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The Heterogeneous Cost of Wage Rigidity: Evidence and Theory

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Non-Technical Summary

In a 2015 speech, the then president of the European Central Bank (ECB) Mario Draghi claimed: *"For a larger sample of countries, firms with flexibility at the plant-level have reduced employment less during the crisis than those bound by centralized wage bargaining agreements, partly because they have been more able to adjust wages to economic conditions."*[1]

Draghi was citing research conducted at the ECB, comparing the effects of the Great Recession in different European countries where workers are subject to heterogeneous labor market regulations.[2] While this argument is intuitively appealing, testing whether rigidly centralized wage bargaining agreements can cause firms' inability to react to aggregate shocks is not an easy task. For example, European countries may differ in a number of institutional factors that could contaminate causal inference.

In the work we present here, we chose to focus on a single, fairly integrated labor market, that of Italy. We do so for two reasons. First, in Italy wage setting is still fairly centralized and firm-level bargaining plays a relatively minor role, contrary to most European countries where recent reforms have increased contract negotiation flexibility. Hence, our results may serve as a useful benchmark. Second, we can make use of a unique employee-employer dataset comprising the universe of the workers employed in the Italian private sector, which we access through the project "VisitINPS Scholars Program" at the Italian Institute of Social Security. We combine this dataset with intraday data on stock returns, as well as hand-collected information on renewals of collective agreements.

We then test, using high-frequency identification, whether wage rigidity induced by collective bargaining amplifies the effects of monetary policy. We focus on monetary policy because of the intense debate, among researchers and policymakers, regarding its effectiveness since the onset of the Great Recession.

The intuition we exploit is straightforward and relies on the fact that a firm may be hit by a shock at different stages of the "life" of its workers' collective agreement. If the monetary policy shock occurs when the agreement is close to the renewal, any change in firm profitability due

[1] Introductory speech at the ECB Forum on Central Banking, Sintra, 22 May 2015.
[2] Ronchi, Maddalena & di Mauro, Filippo, 2017. "Wage bargaining regimes and firms' adjustments to the Great Recession," Working Paper Series 2051, European Central Bank.

to a macroeconomic shock will be taken into account in the new contract. On the other hand, if there is a long time left before the renewal, workers and managers will be stuck with the same wage despite the fact that the firm's profitability might have drastically changed. Hence, in this case, the impact of a change in the Central Bank's monetary policy will have stronger effects on firm outcomes.

Exploiting high-frequency identification of monetary policy shocks, we find results consistent with our hypothesis. More specifically, we find that stock market valuations and employment levels react more when the average time left before the renewal of the employees' collective agreement is large. In further tests, we find that this amplification channel is stronger in firms characterized by high labor intensity and low profitability. This also applies to companies that employ less flexible staffing arrangements and at times of low economic growth. The effects are quantitatively important and are consistent with the predictions of a rigorous general equilibrium model we develop to interpret the results.

Overall, our findings show that the response to monetary policy shocks is heterogeneous and depends on the degree of nominal rigidities, as well as on firms' characteristics, suggesting that monetary policy can have important distributional consequences.

The Heterogeneous Cost of Wage Rigidity: Evidence and Theory*

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Abstract

Using a unique confidential contract level dataset merged with firm-level asset price data, we find robust evidence that firms' stock market valuations and employment levels respond more to monetary policy announcements the higher the degree of wage rigidity. Data on the renegotiations of collective bargaining agreements allow us to construct an exogenous and accurate measure of wage rigidity. The amplification induced by wage rigidity is stronger for firms with high labor intensity and low profitability. There are clear distributional consequences of monetary policy. We rationalize the evidence through a model in which firms in different sectors feature different degrees of wage rigidity due to staggered renegotiations vis-a-vis unions.

JEL:

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1 Introduction

Labor market conditions play a central role in the transmission of monetary policy; indeed, wage rigidity has the longest tenure in macroeconomics as driver of monetary non-neutrality, at least since the seminal work by Fischer (1977) and Taylor (1979). Yet, it has been so far hard to exactly quantify the role and the costs of wage rigidities. Beyond that, wage rigidities differ across sectors, and this can add important dimensions to the recent interest in the distributional consequences of monetary policies.[1] A major obstacles in answering those questions has been the lack of a precise and truly exogenous measure of wage rigidity. Wages have most often been measured through survey evidence, which may underlie large measurement errors.[2] Moreover, the frequency of wage changes may not be an adequate measure of wage rigidity if the time of their adjustment is endogenous to firms or workers' decisions. In addition, in macroeconomics the focus has typically been on aggregate outcomes, despite the fact that there can be heterogeneity in the ability of firms or workers to absorb the effects of such frictions.

Using a unique employer-employee matched dataset for Italian firms we are able to address these concerns and to assess the effects of exogenous changes in monetary policy. We provide a novel identification of wage rigidity by leveraging on the staggered structure of collective renegotiations, which occur at different dates for different firms, and whose dates are outside of individual firms' control. Our dataset covers the whole universe of contract negotiations, thereby allowing us to exploit the large variation in wage rigidity across firms. Due to this, our results provide novel insights on the distributional consequences of monetary policy on firms' stock values and employment. The question is meaningful also because a recent literature has emphasized that there is substantial heterogeneity in firm-level employment dynamics that is masked by aggregate data.[3]

[1]For the role of nominal rigidities, see Nakamura and Steinsson (2008), Gorodnichenko and Weber (2016), and Carvalho (2006). For the importance of heterogeneity in financial conditions, see Bahaj et al. (2017), Jeenas (2018), and Ottonello and Winberry (2018). Despite its importance, the role of heterogeneous wage rigidity has not been examined.

[2]Some exceptions are Avouyi-Dovi et al. (2013) and Le Bihan et al. (2012), who use administrative data from France.

[3]See for example Davis et al. (1996), Fort et al. (2013), and Dinlersoz et al. (2019).

We rationalize the economic channel behind our empirical findings by building a multi-sector model with heterogeneous wage rigidity due to staggered contracts. The model-based regressions match well their empirical counterparts.

Our micro-level dataset contains the contracts from collective bargaining agreements for the entire Italian industrial landscape, merged with high frequency data on stock prices for individual listed firms and other variables for firms' economic activity, such as employment levels. The Italian labor market offers a unique environment for our analysis, as virtually all workers are covered by collective bargaining agreements. Contract renegotiations occur at predetermined schedules and firms in different sectors have different renegotiation dates. This staggered structure, coupled with the large firm-level variation, allows us to construct a measure of wage rigidity based solely on the timing of collective agreements. Our proxy exploits information on the time left before the expiration of the agreement in force on the day of a monetary policy announcement. We argue, in the spirit of Olivei and Tenreyro (2007), that the further the expiration day, the longer the firm will be unable to adjust its wages to a change in the economic environment. Hence, a higher distance to contract renewal will amplify the impact of a monetary policy shock. Once signed, collective agreements are outside of an individual firm's control; for this reason, our proxy provides an exogenous measure of nominal rigidities.

In our empirical design, we identify monetary policy shocks at high frequency via changes in swap rates on money market rates, namely the main ECB policy rate, shortly after and before the time an ECB meeting takes place.[4] Our dependent variable is the volatility of stock returns over the same short horizon, and we show that the effects of monetary policy are amplified by higher wage rigidity, as proxied by our measure based on the timing of contract renewal.

We find that, on announcement days, monetary policy shocks increases stock market volatility. However, this effect is highly heterogeneous and depends on the firm degree of wage rigidity. By

[4]Early work on high frequency identification of monetary policy shocks includes Gürkaynak et al. (2005) and Barakchian and Crowe (2013). Following a recent approach by Corsetti et al. (2018) we employ swap rates to compute the surprise component.

interacting the monetary policy shock variable with our wage rigidity proxy, we find that this effects is larger for firms characterized by high wage rigidity. The magnitudes are economically meaningful. These results are robust to a number of alternative tests. We show that our measure is not simply proxying for some other firm characteristics, such as size, capital structure choices, profitability, and labor intensity. Moreover, we show that they do not depend on the particular horizon of the swap rate we use and that they do not capture an industry or seasonality effect. We also show that shortening the window around the announcement, following recent work by Altavilla et al. (2019), produces qualitatively similar results as well.

The highly refined information available in our comprehensive matched employer-employee dataset allows us also to condition on several firm and worker characteristics, disentangling various aspects of the labor demand channel. On the firm side we find that the amplification induced by wage rigidity is driven by firms with high labor intensity, as measured by the ratio of employees to total assets, confirming that the labor channel is indeed the driving force behind our results. The larger exposure to labor intensity has important implications for the recent trends in market concentration, as firms with high physical and intangible capital intensity also enjoy the privilege of being sheltered from monetary policy shocks and can extract larger rents.[5] We also compare firms according to their profitability, as measured by their return-on-asset. We find that the effects of wage rigidity are large and significant only in firms with low profitability. Hence, nominal rigidities appear especially costly for firms that may be unable to absorb the impact of such shocks. A similar interpretation holds when we show that our results appear especially strong during economic downturns.[6]

We also leverage on worker-level information on flexibility of staffing arrangements. We find that firms that have a larger proportion of workers with short-term or part-time contracts are relatively unaffected by the combination of monetary policy shocks and wage rigidity. Hence, the

[5]See Autor et al. (Forthcoming) documenting the link between the fall in labor share and the raise in market concentration.

[6]See also Grigsby et al. (2019) for US evidence on the state-dependence nature of wage rigidity.

adoption of more flexible employment contracts appears to be a powerful tool to dampen aggregate fluctuations.

To explore heterogeneity on the workers' side, we aggregate the shocks at quarterly frequency. We find that wage rigidity amplifies the impact of monetary policy on the volatility of labor outcomes, whether we focus on the number of employees, hours worked or the total wage bill, and the effects are in the same order of magnitude as those found on stock returns. However, workers with full-time contracts are fairly unaffected by the combined effects of monetary policy shocks and wage rigidity, suggesting that most of the burden of such adjustments is borne by part-time workers. Again, this confirms that monetary policy can have significant distributional consequences, not only across firms but also across workers.

We rationalize this evidence by constructing a macro model whereby firms in different sectors face different degrees of wage rigidity due to staggered renegotiations with unions.[7] Firms in the model act under monopolistic competition, so that fluctuations in marginal costs translate into fluctuations of future discounted profits, and hence firm value. Using simulated data from our model we find that the model-based regressions mirror their empirical counterparts with a reasonable quantitative fit. Intuitively, the transmission mechanism in the model runs as follows. Firms facing larger distance between contract renegotiation at the time of a monetary policy shock cannot re-adjust marginal costs. This induces larger variations in employment demands and in mark-ups. The latter in turn translates into larger fluctuations of future discounted profits, and hence valuations.

Our paper makes three contributions. On the methodological side, we combine the advantage of using a measure of nominal rigidity based on the timing of contract renegotiation (as in Olivei and Tenreyro, 2007, and Björklund et al., 2019), which is crucial to achieve causal identification, to the robustness of a "model-free" approach that infers the role of nominal rigidities from stock market data (as in Gorodnichenko and Weber, 2016), rather than from parametric approaches,

[7]This structure captures well the realm of many Western European countries (Ronchi and di Mauro, 2017), whereby contracts are renegotiated at fixed length, but staggering occurs among firms in different sectors.

such as vector autoregressive models.

Second, we use this proxy to uncover heterogeneous responses of firms, in terms of stock values and employment, to high-frequency identified monetary policy shocks. The heterogeneity in the response varies with a number of firms and workers' characteristics, and we establish a set of novel facts regarding their interaction with nominal rigidities that cannot be detected without relying on micro-data. Third, we construct a dynamic general equilibrium with sectorial firms' heterogeneity in the degree of wage rigidity. While fairly standard in all other respects, the model replicates well the empirical results.

The rest of the paper proceeds as follows. Section 2 compares our work to past literature. Section 3 presents a simple model to assess the role of monetary policy in the presence of rigid wages. The model also serves the purpose of disciplining the subsequent econometric specifications. Section 4 provides some institutional background and describes our data. Section 5 presents our empirical evidence. Section 6 develops a fully dynamic multi-sector general equilibrium model that can rationalize and replicate the evidence. Section 7 concludes. Tables and figures follow.

2 Comparison to the Literature

Our paper is related to the literature attempting to measure wage rigidity and its impact on the real economy. The precise measurement of wage rigidity has traditionally been an unreachable task. Most of past studies attempting to measure it only relied on survey data, whereby measurement errors and large imputations vastly challenge the precision.[8] We take a different route, by using as source of variation the timing of collective agreements, that we match on an administrative employer-employee matched dataset.[9]

[8]For the US, McLaughlin (1994), Kahn (1997), and Barattieri et al. (2014), among others, use survey data. For Europe survey evidence is in Smith (2000) and is summarized in Kramarz (2001). The issue of measurement error in labor surveys is addressed in Card and Hyslop (1997) and Altonji and Devereux (2000). Groshen and Schweitzer (1999) use employer data, while Bewley (1998) conducted interview himself. Finally, the International Wage Flexibility Project (IWFP), whose results are summarized in Dickens et al. (2007), analyzes individuals' earnings in 31 different datasets from sixteen countries.

