

**EONIA analysis**

For comparative purposes, the same baseline model was estimated using the EONIA rate as the monetary policy measure. The results, presented in Table 3, reveal broadly similar patterns to those observed with the Shadow Rate, though with some important distinctions.

Table 3 – Impact of EONIA on wages

| Log (Real Hourly Wage) | 2004 – 2013 | 2014 – 2022 | 2014 – 2019 | 2004 – 2022 |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| EONIA $_{t-1}$ | 0.55*** | -22.70*** | -9.79*** | -2.38*** |
| | (0.01) | (0.06) | (0.18) | (0.01) |
| Observations | 20,268,154 | 20,238,496 | 13,182,955 | 41,506,650 |
| R-squared | 0.04 | 0.04 | 0.03 | 0.04 |

All the regressions include the lagged variation of GDP of the Portuguese economy, the lagged VIX for the US economy and the polynomial of age (Age and Age$^2$) | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured through the EONIA rate) on the log of Real Hourly Wages for the periods 2004 – 2013, 2014 – 2022, 2014 – 2019 (to ensure robustness to COVID-19 effects) and 2004 – 2022.

During the first period (2004 – 2013) – represented in column 1 –, EONIA exhibits a positive effect on wages, with a 1pp increase corresponding to a 0.55% rise in real hourly wages. However, the larger standard deviation of EONIA (1.34) during this period indicates significant fluctuations in monetary policy, potentially spreading wage responses across a wider range of monetary policy shifts.

In the second period (2014 – 2022) – see column 2 –, the effect of EONIA on wages becomes strongly negative, with a 1 pp increase leading to a 22.70% decrease in real hourly wages. The magnitude of this effect reflects the lower variability of EONIA (0.22) during this time[12] and its limitations in capturing unconventional monetary policies such as QE. The robustness check excluding the COVID-19 years confirms this negative relationship but with a smaller impact, as a 1pp increase in EONIA results in a 9.79% wage decline. This suggests that while contractionary monetary policy reduced wages significantly, the extreme effect in the full period may have been amplified by pandemic-related distortions.

Concluding, while the Shadow Rate provides a more comprehensive measure of monetary policy by accounting for unconventional tools like QE, both EONIA and the Shadow Rates

[12] See Figure 6.

reveal similar patterns – positive effects on wages in the first period and negative effects in the second, which confers robustness to the findings.

# 7. Impact of the interaction between firm heterogeneity and MP on wages

The figures A7 and A8 in the appendix illustrate that the share of small firms decreased from nearly 50% to 42%, representing a 16% reduction, while the proportion of young firms fell from 17% to 9%. The figure A9 in the appendix shows that the number of small firms in Portugal has remained relatively stable, fluctuating between a minimum of nearly 900,000 and a maximum of 1,100,000. However, the number of young firms declined sharply during the period 2004 – 2013, dropping from approximately 400,000 to 250,000 (see figure A10 in the appendix). Since then, the number of young firms has stabilized between 250,000 and 300,000. These descriptive statistics suggest that the number of small firms has not changed significantly over the analyzed time frame, but new enterprises were disproportionately affected, particularly during the 2004 – 2013 period, which was marked by the Global Financial Crisis and the Sovereign Debt Crisis.[13]

To assess how monetary policy interacts with firm heterogeneity to influence wages, the following model is estimated:

$$(2)\ \log(RHW_{w,f,t}) = \alpha + \beta_1(FH_{f,t} \times MP_{t-1}) + \beta_2(FH_{f,t}) + \beta_3(Age_{w,t}) + \beta_4(Age2_{w,t}) + \nu_f + \eta_w + \mu_t + \epsilon_{w,f,t}$$

,where $\log(RHW_{w,f,t})$ denotes the logarithm of the real hourly wage for a worker (w) in a firm (f) at time (t). The key interaction of interest is $FH_{f,t} \times MP_{t-1}$**,** which represents the product between firm heterogeneity ($FH_{f,t}$) – indicators for small firms ($SF_{f,t}$) and young firms ($YF_{f,t}$) – and the lagged monetary policy measure **(**$MP_{t-1}$). The model also incorporates age quadratic terms. Fixed effects are accounted for at the firm ($\nu_f$), worker ($\eta_w$), and time ($\mu_t$) levels, while $\epsilon_{w,f,t}$ represents the residual error term.

**Shadow Rate analysis**

Table 4 presents the results of the model presented in equation 2 using the Shadow Rate as the monetary policy measure.

[13] The study follows Jasova et al. (2021) in considering small firms as employing fewer than 50 people and firms born less than five years before as young firms.

Table 4 – The Interaction Between Firm Characteristics and SR on Real Hourly Wages

| Log (Real Hourly Wage) | 2004 – 2013 | | 2014 – 2022 | | 2014 – 2019 | | 2004 – 2022 | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $SF_{f,t}$ x $SR_{t-1}$ | -0.23*** | - | -0.50*** | - | -0.48*** | - | -0.31*** | - |
| | (0.01) | - | (0.00) | - | (0.01) | - | (0.00) | - |
| $YF_{f,t}$ x $SR_{t-1}$ | - | -0.12** | - | -0.42*** | - | -0.56** | - | -0.11*** |
| | - | (0.01) | - | (0.01) | - | (0.01) | - | (0.01) |
| Observations | 18,433,792 | | 19,410,649 | | 12,436,611 | | 38,396,622 | |
| R-squared | 0.92 | | 0.91 | | 0.93 | | 0.89 | |

All the regressions include additional Small/ Young firm variation, the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured by the Shadow Rate) interacted with Firm Heterogeneity (proxied by size and age) on the log of Real Hourly Wages for the periods 2004 – 2013, 2014 – 2022, 2014 – 2019 (to ensure robustness to COVID-19 effects) and 2004 – 2022.

For small firms, a 1 percentage point (pp) decrease in the Shadow Rate during the 2004 – 2013 period is associated with a 0.23 pp higher wage increase compared to larger firms. During the 2014 – 2022 period, this effect is more pronounced, with a 1pp decrease in the Shadow Rate leading to a 0.50pp higher wage increase for small firms compared to larger firms. Over the full period (2004 – 2022), the coefficient is smaller at -0.31, reflecting a more moderate overall response. Additionally, when excluding the pandemic period, the results for 2014 – 2019 (without the years 2020 – 2022) show no significant changes, suggesting that the pandemic shock did not distort the findings. This significant sensitivity of small firms to the Shadow Rate highlights their dependence on liquidity and credit conditions, particularly in the context of low-interest-rate environments enabled by unconventional monetary policies.

For young firms, the relationship between the Shadow Rate and wages also varies across periods. During 2004 – 2013, a 1pp decrease in the Shadow Rate corresponds to a 0.12pp higher wage increase compared to older firms. This effect intensifies in the 2014 – 2022 period, where a 1pp decrease leads to a 0.42pp higher wage increase for young firms. Over the full period (2004 – 2022), the coefficient is smaller at -0.11, reflecting a dampened but still significant overall impact. Excluding the pandemic years, the results for 2014 – 2019 show consistent findings, underscoring that the observed effects are robust and not driven by pandemic disruptions. The significant sensitivity of both small and young firms to the Shadow Rate underscores their reliance on liquidity and credit conditions, particularly in low-interest-rate environments enabled by unconventional monetary policies.

**EONIA analysis**

Table 5 reports results applying equation 2 using EONIA as the monetary policy measure, providing a contrast to the Shadow Rate-based findings.

