Monetary Policy and the Cost of Wage Rigidity: Evidence from the Stock Market

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1 Introduction

The heterogeneity of agents and firms has characterized the recent macro literature quite fervently. The importance of the distributional consequences of monetary policy has taken a central role in both academic and policy debates. Much discussion has been centered around heterogeneity in price stickiness, given its striking micro evidence [1], and many authors have built theoretical models to explore the macro consequences of these facts[2]. Others have assessed the impact on firms' stock market valuations of different degrees of price rigidity. Until now, fewer works have considered heterogeneity in wage stickiness and its consequences for monetary policy. The latter is crucial also because, given that bargaining arrangements between workers and employers depend crucially on institutional factors, and are at least in part outside of managers' control, there is scope for constructing a truly exogenous measure of the nominal rigidities.

To take a step forward into this research question, we merge the INPS data on individual workers with data on the timing of renewals of collective agreements (from CNEL) and with high frequency data on stock prices for individual firms (purchased from the private vendor Tick Data LLC). We then study how staggered wage adjustment affects how firms' stock returns respond to monetary shocks. The Italian labor market, given its peculiar contracting rules, provides a unique

[1] See Nakamura and Steinsson (2008).
[2] See Carvalho (2006).

environment to study our research question. In Italy, virtually all workers are covered by collective bargaining agreements, and contract renegotiation occurs at a predetermined schedule, with an average contract length of 3 years. This institutional feature of the Italian system of industrial relations provides useful variation that could be used to estimate how firms respond to monetary policy shocks when they are closer or farther away from contracts' renewals.

While, of course final wages are set at the level of the individual firm, collective agreements regulate salary conditions, days of vacation, the compensation for extra hours, and a number of other aspects of the employee- employer relationship. Extensive empirical work (Boeri, Ichino, Moretti, and Posch (2017), Belloc, Naticchioni, and Vittori (2018), Devicienti, Fanfani, and Maida (2016)) has shown that they instill a high degree of rigidity that we exploit for identifying the effects of monetary policy. In particular, in a simple model that we take to the data, we show that a monetary policy shock should generate higher stock volatility for firms that employ workers that are far away from the renewal of their collective agreement. Intuitively, the expectation that wages are going to be fixed for a long period of time amplifies the effect of a monetary policy shock on firms' profits and, thus, stock prices.

2 Econometric Strategy

We identify monetary policy shocks at high frequencies via changes in swaps on money market rates in the hours sorrounding the announcement of the main ECB policy rate.[3]

Any firm typically hires workers in several job categories, and are hence subject to different collective agreements. We construct a firm level measure of wage rigidity WR as follows:

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

[3]Early work on high frequency identification of monetary policy shocks is Gürkaynak, Sack, and Swanson (2005) and Barakchian and Crowe (2013). Following a recent approach by Corsetti, Duarte, and Mann (2018) we employ swap rates to compute the surprise component.

where j, t, c index workers, firms and job categories, respectively. We use the max operator to truncate the difference $t - \tau_t$ at 0 for each worker, and take its average at the firm level using the wage earned in the previous month as weight. Because of the truncation at zero, the measure is right-skewed; hence, we take the logarithm of 1 plus the measure to have a more well-behaved proxy. Although many small firms hire workers belonging to a single collective agreement, this turns out not to be the case for workers employed in large, listed firms. As Figure 1 shows, the vast majority of firms in our sample employ workers belonging to at least two collective agreements; hence, the importance of using administrative INPS data.

Of course, our work rests on the assumption that there is a strong relationship between actual compensation and minimum wages. We estimate this relationship in the following dynamic model, that follows Dube, Lester, and Reich (2010):

$$\log(w_{i,t,c}) = \beta \sum_{j=-8}^{16} \left(\eta_{-6j} \Delta_6 \log(w^M_{c,t+6j})\right) + \eta_{-96} \log(w^M_{c,t-96}) + \gamma_i + \delta_t + \omega_c + \varepsilon_{i,c,t} \tag{2}$$

In this equation, Δ_6 represents a a six-month difference operator; Figure 2 plots the resulting η coefficients and, hence the cumulative effect of minimum wage changes on workers' compensation. All the coefficients on the leads are close to zero and statistically insignificant; on the other hand, there is a "jump" at time t, and the effect does not vanish in the long run. To summarize, collective agreements are a significant source of variation in individual wages and, hence, are likely to be priced in the stock market response to monetary policy shocks.

our main econometric specification reads as follows:

$$R^2_{i,t} = \alpha MP^2_t + \beta WR_{i,t} + \gamma MP^2_t \times WR_{i,t} + \delta' X_{i,t} + \theta' X_{i,t} \times MP^2_t + \eta_i + \mu_t + \varepsilon_{i,t} \tag{3}$$

where:

$$MP_t = S^+_t - S^-_t \tag{4}$$

and where WR is defined in equation 1. MP is the change in the 1-year Euro Overnight Index Average (EONIA) swap rate on days of announcements of ECB key rates. We follow Corsetti et al.