[9]See also Abowd et al. (1999) for a study on workers' flows using French employer-employee matched dataset.

Our paper is also related to the recent literature assessing the heterogeneous effects of monetary policy announcements on firms' activity and stock market values. The literature examined mainly two forms of heterogeneity, in price stickiness (Gorodnichenko and Weber, 2016, and Carvalho, 2006)[10] and in financial conditions (Bahaj et al., 2017, Jeenas, 2018, Gürkaynak et al., 2019, and Ottonello and Winberry, 2018). Despite the importance of labor market frictions and wage rigidities in particular, they were absent from this literature so far, a reason being also a lack of granular administrative contract-level data.

Our empirical methodology builds and departs from Gorodnichenko and Weber (2016). They merge confidential micro-level data underlying the producer price index (PPI) with stock price data of individual firms from NYSE Trade and Quote (TAQ) and study how stock returns of firms with different frequencies of price adjustment respond to high-frequency identified monetary shocks. Contrary to them we focus on wage rigidity. While the frequency of price adjustment might be, in some respects, a choice variable for a firm's managers, the factors affecting the timing of the wage renegotiations in our context are outside of a firm's control. Hence, our strategy exploits arguably exogenous variation in nominal rigidities. Moreover to highlight the role of the labor market channel we also examine the differential impact of monetary policy on firms' employment demand, conditioning also on various firms' and workers' characteristics. The latter allows us to best exploit the distributional consequences of monetary policy.

The monetary transmission mechanism in presence of wage rigidity has been studied by Olivei and Tenreyro (2007), who use VAR evidence with aggregate data. Given our access to refined and precise micro data, we can focus on the more novel cross-sectional effects, rather than on the aggregate economy. Moreover, our approach, not relying on parametric assumptions, is essentially model-free. Closer to our strategy, Björklund et al. (2019) construct proxies for wage rigidities based on renegotiation periods using Swedish administrative data. However, their focus is again on aggregate consequences, rather than distributional effects of shocks.

[10]Evidence on the importance of price stickiness heterogeneity is also in Nakamura and Steinsson (2008), Zbaracki et al. (2004), Anderson et al. (2015) and Blinder (1991).

This paper is laterally related to a growing literature linking finance and labor market frictions. Serfling (2016) and Simintzi et al. (2014) show that firms reduce leverage in the presence of higher firing costs, which imply an increase in operating leverage. In our setting, instead, the impact of monetary policy on firms' value and employment is due to the inability of adjusting wages following the shock.

3 A Simple Model to Guide Intuition

The effects of monetary policy are surely best appreciated in a fully dynamic quantitative model. It is instructive, however, to outline the functioning of a simple model that can capture the economic intuition behind our empirical analysis and can discipline its specification. The main goal is to establish a link between shocks to profitability and changes in firms' market values and to show how this connection is amplified by wage rigidity. We impose at this stage a minimal set of assumptions, so that the resulting testable implications from the model can be subject to an agnostic test. We postpone to Section 6 the presentation of a more rigorous dynamic general equilibrium model that can quantify the economic channels underlying our empirical results.

Consider a firm whose expected per-period cash flow is equal to $\mathbb{E}[\pi_t] = \pi$. The firm's horizon is infinite, and discounts each period at a rate δ. As in Fischer (1977), every two periods the trade union representing the workforce bargains with firms" managers on behalf of workers. The firm's total surplus, represented by its cash flow, is then split with bargaining weights β and $1-\beta$ between workers and shareholders, respectively. At the beginning of period t, all players learn the value of π_t. Before the actual value realization, trade union and managers agree on the total wage bill w that will accrue to workers in periods t and $t+1$. Since the value of π_{t+1} is unknown at time t, we simply assume that workers and managers set wages $w_{t+1} = \beta\pi$, which implies that shareholders get $(1-\beta)\pi_t$ in period t and $\pi_{t+1} - \beta\pi$ in period $t+1$.[11]

[11] Other bargaining protocols are, of course, possible. For example, if workers are risk averse, they may be willing to accept a wage lower than $\beta\pi$, "paying" shareholders for this implicit wage insurance. All we need for the intuition of the model to go through is that w_{t+1} is not fully contingent on the realized π_{t+1}. (See also the discussion on indexing below.)

Now consider a shock, such as a monetary policy announcement, that temporarily changes the cash flow of the firm by an amount Δ only in period τ, so that $\pi_\tau = \pi + \Delta$. The impact of this shock to the firm' value depends upon the timing of the contract's renewal. If $t = \tau$, meaning that the renegotiation of the wage contract occurs immediately after the shock is realized, the firm value is:

$$V_{\tau,\tau=t} = (1-\beta)\left(\frac{\pi}{1-\delta} + \Delta\right) \tag{1}$$

On the other hand, if the shock occurs *after* the renegotiation has taken place, hence if $\tau = t+1$, the previously bargained profit share does not reflect the changed profitability of the firm. Hence, in this case, firm value is:

$$V_{\tau,\tau=t+1} = (1-\beta)\frac{\pi}{1-\delta} + \Delta \tag{2}$$

The difference between these two values is $V_{\tau,\tau=t+1} - V_{\tau,\tau=t} = \beta\Delta$. Two immediately testable implications emerge. First, the change in firms' value is directly related to the distance from the contract renegotiation. Second, the change is larger as β increases. Workers' bargaining power captures union' strength, which in turn is related to the firm's labor share.

A few considerations are worth at this stage. First, certain indexing arrangements might restore money neutrality. For example, the effects of wage stickiness could be eliminated by state contingent contracts. However, as further discussed in Sections 4.1 and 4.4, in Italy wages reflect only in a limited way changes in profitability, whereas indexation to the broad consumer price index has been repealed in 1994 (see Manacorda, 2004, for details). Collective agreements require changes in minimum wages to occur according to a predetermined schedule, reflecting *expected* inflation. However, since such changes are fully anticipated, they will be fully incorporated into stock prices, without affecting the predictions of our model.

Second, without making strong assumptions about a firm's profit function and its optimal price level, it is generally impossible to tell whether a monetary policy announcement has a positive or negative effect on its profit (hence whether $\Delta > 0$ or $\Delta < 0$) We make this point graphically in Figure 1. Suppose that an expansionary monetary policy shock moves the optimal price level from p_1^* to p_2^* but output prices are rigid in the short run. The price at the time of the announcement may be low (p_L) or high (p_H), causing profits to fall or rise after the shock, respectively. Rather than making structural assumptions regarding the firm pricing functions, we follow Gorodnichenko and Weber (2016) and accommodate a non-linear relationship between shocks and profits by including the square terms of the monetary policy shock and of the firm's stock return in the econometric specification. Such assumptions also make the identification procedure independent from specific models' assumptions; in other words, all we need is that large shocks have larger effects on firm revenues.[12]

4 Institutional Background and Data

4.1 Institutional Background

In this section we describe the institutional context and illustrate the aspects that make it amenable to the goals of our empirical analysis.

Italy has a centralized wage bargaining process, similar to other developed economies in Western Europe, such as France, Belgium, Portugal,Finland, Iceland, and Slovenia.[13] For each job "category", collective bargaining agreements regulate salary conditions, days of vacation, compensation for extra hours, and a number of other aspects of the employee-employer relationship. While there is a loose relationship between job categories and economic sectors, mapping each agreement to a single industry is generally not straightforward.[14] Hence, it would not be possible to construct

[12] In the model we present in Section 6, we rule out price stickiness to focus solely on the effects of wage rigidity but, for consistency with our reduced-form evidence, estimate the same empirical specification on the simulated data generated by the model.

[13] In other countries, such as Austria, Germany, and Spain, centralized wage-setting is also prevalent, but this coexists with firm-level bargaining (Boeri et al., 2017).

[14] In some cases, collective agreements may regulate the labor conditions of workers with different positions within the same sector. For example, different collective agreements are in force for *banking employees* and *banking managers* In other cases, workers in the same industry may be covered by different collective agreements depending on firm characteristics; for example, *small* and *large textile* firms are subject to different agreements.

an accurate metric of wage rigidity without the use of administrative data that match each worker to her job category. Second, in terms of representativeness, collective agreements, typically valid for two or three years, are signed between unions and industry representatives, but are valid *erga omnes*, meaning that every worker is subject to the provisions of a collective agreement, independent of whether she is enrolled in a union.[15] Therefore, our dataset is not biased toward unionized occupations because workers or firms cannot opt out from the provisions of the agreements. Because the law does not set minimum wages, collective agreements are, for all purposes, equivalent to legislative provisions and an employer is sanctioned if the collective agreement in force is violated.

Recent empirical work has shown that collective bargaining is a major determinant of compensation policies, making nominal wages largely unrelated to firm productivity.[16] For example, Boeri et al. (2017) note that the gap in nominal wages between North and South Italy is 4% despite differences in productivity in the order of 30%. They compare the Italian labor market with the German one, where the increase in pay dispersion has been much more pronounced (Card et al. (2013)). The above implies, first, that the data from our collective bargained contracts well track the wage dynamics in the country and, second, that the disconnect between wages and productivity already signals an impaired ability of firms to adjust marginal costs to economic shocks.

A final importantly observation concerns the link between wages and minimum wages. Our wage rigidity proxy can account for nominal rigidity only if actual wages are closely linked to minimum wages established by collective agreements. This is indeed the case because compensation schemes in Italy follow a "two-tier" scheme (Dell'Aringa, 2017), whereby wages are given by the sum of a minimum wage, prescribed by the relevant collective agreement, and a firm-specific top-up. The two-tier structure implies that any change in the minimum wage will affect the entire distribution of earnings.[17] Despite this, it is possible that firms mitigate or even fully eliminate

[15]From Article 39 of the Italian Constitution: *Registered trade unions (...) may, through a unified representation that is proportional to their membership, enter into collective labor agreements that have a mandatory effect for all persons belonging to the categories referred to in the agreement.*

[16]See also Devicienti et al. (2016) for worker-level evidence. In addition to surveying the existing literature, we will provide additional corroborating evidence in Section 4.4.

[17]Boeri (2015) notes that such arrangement, fairly common in Western Europe, fails to align wages and firm

the effects of changes in minimum wages by adjusting individual top-ups. We check the factual relevance of this possibility and, in Section 4.4, show empirically that minimum wages established by collective agreements do generate significant variation in actual workers' compensation.

4.2 Data

Our dataset combines and matches several sources. Our dataset includes the universe of all the Italian individuals working in the private sector, that we use through restricted, on-site access to a confidential database made available by *Istituto Nazionale della Previdenza Sociale* (INPS), the Italian national institute of social security.[18]

Starting from January 2005, the dataset records income and other information of each worker at monthly frequency. Crucially for our analysis, the dataset also has a variable called *contract code*, which identifies the job category each individual worker's job belongs to. We retrieve information on each collective agreement from the web archive of *Consiglio Nazionale dell'Economia e del Lavoro* (CNEL), a council established by the Italian Constitution that advises the executive and legislative branches of the public administration. For each of the over 2,000 contracts available in the archive we code the dates in which the contract was signed and expired.

We merge the INPS data with the Bureau Van Dijk (BvD) "Amadeus" database using the fiscal identifier of the company, and purchase intraday data on stock prices of all the companies listed on the Milan Stock Exchange between 2005 and 2016 from Tick Data, LLC. Since we rely on stock market reactions over a relatively short window, we exclude firms with stocks that are very illiquid, namely those for which the average price over the sample is below 1 euro. This overall merging of firm-level data allows us to link the contract-based variables with information on firm values. We further merge the combined INPS-Amadeus dataset as well as the stock market data with Compustat Global through ISIN or firm name to obtain accounting variables of the listed companies.

productivity.

[18]The data was made available to researchers selected through a refereed call for projects within the program "VisitINPS".

Once we match these three datasets, we find that workers in the listed firms in our sample belong to 135 job categories, and their minimum wages are determined by 368 collective agreements. Figure 2 displays the number of new agreements signed in each month. Remarkably, the agreements are fairly well distributed across months. This is an advantage of our setting relative to the one studied, for example, by Olivei and Tenreyro (2007) because we do not rely on any assumptions regarding seasonality in the cycle of the collective agreements.

Finally, we use intraday data on Euro Overnight Index Average, or *EONIA*, swap rates.[19] We refer to Section 4.5 for details about how we use swap rates to construct our monetary policy shocks.

4.3 The Wage Rigidity Proxy

One contribution of our paper consists in the precise identification of the nominal rigidities through a fully exogenous proxy of wage rigidity, which varies across firms. To obtain this we aggregate, at the firm-month level, information on workers' contract termination dates, occurring prior to their contract renewal.