Table 5 – The Interaction Between Firm Characteristics and EONIA on Real Hourly Wages

| Log (Real Hourly Wage) | 2004 – 2013 | | 2014 – 2022 | | 2014 - 2019 | | 2004 – 2022 | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $SF_{f,t}$ x EONIA $_{t-1}$ | -0.31*** | - | -5.45*** | - | -4.21*** | - | -0.62*** | - |
| | (0.01) | - | (0.05) | - | (0.06) | - | (0.01) | - |
| $YF_{f,t}$ x EONIA $_{t-1}$ | - | -0.15*** | - | -1.76*** | - | -4.39*** | - | -0.10** |
| | - | (0.01) | - | (0.10) | - | (0.11) | - | (0.01) |
| Observations | 20,681,368 | | 20,239,504 | | 12,436,611 | | 41,489,665 | |
| R-squared | 0.91 | | 0.91 | | 0.93 | | 0.88 | |

All the regressions additional variation of Small/ Young firm, the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured by the EONIA rate) interacted with Firm Heterogeneity (proxied by size and age) on the log of Real Hourly Wages for the periods 2004 – 2013, 2014 – 2022, 2014 – 2019 (to ensure robustness to COVID-19 effects) and 2004 – 2022.

For small firms, during 2004 – 2013, a 1 percentage point (pp) decrease in EONIA was associated with a 0.31pp higher wage increase compared to large firms. In 2014 – 2022, this effect became much stronger, with the coefficient rising to -5.45pp, reflecting heightened wage responsiveness in a low-volatility environment. A robustness check for 2014 – 2019 confirms this trend, showing no significant deviation from the full period, indicating that the stronger impact was not driven by pandemic-specific factors.

For young firms, the response to a 1pp reduction in EONIA increased from a 0.15pp higher wage increase (compared to older firms) in 2004 – 2013 to a 1.76pp higher increase in 2014 – 2022, highlighting greater sensitivity to monetary policy. The 2014 – 2019 results again align with this pattern, reinforcing that the observed effects stem from broader monetary policy dynamics rather than COVID-related distortions.

However, the standard deviation of EONIA fell sharply between the two periods (from 1.45 to 0.22), meaning that the same unit change in wages is associated with larger coefficients in 2014 – 2022 due to lower interest rate volatility. This is the reason why the magnitude of coefficients in the second period is much higher applying EONIA than applying the Shadow Rate.

**Firm heterogeneity-related insights**

The Shadow Rate provides a more nuanced understanding of monetary policy's effects, particularly during the 2014 – 2022 period dominated by unconventional tools. For instance, for small firms, the coefficient shifts from -5.45pp with EONIA to -0.50pp with the Shadow Rate. Small and young firms are consistently more sensitive to shifts in monetary policy, with stronger effects observed during periods of unconventional monetary policy. However, the Shadow Rate reveals more moderate effects than EONIA, likely due to its broader scope, including unconventional monetary policy tools.

Moreover, the results for the period 2014 – 2019, excluding the pandemic years, are consistent with the full 2014 – 2022 period. This suggests that the pandemic disruptions did not significantly distort the analysis, further reinforcing the robustness of the findings.

## 8. The mediating role of firm indebtedness

To explore how financial constraints influence the relationship between monetary policy (MP) and wage adjustments, the following analysis incorporates debt-related variables into the baseline model. Specifically, it examines whether higher levels of indebtedness, captured through two ratios – Liabilities/Assets (L/A) and Obtained Financing/Assets (OF/A) – mediate the impact of monetary policy on wages for small and young firms. Due to data limitation, I only have access to the balance sheet-based rations since 2010. This means that the analysis for the first period will be limited by this constraint and affected to the period of the Global Financial Crisis (2010 – 2013).

The model is the following, where FC (Financial Constraints) represents variables Obtained Financing/Assets and Liabilities/Assets is the following:

$$(3)\ \log(RHW_{w,f,t}) = \alpha + \beta_1(FH_{f,t} \times MP_{t-1}) + \beta_2(FH_{f,t} \times MP_{t-1} \times FC_{f,t}) + \beta_3(FH_{f,t}) + \beta_4(Age_{w,t}) + \beta_5(Age2_{w,t}) + \nu_f + \eta_w + \mu_t + \epsilon_{w,f,t}$$

,where $\log(RHW_{w,f,t})$ denotes the logarithm of the real hourly wage for a worker (w) in a firm (f) at time (t). The key interaction of interest are:

1. $FH_{f,t} \times MP_{t-1}$**,** which represents the product between firm heterogeneity ($FH_{f,t}$) and the lagged monetary policy measure **(**$MP_{t-1}$), where characteristics include indicators for small firms ($SF_{f,t}$) and young firms ($YF_{f,t}$) and;

2. $FH_{f,t} \times MP_{t-1} \times FC_{f,t}$**,** which represents the product between firm heterogeneity ($FH_{f,t}$), the lagged monetary policy measure **(**$MP_{t-1}$) and the financial constraint ratio ($FC_{f,t}$) – OF/A and L/A –, where characteristics include indicators for small firms ($SF_{f,t}$) and young firms ($YF_{f,t}$).

The model also incorporates age quadratic terms, fixed effects, accounted for at the firm ($\nu_f$), worker ($\eta_w$), and time ($\mu_t$) levels, and $\epsilon_{w,f,t}$ , which represents the residual error term.

**Shadow Rate and Liabilities / Assets (L/A) ratio**

To assess the effects of unconventional monetary policy, the analysis first examines the Shadow Rate and its interaction with the L/A ratio. The respective results are on table 6, that follows equation 3.

For small firms, a reduction in the Shadow Rate of 1 percentage point (pp) leads to a statistically significant 0.15pp larger increase in real hourly wages comparing with larger firms**,** indicating their responsiveness to such policies. However, this effect is not uniform across periods. During the post-GFC period (2010 – 2013), the effect is the opposite, as a reduction of 1pp in the shadow rate is associated with a 0.64pp lower increase in wages for small firms comparing with larger firms. On the contrary, in the unconventional policy period (2014 – 2022) small firms experience 0.43pp higher wage increases comparing with larger firms following a 1pp decrease in the Shadow Rate. The additional subdivision for 2014 – 2019 confirms a similar negative effect (-0.42), suggesting that the impact of unconventional policy on small firms' wages remains consistent even when excluding the COVID-19 period. When the interaction term $\text{Small Firm}_{f,t} \times \text{Shadow Rate}_{t-1} \times L/A_{f,t}$ is included, the baseline effect is significantly but mildly reduced, with a positive coefficient (0.25) before 2013 but turning insignificant afterward. This suggests that during unconventional policy periods, higher leverage among small firms does not amplify wage responses as it did previously, but one should keep in mind that these results refer to the Troika period in Portugal, that brought stark wage reductions not related with monetary policy.

Table 6 – Interacting Firm Heterogeneity, Shadow Rates and L/A ratio on Wages

| Log (Real Hourly Wage) | 2010 – 2013 | | 2014 – 2022 | | 2014 – 2019 | | 2010 - 2022 | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $SF_{f,t}$ x $SR_{t-1}$ | 0.64*** | - | -0.43*** | - | -0.42*** | - | -0.15*** | - |
| | (0.03) | | (0.00) | | (0.01) | | (0.00) | |
| $SF_{f,t}$ x $SR_{t-1}$ x $L/A_{f,t}$ | 0.25*** | - | -0.00*** | - | 0.00*** | - | -0.01*** | - |
| | (0.01) | | (0.00) | | (0.01) | | (0.00) | |
| $YF_{f,t}$ x $SR_{t-1}$ | - | 0.39*** | - | -0.50*** | - | -0.68*** | - | 0.09*** |
| | | (0.05) | | (0.01) | | (0.01) | | (0.01) |
| $YF_{f,t}$ x $SR_{t-1}$ x $L/A_{f,t}$ | - | 0.00** | - | 0.00 | - | 0.00 | - | -0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Observations | 6,170,144 | | 16,099,362 | | 10,256,470 | | 22,799,597 | |
| R-squared | 0.94 | | 0.90 | | 0.92 | | 0.89 | |

Both regressions include additional variation of Small / Young Firm, the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on: 1) the impact of Monetary Policy (captured by the Shadow Rate) interacted with Firm Heterogeneity (proxied by size and age); 2) the impact of Monetary Policy (captured by the Shadow Rate) interacted with Firm Heterogeneity (proxied by size and age) and with the Liabilities / Assets ratio on the log of Real Hourly Wages for the periods 2010 – 2013, because I only have access to balance sheet data following 2010, 2014 – 2022, 2014 – 2019, to remove the COVID-19 impact and, finally, 2010 – 2022.