(2018), who kindly shared their data with us, and choose a 6-hour window from 13:00 to 19:00 CET. The dependent variable is firm i's stock return over the same window.

Our hypothesis is that $\gamma > 0$, namely that higher distance from the renewal of a contract magnifies volatility in stock prices due to monetary policy changes.

3 Results and Final Remarks

Table 1 presents descriptive statistics for the variables used in this project. Table 2 shows that the coefficient has the expected sign and is non-negligible in magnitude. (In all the tables that follows standard errors are clustered at the firm level. All the variables in the model are demeaned and divided by their standard deviation for ease of interpretation.) Table 3 shows that, importantly, results are driven by firms with high labor intensity, i.e., firms in which labor costs are meaningful.

Table 4 shows that there are significant effects also on the real side. In this case the dependent variables are the squared growth rates of wage bill and total employment, both for listed firms and for all firms with at least 100 employees.

Finally, we build a New Keynesian to explore the quantitative implications our results. The model is standard in most respects, except that we assume the presence of staggered wage-setting à la Taylor (1979). Table 5 lists the parameters we use to calibrate the model, and Table 6 shows coefficients estimated from regressions run on the artificial data generated by the model, that are in the ballpark of the “true” coefficients.

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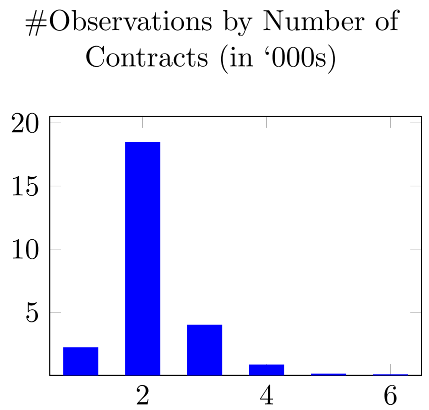
4 Figures and Tables

Figure 1
Collective Agreements by Firm



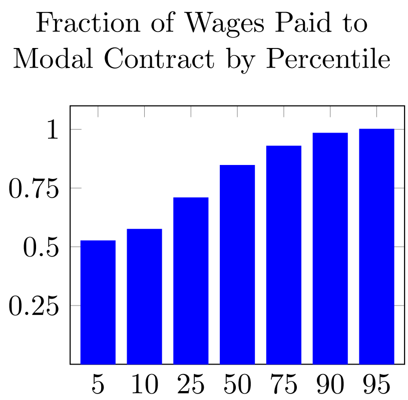


Figure 2
Dynamic Relationship between Minimum Wages and Earnings

Figure 2 shows the coefficients ηs, together with the 95% confidence intervals, obtained by estimating equation 2.