For any given job category c and day t, we know the date on which the agreement in force was signed, its date of expiration τ and the date on which the agreement that replaced the one in force on date t was signed. However, the latter and the date of expiration often do not coincide because of "vacancy periods" during which, as long as employers' representatives and trade unions cannot find an agreement and sign a new contract, the expired contract is assumed to be in force.

We could, in principle, construct the variable "time to renewal" of each agreement simply by subtracting t from the date on which the contract that replaces the one currently in force is signed. This would introduce, however, a forward-looking bias because, on day t, agents are not aware of the date of the next renewal - i.e., they have no certainty on possible delays in the bargaining process. They foresee, however, when the agreement is going to expire. Thus, we adjust our "time to renewal" variable by subtracting the current date from the *expiration* date, which is known to

[19] Kindly shared with us by Corsetti et al. (2018).

agents. We truncate this variable to zero to avoid negative values which would not be meaningful for economic purposes and which would otherwise arise during vacancy periods. Realistically, we conjecture that investors form their expectations assuming that, after the expiration of an agreement, the next agreement will be signed any time soon.

Any firm can hire workers in several job categories, who are therefore subject to different collective agreements. Based on this, we construct a firm level measure of wage rigidity WR as follows:

$$WR_{i,t} \equiv \log \left(1 + \frac{\sum_j w_{i,j,c} \times \max\{0, t - \tau_{i,j,c,t}\}}{\sum_j w_{i,j,c}} \right) \tag{3}$$

where j, t, c index workers, firms, and job categories, respectively. We use the max operator to truncate the difference $t - \tau$ at 0 for each worker, and take its average at the firm level using the wage earned in the previous month w as weight.[20] Because of the truncation at zero, the measure is right-skewed; hence, in our empirical analysis, we add 1 and take its logarithm. As the histogram in Figure 3, that plots the distribution of the wage rigidity measure before the log-transformation, shows, about 15% of the 22,709 observations in our analysis have WR equal to 0. The measure reaches, for a small number of contracts, a maximum of four years.

As Panel A of Figure 4 shows, the vast majority of firms employs workers subject to at least two collective agreements. Beyond that, Panel B shows that the median firm has a sizeable fraction (about 20%) of total wages paid to workers subject to a contract other than the most prevalent. These observations corroborate the conclusion that an accurate measurement of wage rigidity would not be possible without observing the exact job categories.

A potential concern could be that periods with contractual-agreement delays, which correspond to our wage rigidity proxy taking the value of zero, might depend on factors that are priced during days of monetary policy announcements. In Appendix A we test directly whether firms'

[20]This choice is preferable to that of assigning an equal weight to each worker, as it better reflects the actual labor cost of each individual.

performance can systematically predict vacancy periods. As Table A1 shows, neither sale growth nor operating performance are associated with the fraction of workers with an expired contract, attenuating concerns of omitted variable bias.[21]

4.4 Minimum Wages and Workers' Compensation

Our wage rigidity proxy can account for nominal rigidities only if actual wages are closely linked to minimum wages established by collective agreements, a connection that should follow from the "two-tier" compensation structure described in Section 4.1. In this section we check the empirical relevance of this assumption.

To this purpose, we manually code, for each contract, the minimum wage at any given month between 2005 and 2016.[22] We then regress the logarithm of worker's monthly compensation on the logarithm of the minimum wage relevant for her collective agreement, year-month and worker-firm dummies.[23] We include all workers of listed firms except part-time workers since we do not observe hourly compensation. Overall, we have 37,154,864 worker-month observations, and estimate the following model:

$$\log(w_{i,t,c}) = \beta \log(w^M_{c,t}) + \gamma_i + \delta_t + \omega_c + \varepsilon_{i,c,t} \tag{4}$$

where i, c and t identify worker, job category and year-month, respectively. The variable w is the worker's wage, w^M the minimum wage established by the relevant collective agreement, and γ, δ and ω are dummies for worker, year-month, and job category, respectively. The estimate of β, which is 0.763, is large and highly statistically coefficient, with a standard error of 0.120 ($R^2 = 0.715$).[24] Hence, the pass-through from minimum wage to actual compensation is substantial,

[21]Furthermore, in Appendix A we also run a non-parametric test where we sort firms according to their degree of wage rigidity and then test for the sensitivity of the stock market volatility to monetary policy shocks in each subsample. We find that, whether we include or exclude the firms with $WR = 0$, this sensitivity is always the lowest in the bottom tercile (see Appendix-Table A3).

[22]We thank INPS and, in particular, Maria Cozzolino, for helping us in this fairly time-consuming task.

[23]Collective agreements establish minimum wages for different job titles, which are ordered in "levels" depending on the position in the firm hierarchy. Job titles are not, however, recorded by INPS. Hence, we take the "minimum of the minimum wages" for each collective agreement.

[24]See also Fanfani (2019), who studies a different sample and employs a different empirical specification but obtains qualitatively similar results.

even for workers who may earn substantially more than the minimum.

At last, we wish to address concerns on possible reverse causality between actual wages and minimum wages. High growth in an industry may push wages and, at the same time, allow unions to obtain concessions from industry representatives in terms of higher minimum wages. Importantly, profitability in a sector is likely to follow long-term trends, and so to evolve gradually. In this case, a positive correlation would simply be driven by a common omitted variable.

Importantly, profitability in a sector is likely to follow long-term trends, and hence to evolve gradually, but minimum wages move in steps, as they "jump" in given months according to a predetermined schedule. Hence, we test whether minimum wages are led by actual compensation, which could be a signal of a spurious correlation. We examine the relationship between minimum wages and actual compensation by estimating a dynamic model along the lines of Dube et al. (2010):

$$\log(w_{i,t,c}) = \beta \sum_{j=-4}^{15} \left(\eta_{-6j} \Delta_6 \log(w^M_{c,t+6j})\right) + \eta_{-96} \log(w^M_{c,t-96}) + \gamma_i + \delta_t + \omega_c + \varepsilon_{i,c,t} \tag{5}$$

In this equation, Δ_6 represents a a six-month difference operator.[25] Figure 5 plots the resulting η coefficients that represents the cumulative effect of minimum wage changes on workers' compensation. All the coefficients on the leading terms are close to zero and statistically insignificant; however, η_0 is positive, and the effect of an increase in minimum wage persists in the long run. We conclude that collective agreements are a significant source of variation in individual wages and, as such, the timing of their adjustment is likely to be priced in the stock market response to monetary policy shocks.

4.5 Monetary Policy Shocks

We follow standard high-frequency identification methodologies for monetary policy shocks in the spirit of Gürkaynak et al. (2005). The underlying rationale is as follows. Since markets only

[25]We have 24 months of leads and 96 of lags. This asymmetry arises since our sample ends in 2016 and we have data on collective agreements only until 2018. Shortening or extending this window produces similar results.

price new information, it is possible to extract the *unexpected* component of monetary policy decisions by measuring high frequency movements of market prices in a narrow window of the policy announcements. We obtain the list of announcements of the ECB target rates from the ECB website and match these dates with the corresponding changes in the 1-year Euro Overnight Index Average (EONIA) swap rate, our proxy for monetary policy shocks. The 1-year rate strikes the best balance between being highly sensitive to monetary policy announcements, while remaining relatively unaffected by term premia.[26]

An important choice is related to the window around the monetary policy announcement. The ECB target rates are announced at 13:45 CET. However, unlike in the US, investors learn much about the future course of ECB actions during the press conference, followed by a Q&A with the president, which starts at 14:30 CET. Hence, an appropriate window should surround both the actual announcement and the press conference.

We follow Corsetti et al. (2018), who choose a 6-hour window from 13:00 to 19:00 CET, that match the closing times of the Tokyo and London stock exchanges, respectively. While a shorter window could purge stock returns from noise unrelated to monetary policy announcements, some of our stocks are relatively illiquid and infrequently traded, and hence may not react to new information instantaneously, unlike the components of the S&P 500 studied by Gorodnichenko and Weber (2016) or the sovereign bold yields and major stock market indexes studied by Altavilla et al. (2019). Hence, our choice is a compromise between the narrower windows used in these studies and the wider (daily) ones used in other settings (for example in Bernanke and Kuttner, 2005). We will return on this issue in Section 5.2, where we re-estimate our baseline regressions using the dataset of high-frequency monetary policy shocks recently made available by Altavilla et al. (2019).

Given the specifications above, we measure the monetary policy shock as follows:

$$MP_t \equiv S_t^+ - S_t^- \tag{6}$$

where the index t in S indicates the date of an ECB meeting, when ECB target rates are announced,

[26] In Section 5.2 we show that our results are not sensitive to this particular choice.

and S_t^+ and S_t^- are the 1-year Euro Overnight Index Average (EONIA) swap rates, shortly after and before the time of the announcement, respectively.

5 Empirical Evidence

5.1 Data and Econometric Strategy

The goal of our empirical analysis is to test the main implications of the simple model derived in Section 3, and hence to assess whether the impact of a monetary policy shock is larger when the distance from contract renegotiation, is higher, and whether this effect is stronger for firms that rely strongly on labor. Our baseline econometric specification reads as follows:

$$R_{i,t}^2 = \alpha MP_t^2 + \beta WR_{i,t} + \gamma MP_t^2 \times WR_{i,t} + \delta' X_{i,t} + \theta' X_{i,t} \times MP_t^2 + \eta_i + \mu_t + \varepsilon_{i,t} \qquad (7)$$

where WR is the wage rigidity proxy defined in equation 3 and MP is the monetary policy shock (equation 6). The variable $R_{i,t}^2$ is the square of the firm's stock return on an announcement day, defined as the price of the stock at 19:00 CET minus the price at 13:00 CET, all divided by the latter. Economically we are effectively estimating the effects of monetary policy shocks on the volatility of firms' returns. Intuitively, monetary policy, like all short-run policies, is a stabilization tool. Thereby it affects macroeconomic fluctuations or volatilities. This is also in line with the effects of monetary policy in DSGE models, like the one we examine in Section 6. The variable MP^2 represents the squared difference between the swap rate on the target policy rate at 19:00 CET and 13:00 CET. At last, we include an interaction term between the monetary policy shock and the wage rigidity measure. Our key prediction is related to the sign of the coefficient γ, which we expect to be positive.

The econometric specification also includes a vector X of controls that could be potentially related to firm volatility on announcement days. They include: size, defined as the logarithm of total assets; leverage, defined as the sum of debt in current liabilities plus long-term debt, all divided by total assets; ROA, which is earnings before interest, debt and amortization divided by total assets. All variables are measured at the beginning of the fiscal year in which the announcement is made. We also include labor intensity, defined as the total wage expenses in the month preceding the announcement, divided by total assets at the beginning of the fiscal year. Our final sample has 22,709 observations and comprises all the monetary policy announcements occurred between 2005 and 2016. Descriptive statistics for the main variable used in the paper are in Table 1.

Importantly, we also include the same vector interacted with the monetary policy shock to account for the possibility that our proxy WR is correlated with some other firm characteristics. Finally, in most of the regressions we also include the vectors of firm and day dummies η_i and μ_t, respectively. The time-fixed effects, whenever included, will absorb the coefficient on MP^2, but not our main coefficient of interest.

5.2 Results

Estimation results are shown in Table 2. We estimate six variations over the baseline equation, going from the least to the most conservative specification. For ease of interpretation, we divide all variables, before taking interactions, by their sample standard deviations after subtracting their means. In column 1 we include only WR and MP^2, as well as the interaction between the two, which is our coefficient of interest. Consistent with Gorodnichenko and Weber (2016), the coefficient on MP^2 has a positive sign, and is significant at the 1% level. The standalone coefficient on WR, that does not have an obvious economic interpretation, is instead insignificant.

Crucially, the coefficient on the interaction term $MP^2 \times WR$ is positive, and equal to 0.017, significant at the 5% level. The positive sign on this term is in line with the analytics of the simple model described above, as well as with the extended dynamic model that we will present in Section 6. Given that the coefficient on MP^2 is equal to 0.042, the two coefficients are in the same order of magnitude. In column 2 we add controls, namely size, leverage, ROA and labor intensity. We find that firms with higher debt levels and lower profitability exhibit higher volatility during announcement dates. The coefficient of interest is essentially unaffected.

In column 3, we interact MP^2 with the control variables. This allows us to account for the possibility that WR is simply proxying for, or strongly correlated with, some firm's characteristics. Our coefficient of interest is slightly reduced in magnitude, but remains significant at the 10% level. In sum, the influence of our measure of wage rigidity on the sensitivity to monetary policy shocks appears largely orthogonal to that of the most plausible firms' characteristics.

In columns 4 through 6 we add to the specifications of columns 1 through 3 both firm and announcement date dummies. The inclusion of the announcement date dummies implies that the coefficient on MP^2 is not separately identifiable, but its interaction with the wage rigidity proxy still is. The inclusion of firm fixed effects allows us to control for time-invariant firm characteristics that may determine stock volatility during announcement dates. Their inclusion slightly increases the coefficient of interest, which is now significant at the 1% level. The only control variable that remains significant, and negative, is the interaction term $MP^2 \times Size$.