For young firms, the relationship is slightly different. The coefficient for Young $Firm_{f,t}$ × Shadow $Rate_{t-1}$ is 0.09, indicating a modestly lower wage increase for young firms compared with older firms following a reduction of 1pp in the Shadow Rate. When broken down by period, the coefficient is still positive (0.39) in 2010 – 2013, indicating a lower wage increase for young firms compared with older firms but turns negative in 2014 – 2022. In the second period, a 1 percentage point (pp) reduction in the Shadow Rates is associated with a 0.50pp higher wage increase for young firms comparing with older firms and this effect is even more pronounced excluding the COVID years as results indicate a 0.68 higher wage increase for young firms. This suggests that while young firms initially benefited less from monetary easing than older firms, their responsiveness strengthened under unconventional policy settings, ultimately leading to a stronger wage increase.

The interaction terms $FH_{f,t}$ × Shadow $Rate_{t-1}$ × $L/A_{f,t}$ remain not statistically significant across all periods, indicating that young firms' leverage captured through the L/A ratio does not meaningfully mediate the effects of unconventional monetary policy on wages.

**Shadow Rate and Obtained Financing / Assets (OF/A) ratio**

The following analysis turns to the interaction between the Shadow Rate and the OF/A ratio, whose results are shown in table 7, that also follows equation 3.

Table 7 – Interacting Firm Heterogeneity, Shadow Rates and OF/A ratio on Wages

| Log (Real Hourly Wage) | 2010 – 2013 | | 2014 – 2022 | | 2014 – 2019 | | 2010 - 2022 | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $SF_{f,t}$ x $SR_{t-1}$ | 0.30*** | - | -0.44*** | - | -0.43*** | - | -0.17*** | - |
| | (0.03) | | (0.01) | | (0.01) | | (0.00) | |
| $SF_{f,t}$ x $SR_{t-1}$ x $OF/A_{f,t}$ | 3.75*** | - | 0.06*** | - | 0.07*** | - | 0.13*** | - |
| | (0.07) | | (0.01) | | (0.02) | | (0.10) | |
| $YF_{f,t}$ x $SR_{t-1}$ | - | 0.39*** | - | -0.50*** | - | -0.68*** | - | 0.09*** |
| | | (0.05) | | (0.01) | | (0.01) | | (0.00) |
| $YF_{f,t}$ x $SR_{t-1}$ x $OF/A_{f,t}$ | - | 0.01*** | - | 0.00 | - | 0.00 | - | 0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Observations | 6,170,144 | | 16,099,362 | | 10,256,470 | | 22,799,597 | |
| R-squared | 0.94 | | 0.90 | | 0.92 | | 0.89 | |

Both regressions include additional variation of Small / Young Firm, the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on: 1) the impact of Monetary Policy (captured by the Shadow Rate) interacted with Firm Heterogeneity (proxied by size and age); 2) the impact of Monetary Policy (captured by the Shadow Rate) interacted with Firm Heterogeneity (proxied by size and age) and with the Obtained Financing / Assets ratio on the log of Real Hourly Wages for the periods 2010 – 2013, because I only have access to balance sheet data following 2010, 2014 – 2022, 2014 – 2019, to remove the COVID-19 impact and, finally, 2010 – 2022.

For small firms, a reduction in the Shadow Rate of 1 percentage point (pp) is associated with a 0.17pp higher increase in real hourly wages compared with larger firms. However, the effect of the Shadow Rate on wages has evolved over time, exhibiting notable heterogeneity across different periods.

During the period 2010 – 2013, the coefficient for Small $Firm_{f,t}$ × Shadow $Rate_{t-1}$ is 0.30, suggesting monetary policy easing had a weaker effect on wage growth in small firms compared to larger firms. The interaction term with the Obtained Financing/Assets (OF/A) ratio is 3.75, emphasizing that firms with higher financing experienced even smaller wage increases. Considering the magnitude of the other coefficients, this one clearly stands out, as it is almost 30 times higher than the second biggest $SF_{f,t}$ x $SR_{t-1}$ x $OF/A_{f,t}$ coefficient. This happens because these results refer to the only period in our sample when real wages decreased significantly,

following the GFC and the entrance in of Troika in Portugal. Specifically, real wages decreased in 2010, 2011 and 2012 consecutively, by -2.53%, -3.00%, -1.04%, respectively. This period of recession in Portugal, the only one that experienced yearly decreases in real wages in our sample, should be the reason for such extreme coefficient. Considering that the mean Obtained Financing in this period was 42.8 million (only 7 million above the mean for the second period – 35.1 million), variation in this variable cannot be the reason for such extreme coefficient.

From 2014 to 2022, the effect shifts significantly. The coefficient for Small $Firm_{f,t}$ × Shadow $Rate_{t-1}$ turns negative at -0.44, signaling that reductions in the Shadow Rate were now associated with larger wage increases for small firms relative to larger firms. This reversal highlights a critical change in the transmission of monetary policy, reflecting improved credit conditions or greater responsiveness of wages in small firms to monetary easing. Notably, the interaction term with OF/A is 0.06, suggesting that financing had smaller impact on wage determination than in the previous period. This could imply that firms with higher OF/A ratios experience a slightly more moderated wage growth following a 1pp decline in the Shadow Rates, perhaps due to prioritising debt repayment or other financial commitments over increasing wages. Focusing on the narrower period of 2014 – 2019, the findings remain consistent with the broader 2014 – 2022 window, indicating that the covid pandemics did not influence significantly the results.

For young firms, the patterns also exhibit temporal heterogeneity. Between 2010 and 2013, the coefficient for Young $Firm_{f,t}$ × Shadow $Rate_{t-1}$ is 0.39, suggesting that monetary easing had a muted effect on wage growth in young firms, possibly due to their limited ability to adjust wages or allocate resources differently than more established firms. The interaction term with OF/A is 0.01, indicating a minor moderating effect.

In contrast, during 2014 – 2022, the coefficient shifts to -0.50, signaling a reversal. In this period, lower Shadow Rates were linked to larger wage increases for young firms compared to older firms, with the interaction term with OF/A dropping to 0.00. This suggests that young firm wage growth became more sensitive to monetary policy. Excluding the pandemic years (2014 – 2019), the effect slightly intensified, indicating the in the COVID-19 years, this effect was diminished, but the interaction term with OF/A remains at 0.00, confirming that financing no longer mediated this relationship.

Overall, the findings underscore significant heterogeneity in how small and young firms respond to monetary policy across different time periods. The smaller wage increases for small and young firms in 2010 – 2013 contrast sharply with the larger effects observed in 2014 – 2022, highlighting shifting dynamics in the labor market. Similarly, young firms experienced a reversal in wage effects after 2013. Furthermore, the coefficients of both financial ratios related to young firms (in column (2), (4), (6) and (8) of tables 6 and 7) are similar, reinforcing the idea that the baseline interaction of Shadow Rates with firm heterogeneity is the primary factor influencing wages, with financial ratios not mediating the effect.