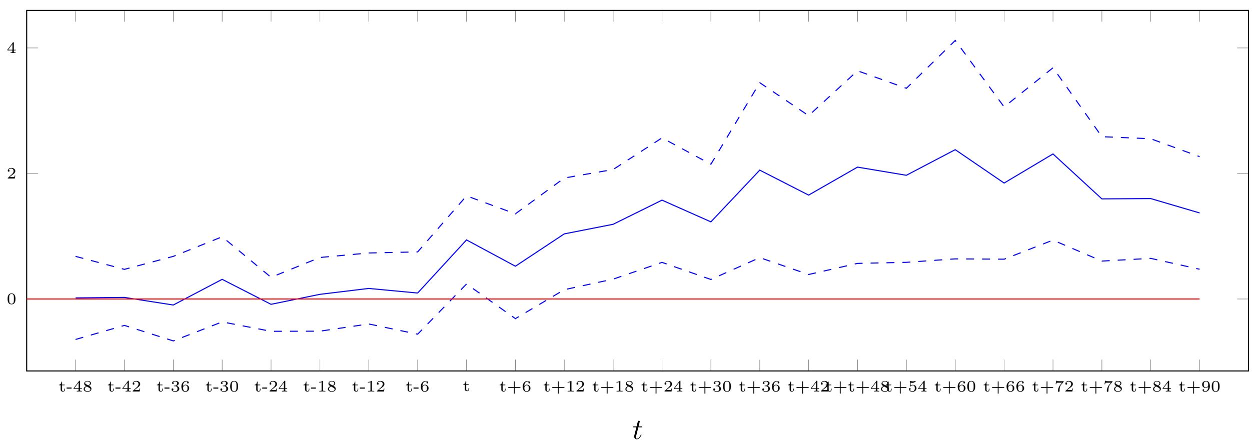


Table 1
Descriptive Statistics

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. 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	25,529	0.03	0.01	0.09	0.00	1.00
MP^2	25,529	0.36	0.05	1.00	0.00	7.41
$\text{MP}^2 \times \text{WR}$	25,529	1.63	0.08	5.29	0.00	50.72
WR	25,529	5.04	5.77	2.03	0.00	7.31
Time to Ren.	25,529	376.54	318.65	316.77	0.00	1,489.00
Size	25,529	6.64	6.23	2.08	2.84	12.96
Leverage	25,529	0.29	0.29	0.17	0.00	0.83
ROA	25,529	0.08	0.08	0.08	-0.19	0.31
Lab. Int.	25,529	7.27	7.49	1.60	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. 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***	0.016**	0.022***	0.021***	0.021***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
MP^2	0.040***	0.042***	0.045***			
	(0.007)	(0.007)	(0.007)			
WR	0.007	0.008	0.008	-0.001	-0.001	-0.002
	(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Size		-0.020	-0.020		-0.048	-0.058
		(0.017)	(0.017)		(0.060)	(0.058)
Leverage		0.033***	0.033***		0.021	0.022
		(0.012)	(0.012)		(0.017)	(0.017)
ROA		-0.046***	-0.047***		-0.008	-0.009
		(0.010)	(0.010)		(0.018)	(0.018)
Lab. Int.		0.026*	0.027*		-0.001	-0.001
		(0.014)	(0.014)		(0.030)	(0.030)
$MP^2 \times$ Size			-0.025***			-0.025***
			(0.009)			(0.009)
$MP^2 \times$ Lev.			0.005			0.004
			(0.010)			(0.010)
$MP^2 \times$ ROA			-0.010			-0.007
			(0.008)			(0.009)
$MP^2 \times$ Lab.			0.002			0.001
			(0.009)			(0.009)
Observations	25,529	25,529	25,529	25,529	25,529	25,529
R^2	0.002	0.007	0.008	0.125	0.125	0.126
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. 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 labor intensity below and above the sample median, respectively. In columns 3 and 4 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:			
	Wages / Assets		Days Worked / Assets	
	Low (1)	High (2)	Low (3)	High (4)
$MP^2 \times WR$	0.014	0.029***	0.013	0.027***
	(0.009)	(0.010)	(0.008)	(0.010)
WR	-0.007	0.000	-0.010	0.006
	(0.011)	(0.012)	(0.010)	(0.012)
Observations	12,763	12,752	12,764	12,759
R^2	0.178	0.106	0.178	0.109
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
Labor Outcomes

Table 4 presents regressions where the dependent variables are different 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. All the regressions include firm and announcement date fixed effects. The dependent variables are the symmetric growth rates of: total wage payments (columns 1 and 3) and total number of employees (columns 2 and 4). Columns 1 and 2 include only listed firms; columns 3 and 4 include all firms with at least 100 employees. 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	ΔEmployees	ΔPay	ΔEmployees
	(1)	(2)	(3)	(4)
$MP^2 \times WR$	0.033***	0.037**	0.008***	0.001
	(0.013)	(0.015)	(0.001)	(0.002)
WR	0.002	0.019*	-0.005***	-0.001
	(0.009)	(0.011)	(0.001)	(0.002)
Observations	12,495	12,495	562,953	562,953
R^2	0.409	0.216	0.525	0.366
Controls	X	X		
Controls$\times MP^2$	X	X		
Time FE	X	X	X	X
Firm FE	X	X	X	X
Sample	Listed	Listed	All	All

Table 5
Model Calibration

Table 5 presents, for each parameter of the theoretical model, 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 6
Regression Coefficients Estimated on Artificial Data

Table 6 presents coefficients estimated on an artificial dataset generated by the theoretical model, with parameter values calibrated using the values indicated in Table 5. 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)