To sum up, these estimates suggest that wage rigidity, as measured by our proxy, amplifies the effects of monetary policy. Results are statistically robust, economically meaningful and appear orthogonal to a number of firm characteristics. In the sections that follow we further emphasize the robustness of this evidence and explore more in depth the economic channels underlying it.

5.3 The Labor Channel

To validate our hypothesis, namely that the labor market channel plays a crucial role in the transmission of monetary policy, we run our baseline model in different subsamples, by conditioning on firms' labor intensity. In this way, we test the prediction of our simple model of Section 3, which highlights that the strength of the wage rigidity channel is larger if the workforce extracts a larger share of the surplus, i.e., if the β of our model is large. Conditioning on firms' specific characteristics, like labor intensity, allows us to make inferences on the distributional consequences of monetary policy.

To this purpose, we sort firms in terciles according to their degree of labor intensity, for which we use the ratio of wage expenses divided by total assets. The numerator is measured in the month preceding the announcement, and is scaled by total assets at the beginning of the fiscal year.[27] We compute, for each firm, the mean labor intensity over the full sample and sort firms according to this average measure, so that each firm is consistently assigned to only one of the three subsamples.

Column 1 of Table 3 shows, as a reference, the baseline regression estimated in column 6 of Table 2. In column 2 we show the regression coefficients obtained after estimating equation 7 in the subsample of firms characterized by labor intensity in the bottom tercile. The coefficient on the interaction term is insignificant and small in magnitude (0.012). The evidence is very similar when we move to column 3, that includes firms in the second tercile of labor intensity, with a coefficient that is also very small and, if anything, negative. Column 4 shows that, instead, firms in the top tercile of labor intensity are driving the evidence in the full sample. In this subsample the coefficient is equal to 0.050 and is precisely estimated (t-statistic=4.17). Hence, this test represents an important validation of our hypothesis, as it shows that the labor demand channel is the true driver of our results.

5.4 Robustness Tests

In Tables 4 and 5 we propose several robustness tests. For brevity, we report only estimates from our most conservative specification, which includes firm and date-fixed effects, as well as the control variables, both as standalone regressors and interacted with the monetary policy shock. As a first test, we note that our results are unchanged when we measure monetary policy shocks using changes in swap rates at different horizons. Columns 1 through 3 of Table 4 show that results are essentially unaffected irrespective of whether we use changes in 1-year, 6-month or 3-month swap rates.

Although workers in a given firm may be subject to different collective agreements, in practice they tend to cluster across industries. This could raise concerns that our results may reflect

[27] Total sales would perhaps be more coherent with the model presented in Section 3 as denominator of the proxy for labor intensity. We chose total assets because the variable sales is missing in about 20% of the observations. We have, in any event, re-run our analysis using labor expenses over revenues as sorting variable and, in this smaller sample, found very similar results.

an "industry effect." We can test non-parametrically for the presence of an industry effect by interacting the monetary policy shock with industry dummies, where industries are defined using the 1, 2 or 3-digit *NACE* industry classification. An attractive feature of our econometric strategy is that, within industry, our stickiness measure changes over time. Hence, for this specification we can exploit time-variation within industry. As columns 4 through 6 of Table 4 show, the coefficient of interest remains similar in magnitude, and significant at the 1% level. Hence, we can safely conclude that our measure is immune from the concern that it is simply capturing some time-invariant industry feature.

In Table 5 we test whether our results depend on our particular window choice for the monetary policy shock and the stock return by making use of the dataset made available by Altavilla et al. (2019). Our monetary policy shock is now the squared change in the median quote of the EONIA swap rate from the window 13:25–13:35 (before the press release) to the median quote in the window 15:40–15:50 (after the press conference). In column 1, we measure the stock market response using the same window. Results are qualitatively similar, although the magnitude is slightly lower (0.012, significant at the 5% level). In column 2 we retain the advantage of this narrower window for the measurement of the monetary policy shock, but choose a 6-hour window for the dependent variable. The coefficient is now 0.017, significant at the 1% level, and very similar to the one estimated in the baseline regressions. Finally, in column 3 we use daily stock returns. The coefficient is similar and remains significant (0.015, significant at the 5% level). To summarize, results do not appear to be dependent on the particular window choice for the measurement of the monetary policy shock. Still, a too narrow window for the stock returns tends to reduce the size of the estimates. This is to be expected with stocks that do not trade very frequently and may respond more sluggishly to new information.

We leave a number of robustness tests to the Appendix for brevity. First, as a "placebo" test, we replicate our main tests by using, as dependent variables, the squared stock returns on the day *before* the actual policy announcement. We replicate both the baseline regression presented in

Table 2 and the heterogeneity analysis presented in Table 3. As Appendix-Table A2 shows, all the coefficients are insignificant and no apparent relationship between wage rigidity and labor intensity emerges. We also examine the relationship between wage rigidity and the response to monetary policy shocks in a non-parametric fashion and show that it is not driven by the truncation at zero in Table A3. Finally, in Table A4 we test whether results are affected when different clustering choices for the standard errors are adopted. We cluster standard errors at the industry, at the date level, and double-cluster the residuals at the firm and date level. While in the latter two cases the precision is slightly lower, coefficients remain precisely estimated when focusing on the firms characterized by high labor intensity.

5.5 Firm Profitability, Business Cycle and Flexible Staffing Arrangements

In this section we examine a number of economic channels that pertain to the distributional effects of monetary policy across different firms and workers and to the cyclicality of the wage rigidity channel. The sensitivity to monetary policy shocks may depend also on other firms' characteristics, such as profitability or flexibility of the workforce. Those distributional channels are important, since they may be a source of potential mis-allocation of resources. Moreover, we examine the temporal variation in the wage rigidity channel. Recently Grigsby, Hurst and Yildirmaz (2019), using payroll data, have found evidence of state-dependence in wage rigidity. We test the impact of the cycle on the link between wage rigidity and monetary policy transmission and find that during downturn previous rigidities further dampen firms' ability to adjust labor costs. This, among other things, corroborates previous evidence on state-dependence. At last, in the next section, we will examine the distributional consequences across different type of workers.

In Table 6, columns 1 and 2 we condition our regressions to firms' profitability. We use one-year lagged ROA as a sorting variable, to distinguish between highly and non-highly profitable firms. The wage rigidity channel appears stronger for firms with low profitability. The coefficient for this group of firms is significant and equal to 0.026. The coefficient drops to 0.014 and is insignificant in highly profitable firms.

In columns 3 and 4 of Table 6, we condition instead on a proxy for the economic cycle, namely the quarterly GDP growth. The strength of the wage rigidity channel appears to be driven by shocks occurring at times of (relative) economic distress. In column 3 the coefficient is 0.024, significant at the 1% level, while in column 4 the coefficient drops to 0.009 and is insignificant.

In Table 7, we sort firms according to a measure of firms' ability to adjust their workforce at the extensive margin. A firm constrained to a fixed wage schedule could more easily absorb the impact of a demand shock when its workforce is subject to more flexible contractual arrangements (Houseman, 2001). Friesen (1997) shows that part-time, as opposed to full-time labor is a source of flexibility when facing economic shocks. Similarly, fixed-term contract also provide an important margin of flexibility, as firms can let fixed-term contract expire in face of an adverse shock. The information provided by our dataset allows us to construct measures of flexibility at the firm level, using either the fraction of part-time or fixed-term workers. Column 1 of 7 shows that in firms with a fraction of part-time workers below the median, the coefficient of interest is 0.021, significant at the 1% level, but drops to an insignificant 0.05 in firms that are above the median. Results are qualitatively similar, although less stark, when looking at firms that differ in their usage of fixed-term contracts, with the coefficient being higher and highly significant for firms that are above the median in terms of this proxy.

Our results complement also other recent evidence on the distributional effects of monetary policy onto heterogeneous firms. Bahaj et al. (2017), using a panel of UK firms, examine the impact of monetary policy on employment dynamics for small and large firms, pointing at the role of different financial frictions.[28] Other works (see, for example, Rodnyansky, 2018) examine the differential impact of monetary policy for exporting and non-exporting firms.

[28] Past works along the same lines include Gertler and Gilchrist (1994), Moscarini and Postel-Vinay (2012), Kudlyak and Sanchez Kudlyak and Sanchez (2017) and Mehrotra and Crouzet (2017), among others.

5.6 Real Effects

Since our focus is on a labor market channel for the transmission of policy shocks, it is paramount to test the sensitivity of the labor demand to such shocks. We estimate a new specification whereby the dependent variables captures various aspects of the labor demand, including intensive and extensive margins. Our dependent variables now are the squared symmetric growth rates of four different objects. "Pay" is the total compensation, given by the sum of all wages paid to the firm's employees. "Days worked" is defined as the total of workers employed times days worked. This captures changes in the intensive margins. "Employees" is the total number of workers (i.e., "bodies") employed. This captures the extensive margin. Finally, "full-time employees" are those who are employed for at least 20 days per month.[29]

Before proceeding we harmonize the observation timing of the variables. First, we aggregate our monetary policy shocks at the quarterly level, following the procedure recommended by Gertler and Karadi (2015). We define $\hat{e}_t$ as:

$$\hat{e}_t \equiv \sum_{-92}^{0} e_t \tag{8}$$

and then cumulate the $\hat{e}_t$s over each quarter Q to obtain a quarterly shock $\hat{e}_Q$:

$$\hat{e}_Q = \sum_{t \in Q} \hat{e}_t \tag{9}$$

Intuitively, this procedure assigns higher weight to shocks that occur early in the quarter. Unfortunately, in absence of plant-level information of the firms' workforce, we are unable to identify changes in employment due to divestitures or acquisitions, that often generate significant outliers. As a partial remedy, we winsorize the dependent variables at the 5% level.

Results are displayed in Table 8. As usual, all the variables are demeaned and divided by their standard deviation. We find economically large effects on each of the first three outcome variables. The coefficients of interest for the one-quarter change in pay, days worked, and employees are

[29]In our dataset, the number of days worked each month is normalized in such a way that the maximum number is always 26. This is convenient for our purpose because our threshold does not need to depend on the actual number of business days in a month.

0.038, 0.030, and 0.037, significant at the 1%, 10%, and 5% level, respectively. Interestingly, the coefficient of interest becomes small for full-time employees, and is insignificant. Its magnitude, 0.015, is much smaller than the one found in column 3 (equal to 0.037), where the change in total employment is used as dependent variable. This adds an interesting dimension and suggests that managers respond to aggregate shocks by primarily adjusting the number or hours of part-time employees. This is consistent with the evidence in Table 7, showing that the stock price of firms with a large fraction of full-time employees, and that therefore are unable to easily adjust the size of the workforce, have larger reactions to monetary policy shocks.

In Appendix-Table A5 we test whether the effects on employment are reversed in the following quarter by using as dependent variable the lead of the change in employment outcome; we find, however, that all the coefficients are insignificant and quite small in economic terms. We also run a "placebo test" by replacing the dependent variables with the their one quarter-lag equivalent. As Appendix-Table A6 shows, the coefficients are small and insignificant and, if anything, display a negative sign.

6 A Multi-Sector Model with Sectorial Wage Rigidity

Our empirical analysis was guided by the predictions of the simple model of Section 3, and has highlighted the significance of the employment channel. Equipped with these results, we can now construct a more sophisticated micro-founded dynamic general equilibrium model, which can account for general equilibrium spillovers and allows us to quantify the cross-sectional and temporal dimensions. A structural estimation also allows us to further validate our previous empirical results through the lenses of the model. To this purpose, we will use the model-based simulated data and run regressions whose specification mirrors the ones in the data. As we will see, these results are not too different from those obtained with the true data.

In the model there are households/workers and firms which are heterogeneous in terms of the negotiation date with the union. Specifically, firms in different sectors $s = \{1, ..., S\}$ negotiate wages with monopolistically competitive unions at staggered dates. Further, we assume that in each sector there is a continuum of monopolistically-competitive firms producing different varieties, indexed by i. In parallel with the data we wish to assess the impact of monetary policy on firms' stock market values. Monopolistic competition over varieties allows us to measure stock values as the expected discounted sum of future mark-ups. Monopolistic power in the in the wage setting process is assigned to unions by having households to supply differentiated labor services them, which in turn supplies them to firms in different sectors (see Schmitt-Grohé and Uribe, 2005). Wages are then set by maximizing union members' utility . The union bargaining allows us to reproduce the collective arrangements underlying our data. Wage bargaining is staggered so that renegotiation dates differ across sectors.