As it was mentioned before, despite only accounting for conventional monetary policy, the EONIA analysis will be pursued to confirm the validity of the Shadow Rate analysis findings.

**EONIA and Liabilities / Assets (L/A) ratio**

Table 8, that also follows equation 3, presents the interaction between monetary policy, firm characteristics, and the L/A ratio.

For small firms, a 1 percentage point (pp) reduction in the EONIA rate is associated with a significant 1.31pp larger increase in real hourly wages compared with larger firms, underscoring the heightened sensitivity of smaller firms to monetary policy changes. The interaction term Small $Firm_{f,t} \times EONIA_{t-1} \times L/A_{f,t}$ has a coefficient of -0.14**,** indicating that higher levels of debt slightly amplify the wage effect of monetary policy for small firms.

During the 2010 – 2013 period, the coefficient on $SF_{f,t} \times EONIA_{t-1}$ is 0.87, suggesting that small firms experienced smaller wage increases than large firms in response to monetary easing.
The leverage interaction term was positive (0.31), implying that higher indebtedness has reinforced this effect. However, in the 2014 – 2022 period, the effect turns negative at -4.77, indicating that small firms' wage responsiveness to monetary policy augmented significantly, promoting higher wage increases than larger firms. The interaction term with leverage also declines to -0.08, suggesting that indebtedness began to weigh more heavily on small firms in this later period.

Table 8 – Interacting Firm Heterogeneity, EONIA and L/A ratio on Wages

| Log (Real Hourly Wage) | 2010 – 2013 | | 2014 – 2022 | | 2014 – 2019 | | 2010 - 2022 | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $SF_{f,t}$ x $EONIA_{t-1}$ | 0.87*** | - | -4.77*** | - | -4.04*** | - | -1.31*** | - |
| | (0.06) | | (0.06) | | (0.07) | | (0.03) | |
| $SF_{f,t}$ x $EONIA_{t-1}$ x $L/A_{f,t}$ | 0.31*** | - | -0.08*** | - | -0.10*** | - | -0.14*** | - |
| | (0.03) | | (0.01) | | (0.01) | | (0.01) | |
| $YF_{f,t}$ x $EONIA_{t-1}$ | - | 0.62*** | - | -5.74*** | - | -6.12*** | - | -0.22*** |
| | | (0.09) | | (0.11) | | (0.13) | | (0.05) |
| $YF_{f,t}$ x $EONIA_{t-1}$ x $L/A_{f,t}$ | - | 0.00 | - | -0.00 | - | -0.00 | - | 0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Observations | 6,170,144 | | 16,099,362 | | 10,256,470 | | 22,799,597 | |
| R-squared | 0.94 | | 0.90 | | 0.92 | | 0.89 | |

Both regressions include additional variation of Small / Young Firm, the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on: 1) the impact of Monetary Policy (captured by the EONIA rate) interacted with Firm Heterogeneity (proxied by size and age); 2) the impact of Monetary Policy (captured by the EONIA rate) interacted with Firm Heterogeneity (proxied by size and age) and with the Liabilities / Assets ratio on the log of Real Hourly Wages for the periods 2010 – 2013, because I only have access to balance sheet data following 2010, 2014 – 2022, 2014 – 2019, to remove the COVID-19 impact and, finally, 2010 – 2022.

For young firms, a reduction of 1 percentage point (pp) in the EONIA rate leads to a significant 0.22pp higher increase in wages comparing with older firms**,** but the interaction term with L/A is not statistically significant. This finding suggests that indebtedness, as measured by the L/A ratio, does not meaningfully mediate the relationship between monetary policy and wages for younger firms, and confers robustness to the finding from the Shadow Rate analysis that these ratios do not mediate the baseline effect.

Furthermore, similar insights emerge from the period-specific breakdown. In 2010 – 2013, the wage response to monetary policy was positive and significant (0.62), indicating that young firms experienced lower wage increases than older firms following dovish monetary policy. Consistent with analysis, this effect turns markedly negative in 2014 – 2022 (-5.74), confirming that in the second sub-period young firms responded with larger increases in wages than older firms following an EONIA decrease. After removing the COVID-19 years, results state that this

effect is slightly aggravated, indicating that young firms engaged on lower wage increases comparing with older firms following monetary policy easing in the post-2019 years.

These results imply that debt levels play a more prominent role for small firms than for young firms**,** which aligns with the hypothesis that smaller firms face greater liquidity and credit constraints**,** making them more sensitive to debt levels during periods of monetary easing.

**EONIA and Obtained Financing / Assets (OF/A) ratio**

Table 9 presents the results of the interaction of monetary policy with the OF/A ratio, following equation 3.

Table 9 – Interacting with Firm Heterogeneity, EONIA and OF/A ratio on Wages

| Log (Real Hourly Wage) | 2010 – 2013 | | 2014 – 2022 | | 2014 – 2019 | | 2010 - 2022 | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $SF_{f,t}$ x $EONIA_{t-1}$ | 0.48*** | - | -4.66*** | - | -3.82*** | - | -1.42*** | - |
| | (0.06) | | (0.06) | | (0.07) | | (0.03) | |
| $SF_{f,t}$ x $EONIA_{t-1}$ x $OF/A_{f,t}$ | 4.20*** | - | -1.18*** | - | -2.26*** | - | 0.10 | - |
| | (0.12) | | (0.14) | | (0.20) | | (0.07) | |
| $YF_{f,t}$ x $EONIA_{t-1}$ | - | 0.62*** | - | -5.74*** | - | -6.12*** | - | -0.22*** |
| | | (0.09) | | (0.11) | | (0.13) | | (0.05) |
| $YF_{f,t}$ x $EONIA_{t-1}$ x $OF/A_{f,t}$ | - | 0.01*** | - | 0.00 | - | 0.00 | - | -0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Observations | 6,170,144 | | 16,099,362 | | 10,256,470 | | 22,799,597 | |
| R-squared | 0.94 | | 0.90 | | 0.92 | | 0.89 | |

Both regressions include additional variation of small / young firm, the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on: 1) the impact of Monetary Policy (captured by the EONIA rate) interacted with Firm Heterogeneity (proxied by size and age); 2) the impact of Monetary Policy (captured by the EONIA rate) interacted with Firm Heterogeneity (proxied by size and age) and with the Obtained Financing / Assets ratio on the log of Real Hourly Wages for the periods 2010 – 2013, because I only have access to balance sheet data following 2010, 2014 – 2022, 2014 – 2019, to remove the COVID-19 impact and, finally, 2010 – 2022.

For small firms, the baseline sensitivity to monetary policy remains evident: a 1 percentage point (pp) reduction in the EONIA rate is associated with a 1.42pp higher increase in real hourly wages. However, the interaction term Small $Firm_{f,t} \times EONIA_{t-1} \times OF/A_{f,t}$ is not statistically significant (-0.10), suggesting that higher levels of external financing do not significantly influence how monetary policy affects wages in small firms.

For young firms, the baseline effect following a reduction of 1pp in the EONIA rate is a 0.22pp higher increase in wages than older firms. The interaction with OF/A is both statistically and economically insignificante, reinforcing the notion that financing levels are not a critical mediating factor for young firms.

The results of the division into subperiods indicates that while in 2010 – 2013 small and young firms did not respond to monetary easing with higher wage increases than larger and older firms, respectively, they did in the following period. Interestingly, results from table 10 show that in the COVID-19 years, the effect of wage increase in small and young firms comparing with larger and older firms was intensified for small firms and diminished for young firms.