6.1 Households

The household has a lifetime utility function:

$$W_t = \mathbb{E}_t \left\{ \sum_{k=0}^{\infty} \beta^k U \left(C_{t+k}, \sum_{s=1}^{S} (f^s) \int_0^1 N_{si,t+k} di \right) \right\}, \tag{10}$$

where β is the discount factor, $\mathbb{E}_t$ is the conditional expectation operator with respect to information at time t, C_t is a consumption aggregate and N_t denotes labor services. The sum of the households in the economy supplies labor services to all sectors, $\sum_{s=1}^{S}(f^s)N_{s,t+k}$, where $N_{s,t+k} = \int_0^1 N_{si,t+k}di$, that is, labor supply in each sector is an aggregate of labor services to the continuum of firms producing varieties, indexed by i. The per-period utility function is $\frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \psi \frac{(N_{s,t})^{1+\eta}}{1+\eta}$, where σ is the elasticity of inter-temporal substitution, η^{-1} is the Frisch elasticity of labor supply, and h is an internal habit parameter.[30] The representative household maximizes its utility subject to the budget constraint:

$$C_t P_t + \sum_{h^{t+1}} \nu_{t+1,t} B_{t+1} = \sum_{s=1}^{S} (f^s) W_{s,t} \int_0^1 N_{si,t+k} di + B_t - \tau_t + \int_0^1 \Gamma_t(i) di, \tag{11}$$

[30] We include external habits in the utility function as this is known to capture well the hump shaped response of output and other variables.

where the household earns income from differentiated labor $N_{si,t}$ at the nominal wage rate $W_{si,t}$. The sectorial union will eventually choose one wage for all firms i operating in sector s. P_t is the price index and τ is a a lump-sum tax. Even though individual household members supply labor services to different firms and sectors, heterogeneity does not affect their consumption-saving decisions. To insure their consumption pattern against random shocks at time t households spend $\nu_{t+1,t}\ B_{t+1}$ in nominal Arrow-Debreu securities,[31] where $\nu_{t,t+1} \equiv \nu(h^{t+1}|h^t)$ is the period t price of a claim to one unit of domestic currency in state h^{t+1}, divided by the probability of occurrence of that state. Each asset in the portfolio B_{t+1} pays one unit of domestic currency at time $t+1$ and in state h^{t+1}. Finally, $\Gamma_t(i)$ is the profit of monopolistic firm i, whose shares are owned by households.

The representative household chooses processes $\{C_t\}_{t=0}^{\infty}$ and bonds $\{B_{t+1}\}_{t=0}^{\infty}$, taking as given the set of processes $\{P_t, \nu_{t+1,t}\}_{t=0}^{\infty}$ and the initial wealth B_0 so as to maximize (10) subject to (11). For any given state of the world, the following set of efficiency conditions must hold:

$$\lambda_t = (C_t - hC_{t-1})^{-\sigma} - \beta h(C_{t+1} - hC_t)^{-\sigma} \tag{12}$$

$$\beta \frac{P_t}{P_{t+1}} \frac{\lambda_{t+1}}{\lambda_t} = \nu_{t,t+1} \tag{13}$$

where λ_t is the Lagrange multiplier on the budget constraint and equation (13) is the Euler condition on the state-contingent bond holding for each state of the world. First order conditions shall hold alongside with the no-Ponzi condition (i.e., $\lim_{k\to\infty} \mathbb{E}_t \{\nu_{t,t+k}\ B_{t+k}\} = 0$). Individual labor services are supplied to a union, which in turn supplies labor monopolistically to a continuum of labor markets of measure 1 indexed by $j \in [0,1]$. The derivations of the optimal supply of each labor service, given the firms' labor demand and the unions' optimization problem is derived in sections 6.2.3 and 6.2.4.

[31] See Schmitt-Grohé and Uribe (2005) and Galí (2015).

6.2 The Final Good Sector

Households consume a homogeneous good, which results from bundling goods produced in different sectors, that in turn originate from varieties produced by different firms in each sector. In each sector, a representative competitive firm bundles, through a Dixit and Stiglitz (1977) aggregator, varieties produced by monopolistically competitive firms. In turn, a representative competitive firm bundles together a Dixit-Stiglitz composite of the sectorial outputs. Each sector size is given by $f_s > 0$, with $\sum_{s=1}^{S} f^s = 1$. The optimization problems solved by each of those firm-level and sectorial-level output bundlers delivers the optimal demand for each variety $i \in [0,1]$, which in turn depends upon the optimal demand of the sectorial product s. The optimal demand for each sectorial variety represents the constraint of the monopolistically competitive firm i, choosing prices in sector s. Hence, sectorial output is given by $Y_{s,t} = \left[(f^s)^{\frac{\epsilon_p - 1}{\epsilon_p}} \int_0^1 Y_{si,t}^{\frac{\epsilon_p - 1}{\epsilon_p}} di \right]^{\frac{\epsilon_p}{\epsilon_p - 1}}$, where $Y_{s,i,t}$ is the variety produced by firm i in sector s. The parameter $\epsilon_p \geq 0$ is the elasticity of substitution within and across sectors. The aggregate output is given by $Y_t = \left[\sum_{s=1}^{S} (f^s)^{\frac{1}{\epsilon_p}} Y_{s,t}^{\frac{\epsilon_p - 1}{\epsilon_p}} \right]^{\frac{\epsilon_p}{\epsilon_p - 1}}$. The output-bundlers at sectorial level solve an optimization problem[32] to obtain the following downward-sloping demand: $Y_{s,t} = f^s \left(\frac{P_{s,t}}{P_t} \right)^{-\epsilon_p} Y_t$. Similarly, the representative firm that bundles individual varieties into sectorial goods solves an optimization problem[33] to obtain the following downward-sloping demand: $Y_{si,t} = (f^s)^{-1} \left(\frac{P_{si,t}}{P_{s,t}} \right)^{-\epsilon_p} Y_{s,t}$. The implied price indices are $P_t = \left[\sum_{s=1}^{S} (f^s) P_{s,t}^{1-\epsilon_p} \right]^{\frac{1}{1-\epsilon_p}}$, and the sectorial price aggregator is $P_{s,t} = \left[\int_0^1 P_{si,t}^{1-\epsilon_p} di \right]^{\frac{1}{1-\epsilon_p}}$.

[32]The problem is rather standard and reads as follow:

$$\max_{Y_t} \left[P_t Y_t - \sum_{s=1}^{S} P_{s,t} Y_{s,t} \right]$$

subject to $Y_t = \left[\sum_{s=1}^{S} (f^s)^{\frac{1}{\epsilon_p}} Y_{s,t}^{\frac{\epsilon_p - 1}{\epsilon_p}} \right]^{\frac{\epsilon_p}{\epsilon_p - 1}}$.

[33]The optimization problem reads as follows:

$$\max_{Y_{si,t}} \left[P_{s,t} Y_{s,t} - f^s \int_0^1 P_{si,t} Y_{si,t} di \right],$$

subject to $Y_{s,t} = \left[(f^s)^{\frac{\epsilon_p - 1}{\epsilon_p}} \int_0^1 Y_{si,t}^{\frac{\epsilon_p - 1}{\epsilon_p}} di \right]^{\frac{\epsilon_p}{\epsilon_p - 1}}$.

6.2.1 Input and Price Choices of Producers of Varieties

Each variety $Y_{s,i,t}$ is produced by a single monopolistic-competitive firm using labor services $N_{s,i,t}$ as factor inputs. The production technology is $Y_{si,t} = N_{si,t}$. We allow for two different specifications of the labor demand and test them in the data. The first is standard, with firms equating the marginal return of labor to the marginal cost. In this second case firms choose labor demand by minimizing discounted future labor costs which include a quadratic hiring cost, $W_{s,t}N_{s,t} + \frac{\xi}{2}N_{s,t}\left[\frac{N_{s,t}}{N_{s,t-1}} - 1\right]^2$, subject to $Y_{si,t} = N_{si,t}$. The demand for individual labor varieties in this case yields:

$$mc_{s,t} = \left[W_{s,t} + \frac{\xi}{2}\left(\frac{N_{s,t}}{N_{s,t-1}} - 1\right)^2 + \left(\xi\frac{N_{s,t}}{N_{s,t-1}} - 1\right) - \beta\xi\mathbb{E}_t\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{N_{s,t+1}}{N_{s,t}} - 1\right)\frac{N^2_{s,t+1}}{N^2_{s,t}}\right]/P_t, \quad (14)$$

Here the real marginal cost $mc_{s,t}$, namely the Lagrange multiplier deflated by the price level, is given by the sector's real wage plus an adjustment cost term that reflects hiring costs. This specification captures possible firms' constraints in adjusting the extensive margin.

Each monopolistic firm i choose prices to maximize the stream of real profits, $\Pi_{si,t} = \frac{P_{si,t}}{P_t}Y_{si,t} - \frac{W_{s,t}}{P_t}N_{si,t}$, subject to (14), $Y_{si,t} = N_{si,t}$ and the demand for individual varieties. The optimality condition reads as follows:

$$P_{si,t} = \frac{\epsilon_p}{\epsilon_p - 1}mc_{si,t}P_t, \quad (15)$$

Prices are set equal to a mark-up on nominal marginal costs. In a symmetric equilibrium we can impose $P_{si,t} = P_{s,t}$, $N_{si,t} = N_{s,t}$ and $mc_{si,t} = mc_{s,t}$.

6.2.2 Firm Value

Our goal is to assess the effects of monetary policy shocks on firm value, which in the model we derive through a recursive formulation of the firm's future discounted profits in sector s:

$$V_{s,t} = \Pi_{s,t} + \beta\mathbb{E}_t\left\{\frac{\lambda_{t+1}}{\lambda_t}V_{s,t+1}\right\}. \quad (16)$$

Sectorial returns are the percentage change in the sectorial value:

$$R_{s,t} = log(V_{s,t}) - log(V_{s,t-1}) \quad (17)$$

6.2.3 Optimal Demand for Labor Services

Wages are set by monopolistic unions, each operating within each sector. Unions have monopoly power over the individual labor services that household members supply to the continuum of firms. Hence, they choose wages subject to the demand for each labor service i.

Likewise for goods, in each sector a competitive labor agent bundles together the labor services demanded by each firm i. The Dixit-Stiglitz aggregator for the sectorial labor demand is $N_{s,t} = \left[(f^s)^{\frac{\epsilon_w-1}{\epsilon_w}} \int_0^1 (N_{si,t})^{\frac{1-\epsilon_w}{\epsilon_w}} di\right]^{\frac{\epsilon_w}{\epsilon_w-1}}$, where ϵ_w is the elasticity of substitution between labor varieties within sectors. Similarly, at the aggregate level a competitive labor-placement agent bundles together the labor services supplied at the sectorial level. The Dixit-Stiglitz aggregator for economy-wide labor demand is $N_t = \left[\sum_{s=1}^S (f^s)^{\frac{1}{\epsilon_w}} N_{s,t}^{\frac{\epsilon_w}{\epsilon_w}}\right]^{\frac{\epsilon_w}{\epsilon_w-1}}$, where ϵ_w is also the elasticity of substitution between labor varieties across sectors. The competitive labor-placement agent in each sector solves an optimization problem[34] yielding the downward-sloping demand curve for labor variety i in sector s, namely $N_{si,t} = (f^s)^{-1}\left(\frac{W_{si,t}}{W_{s,t}}\right)^{-\epsilon_w} N_{s,t}$. Similarly, the competitive placement agent at the aggregate level chooses the optimal labor demand,[35] which results in $N_{s,t} = f^s \left(\frac{W_{s,t}}{W_t}\right)^{-\epsilon_w} N_t$.

6.2.4 Labor Unions and Wage Stickiness

Wage setting is staggered in the spirit of Taylor (1979). In each sector labor unions set the wage at a specific date and keep it fixed for S periods. In each sector the wage setting date is different, generating a staggered structure. This also implies that in each period t only a fraction $1/S$ of all households sees its wage adjusted.

Unions choose the optimal wage $W^*_{s,t}$ by maximizing household utility (10), subject to the

[34] It chooses the optimal demand, $N_{is,t}$, to maximize:

$$W_{s,t}N_{s,t} - \sum_{s=1}^{S} W_{si,t}N_{si,t}$$

subject to $N_{s,t} = \left[(f^s)^{\frac{\epsilon_w-1}{\epsilon_w}} \int_0^1 (N_{si,t})^{\frac{1-\epsilon_w}{\epsilon_w}} di\right]^{\frac{\epsilon_w}{\epsilon_w-1}}$.

[35] The placement agent maximizes $W_tN_t - W_{s,t}N_{s,t}$ subject to the demand constraint $N_t = \left[\sum_{s=1}^S (f^s)^{\frac{1}{\epsilon_w}} N_{s,t}^{\frac{\epsilon_w}{\epsilon_w}}\right]^{\frac{\epsilon_w}{\epsilon_w-1}}$.

relevant part of the budget constraint (11) and the downward-sloping demand curve for labor variety i in sector s. This results in the equilibrium condition:

$$W_{s,t}^{*}=\frac{\epsilon_w}{\epsilon_w-1}\frac{\mathbb{E}_t\left\{\sum_{\tau=t}^{t+S-1}\beta^{\tau-t}U_{Ns,\tau}W_{\tau}^{\epsilon_w}N_{\tau}\right\}}{\mathbb{E}_t\left\{\sum_{\tau=t}^{t+S-1}\beta^{\tau-t}\lambda_t/P_{\tau}W_{\tau}^{\epsilon_w}N_{\tau}\right\}},\tag{18}$$

where U_{Ns} is the marginal dis-utility of labor in sector s. Households' optimal wage is given by a markup, $\frac{\epsilon_w}{\epsilon_w-1}$, over the ratio of weighted marginal utilities of leisure to marginal utilities of income within the duration of wage contracts, with the weights given by the normalized demand for its labor services. If the household expects an increase in the marginal utility of leisure or a fall in the marginal utility of income within the next S periods, the union will respond by setting a higher nominal wage.

6.2.5 Firm Wage Heterogeneity

Given that wages are set at different dates in each sector and are kept constant for a fixed interval S, firms operating in each sector experience different marginal costs. They will thereby react differently to shocks.

In each sector wages are set according to the general functional form given by (18) but, operationally, we stagger the sectorial wages in time. Specifically, the wage for sector $s=1$ is set in $t=\tau$, the wage for sector $s=2$ in $t=\tau-1$, ..., the wage for sector $s=S$ in $t=\tau-S+1$. Hence, in each period t a firm in sector s pays nominal wages W_s^* that have been set either in the current or in one of the past periods. This way of staggering the wage contracts over time allows us to tie firms' marginal costs, and hence profits, to the timing in which the monetary policy shock hits the economy.

To fix ideas, consider a monetary policy shock that occurs in the current period. Firms belonging to a sector whose renegotiation took place in the previous period are able to adjust their wage bill only $S-1$ periods from now. Thus, their marginal costs are tied to nominal wages $W_{s,t-1}^*$ until then. On the other extreme, firms belonging to a sector whose renegotiation takes place in the current period will experience an immediate change in their marginal costs, and hence in their profits. These firms are affected by wage stickiness only through general equilibrium effects, which they take into account when setting their prices.

6.2.6 Market clearing, Monetary Policy, and Calibration

Equilibrium in the model is completed by a market clearing condition, $Y_t = C_t$, and an operational rule for monetary policy, which responds to wage inflation and features interest rate smoothing: $1 + i_t = (1 - \rho_i)(1 + i) + \rho_i(1 + i_{t-1} + b_W(W_t/W - 1)) + \epsilon_t^i$, wherein W represents the steady-state value of the nominal wage index.

We solve the model numerically. Next, we use simulated data to estimate a model-counterpart of the empirical regressions. We calibrate the model to quarterly data using standard values in the literature, given in Table 9. Notably, we choose $S = 8$ sectors in order to roughly match the approximate time span of wage contracts in the data. A value of $S = 8$ implies that the median renegotiation time is 3.5 quarters, i.e. roughly 315 days, which is very close to the median of 318 days in the data. In the specifications with hiring costs, ξ is set to 2.015, which is the average of the values estimated in Cooper and Willis (2009) for positive and negative employment changes.

6.3 Results

We simulate the model for 2,000 periods. With 1,200 periods used as burn-in, the remaining 800 periods are used to obtain artificial data and to sample across sectorial firms' returns so as to run the following regression:

$$R^2_{s,t} = \alpha\epsilon_t^{i2} + \beta WR_{s,t} + \gamma\epsilon_t^{i2} \times WR_{s,t} + u_{s,t}, \tag{19}$$

Note that for the model-based regression we do not need to include controls, as the simulated data result from the solution of our model, ruling out potential confounding factors. The variable $R^2_{s,t}$ represents again the squared return of the firms producing intermediate goods in each sector, the variables $WR_{s,t}$ is the time it takes for the sector's wage contract to be renewed in period t, and ϵ is the monetary policy shock. We also estimate the data-equivalent specification for employment. As in the baseline regressions, all the variables are demeaned and divided by their standard deviation.

Table 10 reports the coefficient estimates for several versions of the model. In its simplest version, with neither habit nor hiring costs, we obtain coefficient estimates of 0.132 and 0.084, respectively for returns and employment. Those are higher than the reduced-form estimates presented in Section 5, but are in the same order of magnitude. Notwithstanding, this is strong evidence that the qualitative channels foreseen in the baseline version of our model can rationalize the empirical evidence well. The monetary transmission channel in the model goes as follows. In response to an increase in the interest rate at time t, firms that can adjust wages will be able to reduce their marginal costs. They will then shelter the negative impact of the shocks on the future sum of discounted profits. The cohort of firms which cannot adjust wages will experience a larger change in profits, reflected in stock returns.

Next, we extend our model along two dimensions to make it more realistic and improve its quantitative performance. We introduce both habit persistence in consumption and hiring costs. The macro literature has already uncovered that this feature allows the model to match a number of business cycle facts. Intuitively, external habits in consumption smooth the marginal weight that investors, and hence firms' owners, attach to fluctuations in future profits. This in turn smooths the response of stock returns to monetary policy shocks. Hiring costs, by paralleling firms' constraints in adjusting the extensive margin, tend to delay the response of employment to shocks. In this variant of the model, regression coefficients become lower and closer to the empirical counterparts, being equal to 0.33 and 0.071 for stock returns and employment, respectively.

An additional feature which can affect the response of stock values, through its impact on the stochastic discount factor, is the degree of risk aversion. Raising the coefficient of relative risk aversion σ from 2 to 2.15 further improves the fit, bringing down the coefficients to 0.025 and 0.056. An increase in risk-aversion implies that investors attach a higher price of risk to future contingencies. This translates into a more muted response of the stochastic discount factor.

7 Conclusion

Quantifying the exact role of nominal rigidities in the transmission of monetary shocks has been difficult due to lack of accurate and exogenous measures of wage stickiness. Moreover, aggregate responses typically mask large heterogeneity which can inform on the distributional effects of monetary policy. By relying on a unique confidential contract-level dataset for the Italian economy, we are able to construct a fully exogenous measure of wage rigidity based on the staggered structure of wage renegotiations.

We find strong evidence that monetary policy shocks, identified at high frequency, have a significant impact on firms that are subject to wage rigidities. The richness of firm level characteristics available in our dataset allows us to examine in depth the distributional effects of monetary policy. Its impact indeed is stronger and more significant for firms with high labor intensity, low profitability, with constraints on adjusting the extensive margins and with a higher fraction of long-term job contracts. We rationalize our evidence with a dynamic multi-sector general equilibrium model in which firms face different degrees of wage rigidity as dictated by union bargaining and show that the model can rationalize and replicate the empirical evidence well.

We conclude by noticing that our empirical design and our model have a more general validity. Indeed our basic empirical strategy and our laboratory economy can be adapted to study the response to other common events, such as trade shocks.

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8 Figures and Tables

Figure 1

The Effect of an Expansionary Monetary Policy Shock on Firm Profit: An Example

Figure 1 presents the example described in Section 3. The solid black line and the dotted red line plot a firm's profit function before and after an expansionary monetary policy shock, respectively. The optimal price level shifts, accordingly, from p_1^* to p_2^*. If prices are rigid in the short run, a firm's profit may benefit or not from the shock, depending on whether its initial price level is too low (p_L) or too high (p_H). In the first case, the profit will decrease after the shock, in the second it will rise.

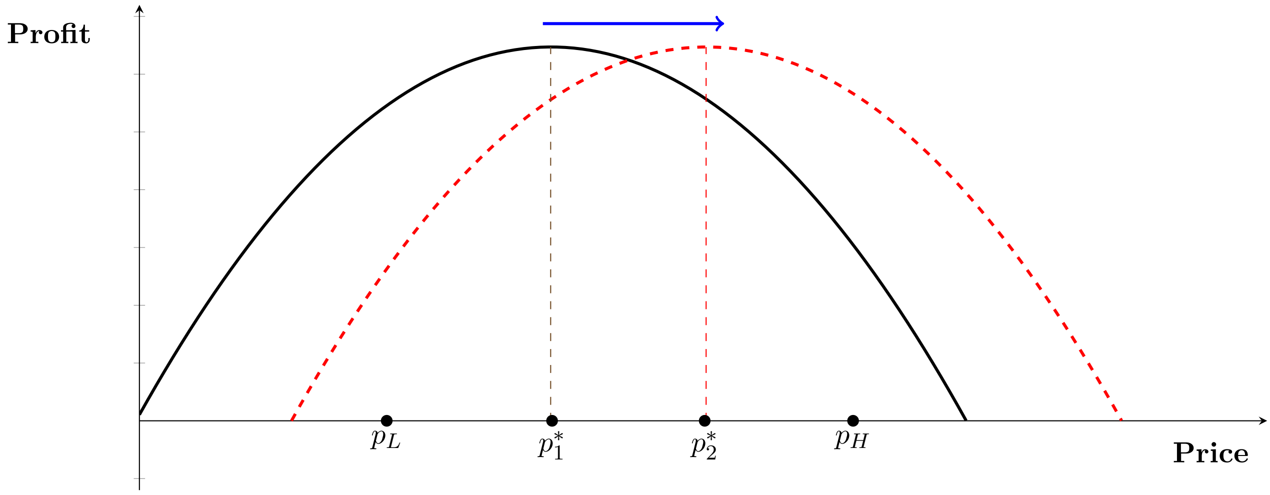

Figure 2
Collective Agreements by Month

The histogram plots, for each month, the number of new collective agreements signed.

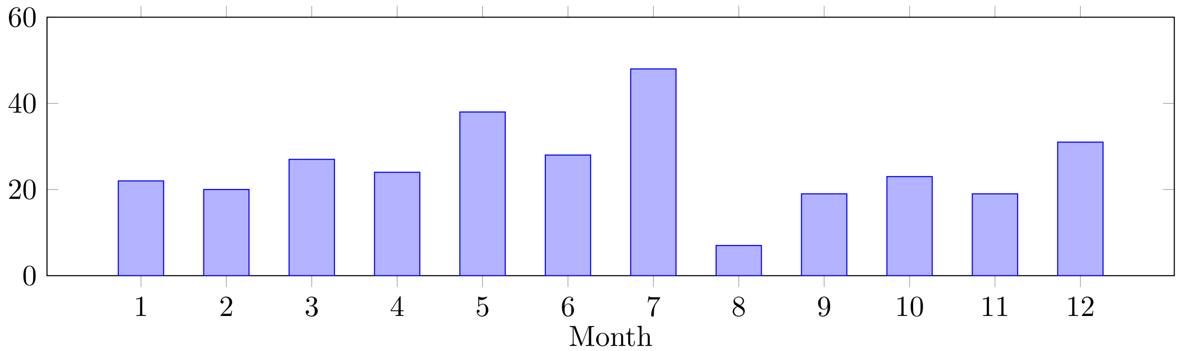

Figure 3
Histogram of the Wage Rigidity Measure

Figure 3 shows an histogram of the wage rigidity proxy defined in Section 4.3 for the full sample of 22,709 observations. The observations are grouped in 30 bins, and the vertical axis indicates the fraction of observations in each group.