Concluding, we only get statistically significant results of the mediating effect of the indebtedness ratios in influencing the monetary policy impact on wages for small firms:

1) It is not found consistent statistically and economically evidence to support that the ratios L/A and OF/A mediate the transmission of monetary policy through Shadow Rates and EONIA.
2) In the period 2010 – 2013, coefficients related with the interaction of the ratio OF/A with small firms and both monetary policy measures are disproportionately high, indicating that small firms with a 1pp higher OF/A increase wages by around less 4pp than small firms with lower debt.

We retrieve from this that higher indebtedness ratios in small firms exhibit a more pronounced sensitivity to monetary policy comparing with young firms, that show a more limited and uniform response.

## 9. Monetary policy and skill premium

This section examines how skill levels, proxied by the college attainment dummy, mediate the transmission of monetary policy (MP) into real hourly wages. The model, specified in equation 4, allows for differential effects of monetary policy on high-skilled.

$$(4)\ \log(RHW_{w,f,t})=\alpha+\beta_1(College_{w,t}\times MP_{t-1})+\beta_2(College_{w,t})+\beta_3(Age_{w,t})+\beta_4(Age2_{w,t})+\nu_f+\eta_w+\mu_t+\epsilon_{w,f,t}$$

,where $\log(RHW_{w,f,t})$ denotes the logarithm of the real hourly wage for a worker (w) in a firm (f) at time (t). The key interaction of interest is $College_{w,t}\times MP_{t-1}$**,** which represents the product between firm heterogeneity ($College_{w,t}$) and the lagged monetary policy measure **(**$MP_{t-1}$). The additional college variation and age quadratic terms. Fixed effects are accounted for at the firm ($\nu_f$), worker ($\eta_w$), and time ($\mu_t$) levels, while $\epsilon_{w,f,t}$ represents the residual error term.

The results, presented in Tables 10 and 11, highlight the varying impact of monetary policy across the entire sample (2004 – 2022) and into periods, respectively.

Table 10 – Monetary policy and skill premium (2004 – 2022)

| Log (Real Hourly Wage) | Shadow Rate<br>(1) | EONIA Rate<br>(3) |
|---|---|---|
| $College_{w,t}$ x $MP_{t-1}$ | -0.09*** | -0.21*** |
| | (0.00) | (0.01) |
| $College_{w,t}$ | 0.06*** | 0.08*** |
| | (0.03) | (0.00) |
| Observations | 38,396,622 | 40,357,108 |
| R-squared | 0.89 | 0.88 |

All the regressions include the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured by the Shadow and EONIA rates) interacted with college attainment on the log of Real Hourly Wages for the entire sample period.

The interaction term between the college attainment dummy and monetary policy ($College_{w,t}\times MP_{t-1}$) is negative and statistically significant for both the Shadow Rate and the EONIA rate. Specifically, a 1 percentage point (pp) decrease in the Shadow Rate is associated with a 0.09pp higher wage increase for college-educated workers relative to non-college workers, while a similar change in the EONIA rate corresponds to a 0.21pp higher increase. These findings

suggest that expansionary monetary policy disproportionately increases wage growth for highskilled workers relative to their lower-skilled counterparts.

Table 11 – Monetary policy and skill premium across different periods

| Log (Real Hourly Wage) | 2004 – 2013 | 2014 – 2022 | 2014 – 2019 |
|---|---|---|---|
| | (1) | (2) | (3) |
| $College_{w,t}$ x $SR_{t-1}$ | -0.44*** | 0.02*** | -0.08*** |
| | (0.01) | (0.01) | (0.01) |
| $College_{w,t}$ | 0.08*** | 0.04*** | 0.03*** |
| | (0.05) | (0.05) | (0.06) |
| Observations | 18,433,792 | 19,410,649 | 12,436,611 |
| R-squared | 0.92 | 0.91 | 0.93 |

All the regressions include the polynomial of age (Age and $Age^2$), as well as firm, time and worker fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured by the Shadow and EONIA rates) interacted with college attainment on the log of Real Hourly Wages for the three subperiods of analysis (2004 – 2013, 2014 – 2022 and 2014 – 2019).

During the first period (2004 – 2013) – see column 1 –, the interaction term is strongly negative (-0.44), indicating that contractionary monetary policy had a significantly larger negative effect on high-skilled wages. However, in the second period (2014 – 2022), the interaction term turns mildly positive (0.02), suggesting that the previous effect gets diminished. The robustness check for 2014 – 2019 reaffirms the overall trend, with a negative interaction coefficient (0.08), which suggests that skill-premium wage increases following monetary easing was interrupted by the COVID-19 disruptions.

The results indicate that monetary policy has a differential impact on wages depending on skill level, with easing policies disproportionately benefiting high-skilled workers across the sample period (excluding the COVID-19 years).

## 10. Back – loaded wage mechanism

This study explores the back-loaded wage mechanism, which examines how firm size and employee tenure influence the transmission of monetary policy into real hourly wages. The back-loaded wage mechanism suggests that long-term employees ("stayers") may experience

distinct wage growth patterns compared to new hires following monetary policy changes. I will evaluate this through the following model, where firm size accounts for small firms and large firms:

$$(5)\ \log(RHW_{w,f,t})=\alpha+\beta_1(Stayer_{w,t}\times MP_{t-1})+\beta_2(Firm\_Size_{f,t})+\beta_3(Age_{w,t})+\beta_4(Age2_{w,t})+\nu_f+\eta_w+\mu_t+\epsilon_{w,f,t}$$

,where $\log(RHW_{w,f,t})$ denotes the logarithm of the real hourly wage for a worker (w) in a firm (f) at time (t). The key interaction of interest is $Stayer_{f,t}\times MP_{t-1}$**,** which represents the product between stayer worker and the lagged monetary policy measure **(**$MP_{t-1}$). The model also incorporates age quadratic terms and fixed effects, that are accounted for at the firm ($\nu_f$), worker ($\eta_w$), and time ($\mu_t$) levels, while $\epsilon_{w,f,t}$ represents the residual error term.

**Shadow Rates and wage adjustments**

The analysis using Shadow Rates reveals distinct patterns in how small and large firms adjust wages for stayers relative to new hires in response to monetary policy easing.

Table 12 – Back-loaded Wage Mechanism – Shadow Rate analysis (2004 – 2022)

| Log (Real Hourly Wage) | Small Firms | | Larger Firms | | Full Sample |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $Stayer_{w,t-1}$ x $SR_{t-1}$ | -0.16*** | -0.22*** | -0.27*** | -0.26*** | -0.32*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| $SF_{f,t}$ x $Stayer_{w,t-1}$ x $EONIA_{t-1}$ | - | - | - | - | 0.05*** |
| | - | - | - | - | (0.01) |
| Year FE | X | - | X | - | - |
| Firm FE | X | - | X | - | - |
| Worker FE | X | X | X | X | X |
| Year x Firm FE | - | X | - | X | X |
| Observations | 15,964,023 | 14,608,356 | 20,985,492 | 20,900,872 | 36,893,452 |
| R-squared | 0.86 | 0.92 | 0.90 | 0.93 | 0.92 |

All the regressions include additional variation of Small/ Large Firm, the polynomial of age (Age and $Age^2$), as well as: 1) firm, time and worker fixed effects in columns 1 and 3; 2) worker and year-firm fixed effects in columns 2, 4 and 5. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on:
1. The impact of Monetary Policy (captured by the Shadow Rate) interacted with stayer worker on the log of Real Hourly Wages for the entire sample period in columns 1, 2, 3 and 4 for both small and larger firms.
2. The impact of 1) Monetary Policy (captured by the Shadow Rate) interacted with stayer worker and 2) Monetary Policy (captured by the Shadow Rate) interacted with stayer worker and firm size on the log of Real Hourly Wages for the entire sample period in column 5 for both small and larger firms.

Table 12, that shows the results of the application of equation 5 using Shadow Rates, illustrates that following a 1 percentage point (pp) reduction in the Shadow Rate, stayers in small firms experience a 0.22pp higher increase in wages compared to new hires. For large firms, the corresponding figure is slightly higher at 0.26pp. These findings suggest that under conditions of accommodative monetary policy, firms prioritize increasing the wages of long-term employees, emphasizing the retention of institutional knowledge and experience.

When disaggregating the analysis into two periods, as shown in Table 13, the impact of Shadow Rates on wage adjustments for stayers versus new hires shifts significantly over time.

Table 13 – Back-loaded Wage Mechanism – subperiod analysis with Shadow Rates

| | 2004 – 2013 | | 2014 – 2019 | | 2014 – 2022 | |
|---|---|---|---|---|---|---|
| Log (Real Hourly Wage) | Small Firms (1) | Larger Firms (2) | Small Firms (3) | Larger Firms (4) | Small Firms (5) | Larger Firms (6) |
| $Stayer_{w,t-1}$ x $SR_{t-1}$ | 0.69** | 0.65*** | -0.37*** | -0.32*** | -0.32*** | -0.33*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.00) | (0.00) |
| Observations | 6,764,336 | 9,697,981 | 4,757,787 | 6,811,239 | 8,113,188 | 10,789,299 |
| R-squared | 0.94 | 0.94 | 0.95 | 0.95 | 0.89 | 0.92 |

All the regressions include additional variation of Small/ Large Firm, the polynomial of age (Age and $Age^2$), as well as Worker and Year*Firm fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured by the Shadow Rate) interacted with stayer worker on the log of Real Hourly Wages for each of the three subperiods of analysis for both small and larger firms.

During the 2004 – 2013 period, a 1 percentage point (pp) reduction in the Shadow Rate results in significantly 0.69pp lower wage increases for stayers in small firms and 0.65pp lower wage increases for large firms. This suggests that during this period, firms prioritized wage increases for new hires rather than stayers. However, this pattern reverses in the 2014 – 2022 period. Here, a 1pp reduction in the Shadow Rate leads to wage increases for stayers that are 0.32pp higher in small firms and 0.33pp higher in large firms compared to new hires. This reversal indicates a shift in firm behavior, where monetary policy easing during this later period favored the retention and rewarding of stayers over new hires. This evolution could reflect changing macroeconomic conditions, with firms valuing the stability and productivity of experienced employees more during periods of heightened uncertainty or economic recovery. Finally, the

results do not show differences caused by the Covid-19 years and show limited differences between small / large firms.

**EONIA and wage adjustments**

The findings using EONIA align with some of the patterns observed under Shadow Rates but diverge in key aspects. Table 14 follows equation 5 applying the EONIA and highlights that new hires tend to benefit more from accommodative monetary policy than stayers, with this effect being more pronounced in small firms.

Table 14 – Back-loaded Wage Mechanism – EONIA analysis (2004 – 2022)

| Log (Real Hourly Wage) | Small Firms | | Larger Firms | | Full Sample |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $Stayer_{t-1}$ x $EONIA_{t-1}$ | 0.69*** | 0.79*** | 0.42*** | 0.61*** | 0.66*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| $SF_{f,t}$ x $Stayer_{t-1}$ x $EONIA_{t-1}$ | - | - | - | - | 0.25*** |
| | - | - | - | - | (0.01) |
| Year FE | X | - | X | - | - |
| Firm FE | X | | X | - | - |
| Worker FE | X | X | X | X | X |
| Year x Firm FE | - | X | - | X | X |
| Observations | 18,388,159 | 16,838,604 | 22,294,606 | 22,210,202 | 39,871,579 |
| R-squared | 0.86 | 0.91 | 0.90 | 0.92 | 0.91 |

All the regressions include additional variation of Small/ Large Firm, the polynomial of age (Age and $Age^2$), as well as: 1) firm, time and worker fixed effects in columns 1 and 3; 2) worker and year-firm fixed effects in columns 2, 4 and 5. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on:
1. The impact of Monetary Policy (captured by the EONIA rate) interacted with stayer worker on the log of Real Hourly Wages for the entire sample period in columns 1, 2, 3 and 4 for both small and larger firms.
2. The impact of 1) Monetary Policy (captured by the EONIA rate) interacted with stayer worker and 2) Monetary Policy (captured by the EONIA rate) interacted with stayer worker and firm size on the log of Real Hourly Wages for the entire sample period in column 5 for both small and larger firms.

Specifically, a 1 percentage point (pp) reduction in EONIA is associated with a 0.79pp higher increase in wages for new hires compared to stayers in small firms. For large firms, the corresponding figure is 0.61pp. Column 5 captures the differential effect of EONIA changes on stayers in small firms relative to large firms, revealing a significant and negative additional impact of 0.25pp on wage growth, following a 1pp reduction in EONIA.

Table 15 – Back-loaded Wage Mechanism – subperiod analysis with EONIA

| Log (Real Hourly Wage) | 2004 – 2013 | | 2014 – 2022 | | 2014 – 2019 | |
|---|---|---|---|---|---|---|
| | SF | LF | SF | LF | SF | LF |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $Stayer_{w, t-1}$ x $EONIA_{t-1}$ | 0.71*** | 0.48*** | -3.47*** | -3.68*** | -2.06*** | -1.93*** |
| | (0.01) | (0.01) | (0.07) | (0.06) | (0.11) | (0.10) |
| Observations | 7,438,318 | 12,147,959 | 8,113,188 | 10,789,299 | 5,219,483 | 6,836,589 |
| R-squared | 0.90 | 0.93 | 0.89 | 0.92 | 0.91 | 0.94 |

All the regressions include additional variation of Small/ Large Firm, the polynomial of age (Age and $Age^2$), as well as Worker and Year*Firm fixed effects. | Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
This table presents regression results on the impact of Monetary Policy (captured by the EONIA rate) interacted with stayer worker on the log of Real Hourly Wages for each of the three subperiods of analysis for both small and larger firms.

Table 15 illustrates the differential impact of this effect across subperiods, where SF stands for Small Firms and LF for Larger Firms. During the 2004 – 2013 period, a 1 percentage point (pp) reduction in EONIA resulted in a relatively smaller impact on wage increases for stayers, with small firms showing slightly higher sensitivity than larger firms. This suggests that firms' wage growth policy during this period benefitted new hires the most. In contrast, the 2014 – 2022 period saw a stronger effect of EONIA reductions on wage growth for stayers in both small and large firms. Excluding the COVID-19 years (2020 – 2022) does not significantly alter the results, but we still observe that stayers benefited more in these years from wage increases than new hires.

Overall, the findings from the Shadow Rate analysis are not consistent with those from the EONIA analysis, as in the first case firms seem to prioritize wage increases following monetary easing to stayers and in the second the priority is increasing wages to new hires. I confer more credibility to Shadow Rates, as they are sensitive to conventional and unconventional monetary policy. However, there is a conclusion robust to both types of analysis: firms prioritized in the period 2004 – 2013 new hires, while in the latter period stayers. This shift in firm behavior might reflect the preference for stability and the knowledge of the firms and industry in the last decade, while before the priority might have been hiring new talent.

# 11. *Conclusion*

This study examines the impact of monetary policy on wages, firm heterogeneity, firm indebtedness, and skill premium in Portugal from 2004 to 2022. By integrating employeremployee matched data with firm financial records, empirical evidence is provided on how monetary policy affects labor income distribution across workers and firms. A key contribution of this study lies in the division of the time frame into subperiods, namely 2004 – 2013 and 2014 – 2019, as well as the interaction of monetary policy with leverage ratios as mediating effects, offering new insights into the heterogeneous transmission of monetary policy.