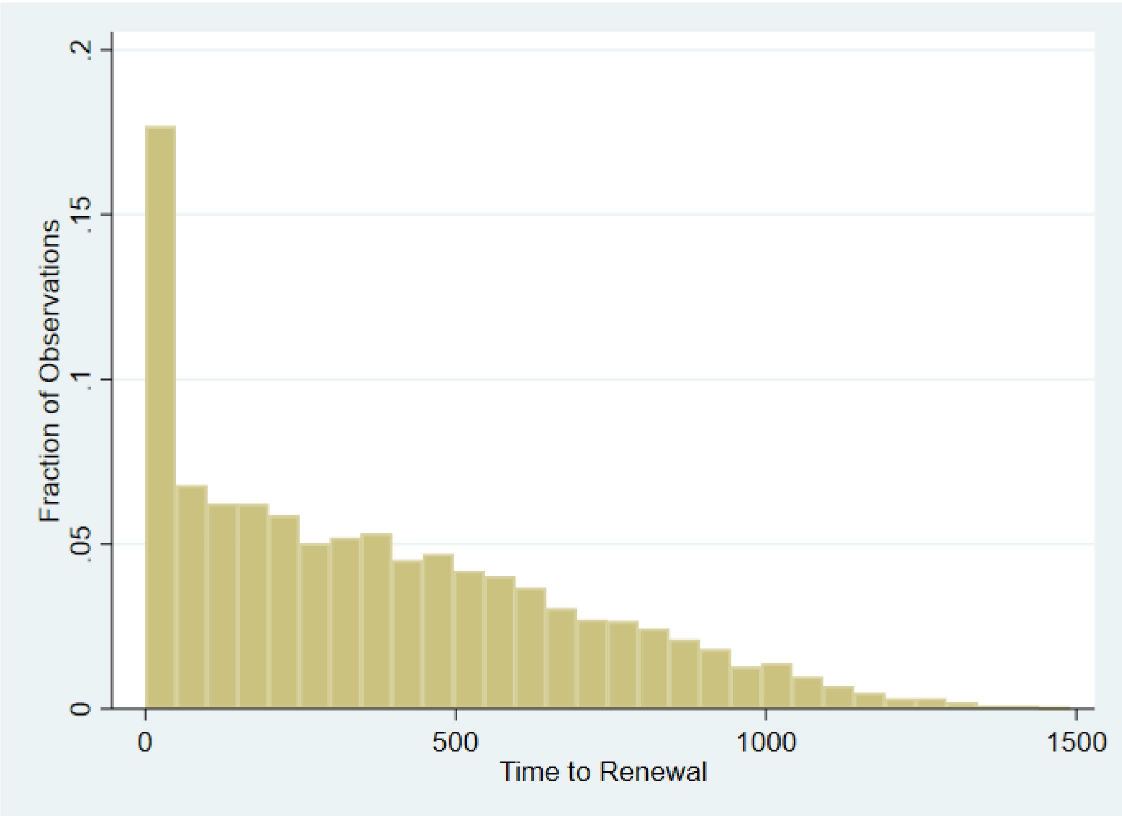

Figure 4
Collective Agreements by Firm

Panel A
#Observations by Number of Contracts (in ‘000s)

Panel B
Fraction of Wages Paid to Modal Contract by Percentile

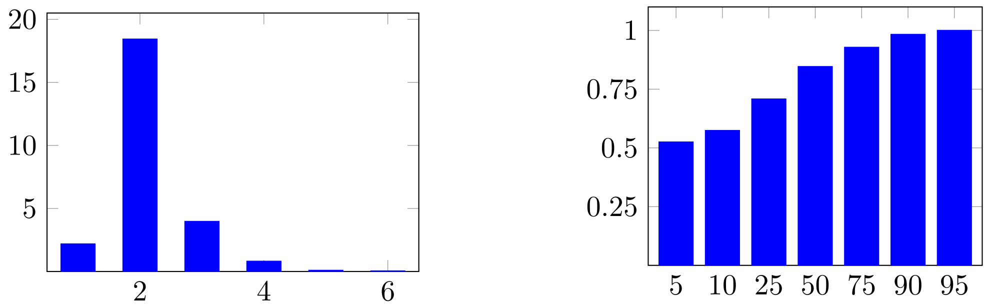

Figure 5
Dynamic Relationship between Minimum Wages and Earnings

Figure 5 shows the coefficients ηs, together with the 95% confidence intervals, obtained by estimating equation 5.

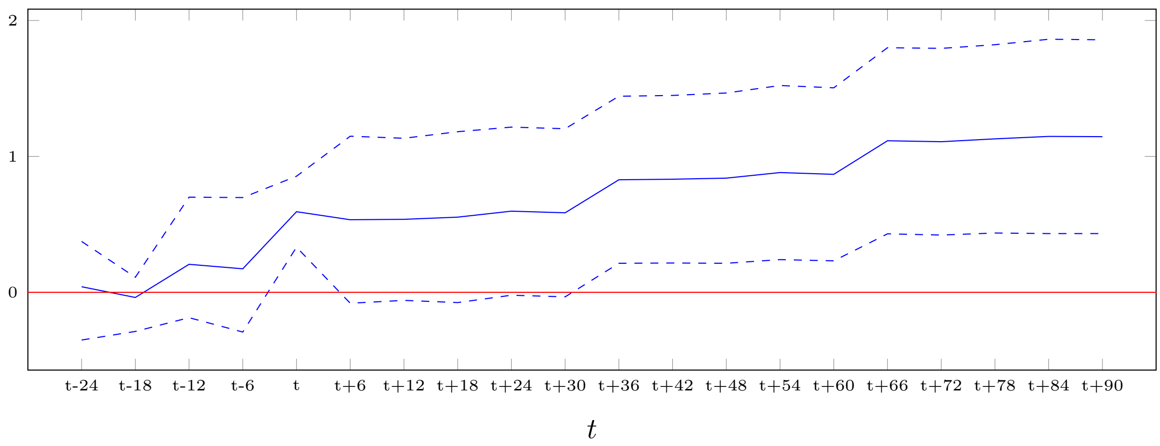

Table 1
Descriptive Statistics

Table 1 has descriptive statistics for the main variables used in the paper. Return^2 is the squared stock return between 19:00 CET and 13:00 CET on announcement dates of ECB key target rates. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a proxy for the average number of days left before the renewal of the relevant collective bargaining agreement. (See Section 4.3 for details.) Size is the logarithm of total assets. Leverage is given by non current liabilities plus current liabilities, all divided by total assets. ROA is earnings before interest and debt divided by total assets. Labor intensity is total monthly wage expenses divided by total assets.

	N	Mean	Median	St. Dev.	Min	Max
Return^2	22,709	0.03	0.01	0.09	0.00	0.98
MP^2	22,709	0.36	0.05	1.00	0.00	7.41
MP^2 $\times$ WR	22,709	1.64	0.08	5.33	0.00	50.72
WR	22,709	5.05	5.77	2.01	0.00	7.31
Time to Ren.	22,709	375.72	318.12	314.88	0.00	1,489.00
Size	22,709	6.76	6.40	2.13	2.84	12.96
Leverage	22,709	0.28	0.29	0.16	0.00	0.83
ROA	22,709	0.08	0.08	0.07	-0.19	0.31
Lab. Int.	22,709	7.27	7.49	1.63	3.33	10.00

Table 2
Baseline Results

Table 2 presents regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a measure of wage rigidity. (See Section 4.3 for details.) Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses (measured in the month previous to the announcement) over beginning-of-year total assets. Columns 4 through 6 also include firm and announcement date fixed effects. All the accounting control variables are measured at the beginning of the year. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
$MP^2 \times$ WR	0.017**	0.016**	0.013*	0.022***	0.022***	0.020***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
MP^2	0.042***	0.044***	0.047***			
	(0.007)	(0.007)	(0.008)			
WR	0.007	0.008	0.007	-0.001	-0.001	-0.001
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
Size		-0.017	-0.017		-0.050	-0.064
		(0.019)	(0.019)		(0.065)	(0.062)
Leverage		0.029**	0.029**		0.026	0.028
		(0.014)	(0.014)		(0.020)	(0.020)
ROA		-0.045***	-0.045***		-0.003	-0.003
		(0.011)	(0.011)		(0.019)	(0.019)
Lab. Int.		0.027*	0.027*		0.011	0.010
		(0.016)	(0.016)		(0.034)	(0.034)
$MP^2 \times$ Size			-0.029***			-0.028***
			(0.010)			(0.010)
$MP^2 \times$ Lev.			0.009			0.010
			(0.011)			(0.010)
$MP^2 \times$ ROA			-0.008			-0.006
			(0.009)			(0.009)
$MP^2 \times$ Lab.			0.002			0.001
			(0.010)			(0.010)
Observations	22,709	22,709	22,709	22,709	22,709	22,709
R^2	0.002	0.006	0.007	0.130	0.130	0.131
Controls		X	X		X	X
Controls$\times MP$			X			X
Time FE				X	X	X
Firm FE				X	X	X

Table 3
The Effect of Labor Intensity

Table 3 presents regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. Column 1 includes the full sample. In columns 2 through 4 firms are sorted accordint to their degree of labor intensity, going from the bottom tercile (column 2) to the highest tercile (column 4). Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

		Sorting by:		
	Baseline	Wages / Assets		
		Low	Medium	High
	(1)	(2)	(3)	(4)
$MP^2 \times WR$	0.014	0.026**	0.015*	0.025**
	(0.009)	(0.012)	(0.009)	(0.012)
WR	-0.010	0.003	-0.014	0.009
	(0.012)	(0.012)	(0.012)	(0.012)
Observations	11,337	11,360	11,371	11,333
R^2	0.191	0.108	0.190	0.110
Controls	X	X	X	X
Controls$\times MP$	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

Table 4
Robustness Tests: Industry Effects and Swap Horizons

Table 4 presents regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon, except in columns 2 and 3, where we use the 6-month and the 3-month swap, respectively. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include, as control variables, size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. In columns 4 through 6, regressions also include industry dummies interacted with MP^2. In columns 4, 5 and 6, industries are defined using the 1, 2 or 3-digit NACE classification, respectively. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

	Using Different Measures of MP Shocks:			Controlling for Industry FE×Shock:		
	1-Year Swap	6-Mo Swap	3-Mo Swap	1-Digit NACE	2-Digit NACE	3-Digit NACE
WR	-0.001	-0.002	-0.002	-0.002	-0.006	-0.008
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
$MP^2 \times WR$	0.020***	0.021***	0.023**	0.017***	0.017***	0.019***
	(0.007)	(0.007)	(0.010)	(0.006)	(0.006)	(0.007)
Observations	22,709	22,709	22,709	22,709	19,991	16,603
R^2	0.131	0.131	0.131	0.132	0.135	0.143
Controls	X	X	X	X	X	X
Controls$\times MP^2$	X	X	X	X	X	X
Time FE	X	X	X	X	X	X
Firm FE	X	X	X	X	X	X
Ind. FE$\times MP^2$				X	X	X

Table 5

Robustness Tests: Different Windows around Announcements

Table 5 presents regressions where the dependent variable is the squared firm's stock return over several windows. MP^2 is the square of the change in the median quote of the 1-year Euro Overnight Index Average (EONIA) swap rate from the window 13:25-13:35 before the press release to the median quote in the window 15:40-15:50 after the press conference. The dependent variable is the squared stock return of the same horizon in column 1, between 13:00 and 19:00 in column 2 and over the entire day in column 3. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include, as control variables, size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. In columns 4 through 6, regressions also include industry dummies interacted with MP^2. In columns 4, 5 and 6, industries are defined using the 1, 2 or 3-digit NACE classification, respectively. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

Window of Dep. Variable:	Altavilla et al. (2019)	Corsetti et al. (2019)	Daily
	(1)	(2)	(3)
$MP^2 \times WR$	0.012**	0.017***	0.015**
	(0.006)	(0.006)	(0.007)
WR	0.021***	-0.002	-0.002
	(0.008)	(0.009)	(0.008)
Observations	22,709	22,709	22,287
R^2	0.078	0.131	0.094
Controls	X	X	X
Controls$\times MP^2$	X	X	X
Time FE	X	X	X
Firm FE	X	X	X

Table 6
Firm's Performance and Business Cycle

Table 6 presents regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. Columns 1 and 2 include firms that have ROA below and above the sample median, respectively. In columns 3 and 4 the sorting variable is the quarterly GDP growth. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

	Sorting by:			
	ROA		GDP Growth	
	Low (1)	High (2)	Low (3)	High (4)
$MP^2 \times WR$	0.026**	0.014	0.024***	0.009
	(0.011)	(0.010)	(0.008)	(0.010)
WR	-0.014	0.002	0.005	-0.008
	(0.012)	(0.012)	(0.013)	(0.013)
Observations	10,480	12,222	11,431	11,269
R^2	0.149	0.142	0.139	0.138
Controls	X	X	X	X
Controls$\times MP$	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

Table 7
The Effects of Part-Time and Fixed-Term Contracts

Table 7 presents regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. Columns 1 and 2 include firms that have a fraction of workers with part-time contracts below and above the sample median, respectively. In columns 3 and 4 the sorting variable is the fraction of workers with fixed-term contracts. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

	Sorting by Fraction of Workers with:			
	Part-Time Contracts		Fixed-Term Contracts	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
$MP^2 \times WR$	0.021***	0.005	0.024***	0.017*
	(0.008)	(0.012)	(0.008)	(0.010)
WR	0.006	-0.018	-0.003	-0.000
	(0.012)	(0.013)	(0.012)	(0.012)
Observations	11,466	11,243	11,382	11,327
R^2	0.148	0.130	0.142	0.133
Controls	X	X	X	X
Controls$\times MP$	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

Table 8
Labor Outcomes

Table 8 presents regressions where the dependent variables are several employment outcomes, measured at the quarterly horizon. MP^2 is the square of the weighted sum of changes in the 1-year Euro Overnight Index Average (EONIA) swap rate over the quarter. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. The dependent variables are the symmetric growth rates of: total wage payments (column 1), total days worked (column 2), total number of employees (column 3), total number of employees with at least 20 days worked in the month (column 4). Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

Dep. Var.	ΔPay	ΔDays Worked	ΔEmployees	ΔFull Time Employees
	(1)	(2)	(3)	(4)
$MP^2 \times WR$	0.038***	0.030*	0.037**	0.014
	(0.013)	(0.016)	(0.017)	(0.015)
WR	0.002	0.008	0.010	-0.001
	(0.010)	(0.013)	(0.012)	(0.013)
Observations	10,928	10,928	10,928	10,928
R^2	0.418	0.239	0.227	0.231
Controls	X	X	X	X
Controls$\times MP^2$	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

Table 9
Model Calibration

Table 9 presents, for each parameter of the model presented in Section 6, the value chosen for the calibration with the relevant source.

	Value	Description	Source
β	0.99	Discount factor	Standard
b_W	1.5	Response coefficient in mon. pol. rule	Standard
σ	2	Coefficient of relative risk aversion	Standard
η	1.17	Inverse Frisch labor elasticity	Fernández-Villaverde et al. (2010)
ϵ_p	10	Elasticity of substitution of goods	Fernández-Villaverde et al. (2010)
ϵ_w	10	Elasticity of substitution of labor services	Fernández-Villaverde et al. (2010)
ρ_i	0.77	Smoothing parameter in mon. pol. rule	Fernández-Villaverde et al. (2010)
f^s	1/S	Sector shares	Avg. renegotation time in data
S	8	Number of sectors	Avg. renegotation time in data
σ^i	0.0043	Volatility of monetary policy shock	Gorodnichenko and Weber (2016)
h	0.815	Internal consumption habit	Gertler and Karadi (2013)
ξ	2.015	Hiring cost parameter	Cooper and Willis (2009) (avg.)

Table 10
Regression Coefficients Estimated on Artificial Data

Table 10 presents coefficients estimated on an artificial dataset generated by the model described in Section 6, with parameter values calibrated using the values indicated in Table 9. In column 1 the dependent variable is the firm stock return squared. In column 2 it is the symmetric growth rate of employment squared. The regressors are the wage rigidity proxy, the monetary policy shock and an interaction term of the two. Only the coefficients associated to the latter regressor are showed. In the first row the coefficients are estimated on a simplified version of the model that has neither an habit component in the utility function, nor hiring costs. The second row presents data generated from the fully specified model. In the third row the model is identical but the relative risk aversion parameter is increased from 2 to 2.15.

Specification	Stock Return	Employment Growth
Baseline	0.132***	0.084***
	(0.011)	(0.012)
...plus habit and hiring costs	0.033***	0.071***
	(0.012)	(0.012)
...plus habit and hiring costs,	0.025**	0.056***
relative risk aversion = 2.15	(0.012)	(0.012)

A Appendix

In this Appendix we include robustness tests omitted from the main text for brevity. In Table A1 we test whether vacancy periods are systematically correlated with the performance of the firms that employ such workers. We compute, for each firm, the fraction of workers subject to a contract that has expired (and so that have the time to renewal truncated to zero) at the end of each quarter. Then, using Compustat quarterly data, we regress this variable on the first differences of Log(sales) and ROA (operating profits over lagged total assets). We include two lags of each regressor, demeaned and standardized, as well as time and industry tummies. Table A1 shows that, no matter whether we include only sale growth (column 1), only profitability (column 2), or both (column 3) as regressors, firm performance does not appear to predict vacancy periods. In column 4, where industry dummies are replaced by firm fixed effects, coefficients are again insignificant. Hence, we are reassured that the vacancy periods are unlikely to mask some relevant omitted variables.

In Table A3, we sort firms in terciles according to their degree of wage rigidity, and regress the squared stock return on the squared monetary shock, firm fixed effects and control variables, including the wage rigidity proxy itself. The results of this non-parametric exercise confirm the finding of the main text. The coefficient on MP^2 is negative and insignificant in the first tercile, and becomes positive and significant in terciles II and III. Moreover, results do not appear to be driven by firms with $WR = 0$; in column 2, we exclude them from the first tercile, and the coefficient on MP^2 remains small and significant only at the 10% level.

We also test for the presence of any pre-trends in stock market returns that could anticipate the monetary policy shocks. More specifically, we replace our dependent variable with the stock return between 1pm and 7pm on the day *prior to* each monetary policy announcement. If the correlations found so far were spurious, we could in principle obtain similar estimates even in days in which monetary policy announcements do not take place. On the other hand, a small and insignificant coefficient on the interaction term of interest would suggest that our results are indeed driven by heterogeneity in the response to monetary policy shocks.

In Table A2 we first replicate our baseline test of Table 2, focusing for brevity on the most conservative specification. In column 1 we find a coefficient on the interaction term that is small and insignificant, equal to -0.003 (t-statistic=0.38). We also replicate our analysis of Table 3, where we sort firms according to their degree of labor intensity. This test is crucial because it provides strong evidence that the labor channel is indeed the driving force of our results. As columns 2 through 4 show, the coefficient of interest remains small and insignificant in all the subsamples.

As a further test, we adopt alternative choices for the clustering of standard errors. Given that the focus of our analysis is on heterogeneity in wage rigidity, that varies across firms, in the main text we cluster standard errors at the firm level. However, in Table A4 we report the coefficient on the interaction term between wage rigidity and the monetary policy shock and, in parenthesis, standard errors estimated through clustering at different levels. We re-estimate our baseline empirical model both in the full sample and in the three subsamples where firms are sorted by their degree of labor intensity. Because collective agreements are signed at the sector level, we first re-estimates the baseline regression by clustering standard errors at the industry level (using the NACE 2-digit classification), and find virtually no difference in the results. We also experiment by clustering at the date level and by double-clustering standard errors at the firm and date level. Although results are more imprecise in the tests that use the full sample, when we focus on the subsample of firms characterized by high labor intensity (column 4) the coefficient of interest is again highly significant.

In Table A5 we replicate the regressions presented in Table 8 using the leads of the dependent variables. The coefficient of interest is insignificant, suggesting that there is no reversal in the amplification effects of wage rigidity. In Table A6, we perform a "placebo test" similar to the one of Table A2, now for the regressions with labor market outcomes. Here we use as dependent variables the one-quarter lags of those used in our main tests. As expected, we do not find any significant relationship between changes in employment and shocks occurring in the following quarters.

Table A1
Firm Performance and Vacancy Periods

Table A1 presents regressions where the dependent variable is the fraction of the firm workers that are subject to an expired collective agreement. ΔSales is the first difference in the logarithm of revenues; ROA is operating income over lagged total assets. The continuous variables are demeaned and divided by their standard deviation for ease of interpretation. All regressions include year-quarter dummies. Columns 1 through 3 include industry dummies using the 2-digit SIC code definition; column 4 includes firm fixed effects. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

	(1)	(2)	(3)	(4)
ΔSales_{t-1}	-0.004		0.023	0.002
	(0.035)		(0.044)	(0.003)
ΔSales_{t-2}	-0.018		0.003	-0.001
	(0.037)		(0.040)	(0.003)
ROA_{t-1}		-0.017	-0.034	-0.003
		(0.063)	(0.066)	(0.004)
ROA_{t-2}		-0.000	0.017	-0.004
		(0.079)	(0.084)	(0.005)
Observations	8,301	5,803	5,465	5,690
R^2				0.367
Year-Quarter FE	X	X	X	X
Industry FE	X	X	X	
Firm FE				X

Table A2
Placebo Test

Table A2 presents regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET on the days prior to the monetary policy announcement dates. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. Column 1 includes the full sample. Columns 2 and 3 include firms that have labor intensity below and above the sample median, respectively. In columns 4 and 5 the proxy for labor intensity is given by total days worked divided by total assets. The numerators of both proxies are measured in the month previous to the announcement date, whereas total assets are measured at the beginning of the year. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

		Sorting by:		
	Baseline	Wages / Assets		
		Low	Medium	High
	(1)	(2)	(3)	(4)
WR	0.008	-0.009	-0.005	0.031
	(0.008)	(0.009)	(0.013)	(0.020)
$MP^2 \times$ WR	-0.004	0.014	-0.049**	-0.008
	(0.008)	(0.009)	(0.022)	(0.019)
Observations	22,301	7,433	7,521	7,347
R^2	0.088	0.161	0.086	0.082
Controls	X	X	X	X
Controls$\times MP$	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

Table A3
Robustness Tests: Tercile Split

Table A3 presents regressions regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET on the days prior to the monetary policy announcement dates. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm fixed effects. The coefficients presented in column 1, 3 and 4 are estimated over subsamples characterized by WR being in the first, second or third tercile of the entire sample distribution. The subsample used in column 2 has WR in the bottom tercile but excludes all the observations such that WR= 0. Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

WR Tercile	I	I (excl. zeroes)	II	III
	(1)	(2)	(3)	(4)
MP^2	0.013	0.018*	0.051***	0.046***
	(0.009)	(0.010)	(0.014)	(0.015)
Observations	7,561	5,258	7,564	7,558
R^2	0.055	0.063	0.058	0.068
Controls	X	X	X	X
Firm FE	X	X	X	X

Table A4
Alternative Clustering Choices

Table A4 presents regressions where the dependent variable is the squared firm's stock return between 13:00 CET and 19:00 CET on the days prior to the monetary policy announcement dates. The table shows the coefficient associated with the interaction term $MP^2 \times WR$. MP^2 is the square of the change in the 1-year Euro Overnight Index Average (EONIA) swap rate over the same time horizon. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. Column 1 includes the full sample. In columns 2 through 4 firms are sorted accordint to their degree of labor intensity, going from the bottom tercile (column 2) to the highest tercile (column 4). Standard errors are reported in parentheses, and are clustered at the industry, date, or double-clustered at the firm and date level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

		Sorting by:		
	Baseline		Wages / Assets	
		Low	Medium	High
	(1)	(2)	(3)	(4)
Coefficient:				
	0.020	0.012	-0.007	0.050
Clustering by:				
Industry	(0.005)***	(0.009)	(0.013)	(0.012)***
Date	(0.012)	(0.011)	(0.014)	(0.011)***
Date & Firm	(0.012)*	(0.011)	(0.014)	(0.009)***
Observations	22,709	7,632	7,601	7,476
R^2	0.131	0.215	0.162	0.099
Controls	X	X	X	X
Controls×MP	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

Table A5
Labor Outcomes: Leads of Outcome Variables

Table A5 presents regressions where the dependent variables are the one-quarter leads of several employment outcomes, measured at the quarterly horizon. MP^2 is the square of the weighted sum of changes in the 1-year Euro Overnight Index Average (EONIA) swap rate over the quarter. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. The dependent variables are the symmetric growth rates of: total wage payments (column 1), total days worked (column 2), total number of employees (column 3), total number of employees with at least 20 days worked in the month (column 4). Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

Dep. Var.	ΔPay$_{t+1}$	ΔDays Worked$_{t+1}$	ΔEmployees$_{t+1}$	ΔFull Time Employees$_{t+1}$
	(1)	(2)	(3)	(4)
$MP^2 \times WR$	0.023	-0.009	-0.018	-0.004
	(0.014)	(0.023)	(0.021)	(0.025)
WR	-0.003	0.005	0.001	-0.002
	(0.010)	(0.013)	(0.012)	(0.012)
Observations	10,645	10,643	10,646	10,639
R^2	0.408	0.236	0.227	0.230
Controls	X	X	X	X
Controls$\times MP^2$	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

Table A6
Labor Outcomes: Placebo test

Table A6 presents regressions where the dependent variables are several employment outcomes, measured at the quarterly horizon and lagged one quarter. MP^2 is the square of the weighted sum of changes in the 1-year Euro Overnight Index Average (EONIA) swap rate over the quarter. WR is a measure of wage rigidity. (See Section 4.3 for details.) All regressions include as control variables size, leverage, ROA and labor intensity, both as standalone variables and interacted with MP^2, all measured at the beginning of the year. Size is the logarithm of total assets. Leverage is the sum of debt in current liabilities and debt in non current liabilities, with all divided by total assets. ROA is the ratio of EBITDA over total assets. Labor intensity is the ratio of wage expenses over total assets. All the regressions include firm and announcement date fixed effects. The dependent variables are the symmetric growth rates of: total wage payments (column 1), total days worked (column 2), total number of employees (column 3), total number of employees with at least 20 days worked in the month (column 4). Standard errors, in parentheses, are clustered at the firm level. ***, **, and * indicate statistically different from zero at the 1%, 5%, and 10% level of significance, respectively.

Dep. Var.	ΔPay$_{t-1}$	ΔDays Worked$_{t-1}$	ΔEmployees$_{t-1}$	ΔFull Time Employees$_{t-1}$
	(1)	(2)	(3)	(4)
$MP^2 \times WR$	-0.027	-0.002	-0.001	-0.004
	(0.016)	(0.020)	(0.021)	(0.022)
WR	-0.007	-0.005	-0.000	-0.010
	(0.010)	(0.013)	(0.013)	(0.013)
Observations	10,702	10,700	10,702	10,691
R^2	0.399	0.242	0.231	0.233
Controls	X	X	X	X
Controls$\times MP^2$	X	X	X	X
Time FE	X	X	X	X
Firm FE	X	X	X	X

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