Firm heterogeneity plays a crucial role in labor market outcomes, as small and young firms systematically pay lower wages across the sample and their increase is correlated with lower unemployment, according to the literature, reinforcing their importance in labor market stability. These firms tend to be more financially constrained and dependent on external financing, which makes them particularly sensitive to changes in monetary policy. Findings highlight that monetary policy softening – particularly unconventional policies post-2014 – leads to stronger wage increases, especially in small and young firms compared to larger and older firms. This supports the notion that financial constraints play a critical role in shaping firms' wage-setting behavior and labor market outcomes. However, results also highlight that firm indebtedness, captured by the ratios Obtained Financing / Assets and Liabilities / Assets, does not mediate the transmission of monetary policy into small and young firms.

Additionally, monetary policy affects wage differentials through the skill premium. Highskilled workers experience greater wage increases following monetary easing, while lowskilled workers tend to adjust by increasing their hours worked. This suggests that monetary policy can contribute to shifts in wage structures by favoring workers with higher educational attainment.

Results from the Shadow Rate analysis also provided evidence of a back-loaded wage mechanism, where firms prioritize wage growth for long-term employees (stayers) during expansionary monetary periods. This distinction underscores the role of firm behavior in transmitting the effects of monetary policy into workers' wages.

These findings have important policy implications. When addressing labor market dynamics, policymakers should consider, on the one hand, supporting small and young firms, specially in times of crisis, as monetary policy softening has been shown to effectively benefit financially

constrained firms and their workers. However, it is also crucial to acknowledge that inflation itself can impact real wage adjustments as nominal wages may not respond immediately to changing economic conditions. Furthermore, this study seeks to describe the importance of firm heterogeneity, based on size, age and financial constraints, in its behavior. To project the consequences of policy in the future, this heterogeneity should be considered, because different firms do not react in the same way.

One key limitation of this study, particularly in the analysis of firm indebtedness, is data constraints. The absence of credit bank channel data – such as that used in Jasova et al. (2021) – affected data collection, as I was limited to the publicly available IES dataset.

Additionally, the study does not incorporate the economic effects of the recent geopolitical events, such as the war in Ukraine and conflicts in the Middle East, which significantly influenced inflation and monetary policy decisions. Since the analysis ends in 2022, extending this study to cover the last three years would provide valuable insights into how these external shocks impacted wage dynamics and firm behavior.

Finally, results contribute to the growing literature on monetary policy's effects on wage structures, demonstrating that central bank actions influence wage dynamics through both firm and worker dynamics. Moreover, the analysis highlights notable differences in the results of regressions using Shadow versus EONIA rates, underscoring the importance of selecting appropriate monetary policy indicators. Considering that we are now living in an era where monetary policy is not only conventional, the use of Shadow Rates confers more robustness to future research analysis.

## 12. *References*


Auclert, A., 2019, Monetary policy and the redistribution channel, *American Economic Review, 109*(6), 2333 – 2367, https://www.nber.org/system/files/working_papers/w23451/w23451.pdf .

Bernanke, B., Gertler, M., & Gilchrist, S., 1994, The financial accelerator and the flight to quality, National Bureau of Economic Research, Working Paper No. 4789, https://doi.org/10.3386/w4789 .

Cloyne, J., Ferreira, C., Froemel, M., & Surico, P., 2018, Monetary policy, corporate finance, and investment, National Bureau of Economic Research, Working Paper No. 25366, https://doi.org/10.3386/w25366 .

Costa Pinto, A., & Pequito Teixeira, C., 2019, Political institutions and democracy in Portugal: Assessing the impact of the Eurocrisis, Palgrave Macmillan, https://doi.org/10.1007/978-3-319-98152-9 .

Dekten, C., Gartner, M., Governments, trade unions and the macroeconomy: An expository analysis of the political business cycle, 1992, Volume 73, pages 37– 53, https://link.springer.com/article/10.1007/BF00142915 .

Dinlersoz, E., Kalemli-Ozcan, S., Hyatt, H., & Penciakova, V., 2018, Leverage over the firm life-cycle, firm growth, and aggregate fluctuations, National Bureau of Economic Research, Working Paper No. 25226, https://doi.org/10.3386/w25226 .

European Central Bank, n.d., EONIA historical data: FM.M.U2.EUR.4F.MM.EONIA.HSTA, ECB Statistical Data Warehouse, retrieved November 15, 2024, from https://data.ecb.europa.eu/data/datasets/FM/FM.M.U2.EUR.4F.MM.EONIA.HSTA .

Fort, T. C., Haltiwanger, J., Jarmin, R. S., & Miranda, J., 2013, How firms respond to business cycles: The role of firm age and firm size, National Bureau of Economic Research, Working Paper No. 19134, http://www.nber.org/papers/w19134 .

Guiso, L., Pistaferri, L., & Schivardi, F., 2013, Credit within the firm, *The Review of Economic Studies, 80*(1), 211–247, https://doi.org/10.1093/restud/rds024 .

Gylfason, T., & Lindbeck, A., 1992, The interaction of monetary policy and wages, European Economic Review 36(2-3), 489-507, https://doi.org/10.1016/0014-2921(92)90037-B .

Haldane, A. G., 2017, A little more conversation, a little less action, Speech at the Federal Reserve Bank of San Francisco, Macroeconomics and Monetary Policy Conference, https://www.bankofengland.co.uk/-/media/boe/files/speech/2017/a-little-more-conversation-alittle-less-action.pdf .

Ippolito *et. al, 2018, CEPR Discussion Paper No. DP16549*, The transmission of monetary policy through bank lending: The floating rate channel , *Journal of Monetary Ecomonics,* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3928862 .

Jasova, M., Mendicino, C., Panetti, E., Peydró, J.-L., & Supera, D., 2021, Monetary policy, labor income redistribution, and the credit channel: Evidence from matched employeremployee and credit registers, *CEPR Discussion Paper No. DP16549*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3928862 .

Jiménez, G., Ongena, S., Peydró, J.-L., & Saurina, J., 2012, Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications, *American Economic Review, 102*(5), 2301–2326, https://assets.aeaweb.org/asset-server/articlesattachments/aer/data/aug2012/20100064_app.pdf .

Michelacci, C., & Quadrini, V., 2005, Financial markets and wages, National Bureau of Economic Research, Working Paper No. 11050, https://doi.org/10.3386/w11050 .

Moscarini, G., & Postel-Vinay, F., 2012, The contribution of large and small employers to job creation in times of high and low unemployment, American Economic Review 102(6), 2509–2539, https://doi.org/10.1257/aer.102.6.2509 .

Wu, J. C., n.d., Shadow rates, Retrieved from https://sites.google.com/view/jingcynthiawu/shadow-rates .

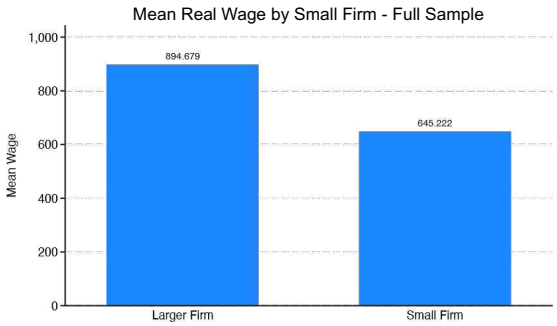
# 13. Appendix

*Table A 1*

| Variable | Description |
|---|---|
| **Dependent variable:** | |
| Log (Real Hourly Wage) | The logarithm of the Real Hourly Wage. |
| **Monetary Policy variables:** | |
| EONIA rate | Yearly Euro Overnight Index Average. |
| Shadow rate | The estimated interest rates used as monetary policy tools when the nominal rates are at or near zero. |
| **Macroeconomic variables:** | |
| Real GDP growth | Portuguese real GDP growth rate. |
| Volatility Index – US economy | US economy volatility index. |
| **Firm level heterogeneity:** | |
| Firm age | Years passed since the constitution of the firm. |
| Obtained Financing | Loans obtained from the firm's Balance Sheet. |
| Liabilities | Liabilities from the firm's Balance Sheet. |
| Assets | Assets from the firm's Balance Sheet. |
| Small Firm (SF) | A dummy variable that equals 1 if the firm has fewer than 50 employees, and 0 otherwise. |
| Young Firm (YF) | A dummy variable that equals 1 if the firm is 5 years old or younger, and 0 otherwise. |
| **Worker level heterogeneity:** | |
| Employee Age | Worker's age |
| College education | A dummy variable that equals 1 if the individual has attained a university degree, and 0 otherwise |
| Stayer | A dummy variable that equals 1 if the individual did not change firms in the previous year, and 0 otherwise. |
| Female | A dummy variable that equals 1 if the individual is a woman. |
| **Other variables of interest:** | |
| Daily Hours Worked | Average total hours worked a day, assuming 22 working days a month. |
| Real Wage | Nominal wages discounted by the inflation |

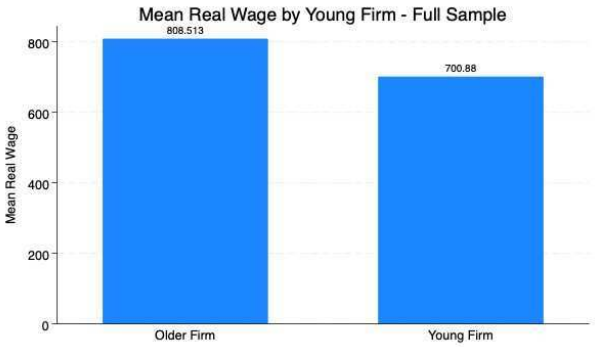
This table presents the descriptive statistics of each variable of interest in the study.

*Figure A 1 – Mean Real Wage by Small Firm – Full Sample*



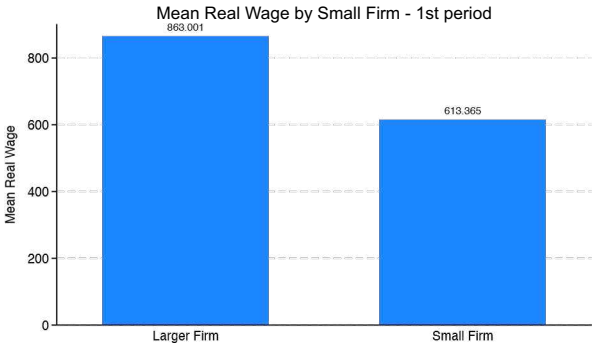

This figure presents the differences in the mean real wage paid by larger firms in comparison with smaller firms across the sample period.

*Figure A 2 – Mean Real Wage by Young Firm – Full Sample*




This figure presents the differences in the mean real wage paid by older firms in comparison with young firms across the sample period.

*Figure A 3 – Mean Real Wage by Small Firm – 1st period*

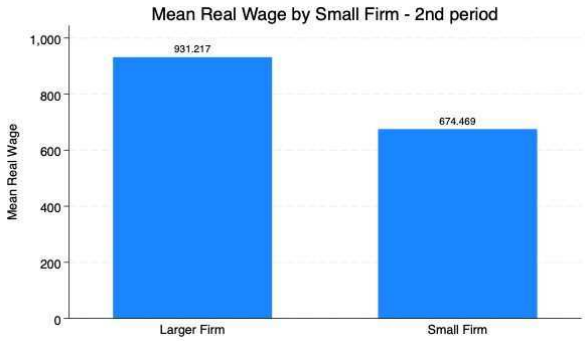



This figure presents the differences in the mean real wage paid by larger firms in comparison with small firms across the first subperiod of analysis: 2004 – 2013.

*Figure A 4 – Mean Real Wage by Young Firm – 1st period*


This figure presents the differences in the mean real wage paid by older firms in comparison with young firms across the first subperiod of analysis: 2004 – 2013.

*Figure A 5 – Mean Real Wage by Small Firm – 2nd period*

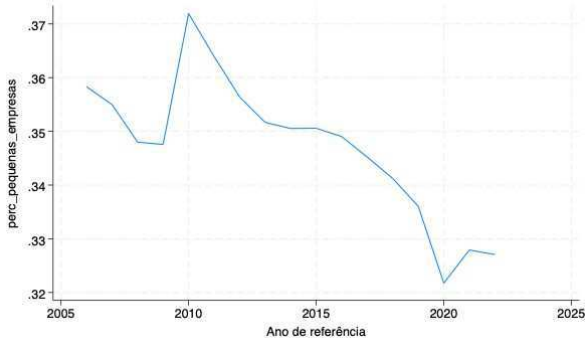



This figure presents the differences in the mean real wage paid by larger firms in comparison with small firms across the second subperiod of analysis: 2014 – 2022.

*Figure A 6 – Mean Real Wage by Young Firm – 2nd period*

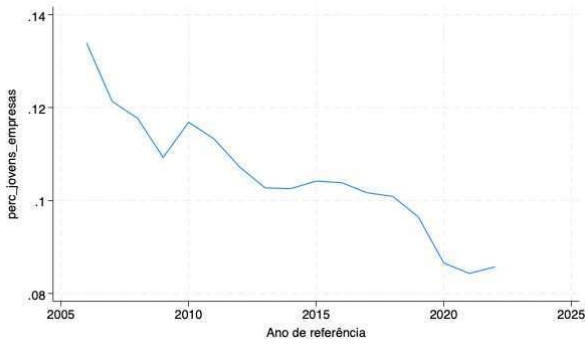

This figure presents the differences in the mean real wage paid by older firms in comparison with young firms across the second subperiod of analysis: 2014 – 2022.

*Figure A 7 – Share of Small Firms*




This figure represents the evolution of the share of small firms in Portugal across the sample period.

*Figure A 8 – Share of Young Firms*

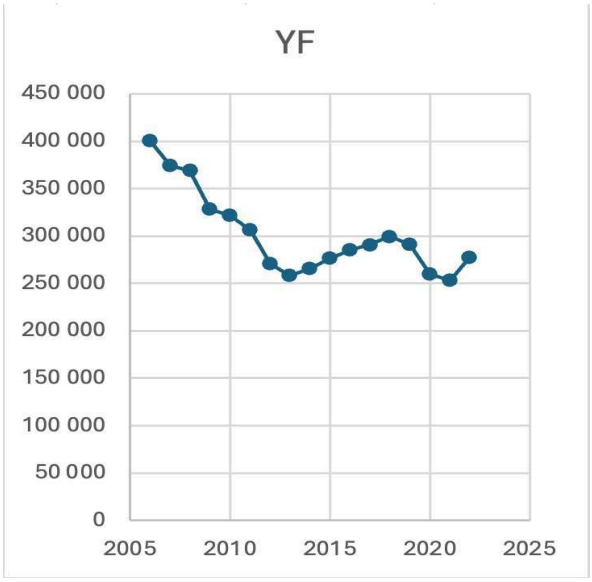



This figure represents the evolution of the share of young firms in Portugal across the sample period.

*Figure A 9 – Number of Small Firms*


This figure represents the evolution of the number of small firms in Portugal across the sample period.

*Figure A 10 – Number of Young Firms*




This figure represents the evolution of the number of young firms in Portugal across the sample period.