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Rigid yet resilient: Firm's margins of adjustment to demand shocks in regulated labour markets

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Abstract

This paper investigates how firms adjust to demand shocks when wages and employment determination are regulated. Using firm-level data for the Italian metal engineering industry for the 2009-2015 period, we estimate the elasticity of the wage bill and, separately wage and employment margins, to changes in firm's real sales. We disentangle the effect on different wage components (base wage and wage cushion) and labour inputs (permanent or temporary employment and working hours). Results show that resilience of the wage bill to demand shocks mainly works through the adjustment of working hours (especially *via* short-time work), while wage and employment margins are less sensitive. Industrial relations significantly influence the firm's adjustment process: strong unions reduce the sensitivity of employment adjustment, conversely firm-level collective agreements show higher sensitivity *via* the wage cushion components. We discuss the implications of rent sharing for firm's profitability.

Key words: labour adjustment, demand shock, short-time work, unions, collective bargaining
JEL codes: J30, J58, C81

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1. Introduction

The 2008 economic crisis, and more recently the Covid-19 pandemic, exposed most firms to unprecedented large and persistent product demand shocks. Firms' reaction to these shocks has been quite heterogeneous both between and within countries, with large employment adjustment. In order to explain firm's resilience to these shocks, and the differential impact across countries, the economic literature has renewed attention on the interactions between economic shocks and labour market institutions (Blanchard and Wolfers, 2000; Boeri and Jimeno, 2016).

In this paper, we investigate how firms adjust to demand shocks, as proxied by changes in real sales, when wages and employment are regulated by either legislation or collective bargaining.

Typically, when a profit maximizing firm faces a sudden change in product demand, it can react by either adjusting output price or revising production costs. This mix has been shown to vary over the business cycle, with price adjustment mainly used when demand is high and competition weak, while cost margins are more likely under low demand and intense competition (Druant et al., 2012). Restricting attention on labour costs, firms can adjust the wage bill to a negative demand shock either cutting wages or reducing labour inputs. Both wages and labour inputs can be adjusted along a number of different margins, such as hours worked, share of temporary contracts and incidence of variable pay.

The different margins of adjustment firms can resort to, strongly depends on regulations and the institutional settings. More specifically, the presence of multi-period collective agreements, at the national or industry level, may generate nominal wage rigidity forcing firms to react to a negative shock mainly by reducing employment (Magruder, 2012). Alternatively, the presence of costly turnover due to strict employment protection legislation may slow down employment adjustment (Bertola et al., 1999; Kugler and Pica, 2008), or affect employment composition *via* termination of temporary contracts (Bertola et al., 2012).

Collective bargaining reduces firm's ability to adjust wages, particularly when collective agreements last several periods (Holden 2004), while strong unions typically resist employment adjustments,

favouring working hours flexibility, and the use of short-time work schemes (Adamopoulou et al 2016, Adamopoulou and Villanueva, 2020).

While the economic implications of labour market institutions on aggregate employment flows and unemployment have been widely studied in the economic literature (Bertola and Rogerson 1997; Blanchard and Wolfers, 2000; Bassanini and Duval, 2009), less is known about firm's specific response to demand shocks under different collective bargaining arrangements and presence of unions within the firm (Addison, 2016).

Much of the recent research on this topic in Europe, which regained momentum after the 2008 economic crisis, mainly uses firm-level cross-section survey data and qualitative information based on self-reported answers from the Wage Dynamics Network project (WDN).[2] Studies based on the WDN data confirm that downward nominal wage rigidity is a relevant phenomenon, with important implications for economic policy. For example, Marotzke et al. (2017) show that firms with more constraints in cutting base wages are also those declaring larger employment losses. Fabiani et al. (2015) confirm that labour cost reduction through the adjustment of quantities (i.e., employment) rather than price (i.e., wage) was the prevailing strategy that most European firms adopted to cope with demand shocks during the crisis.

Babecky et al. (2012) and Dias et al (2013) argue that, although workers' nominal base wages are seldom cut, firms can more easily adjust other wage components, such as bonuses and non-pay benefits. In light of this evidence, the impact of downward wage rigidity on labour costs might be lower than previous research has suggested (Devicienti et al., 2007). However, the qualitative nature of the questions in the WDN survey does not enable to assess the quantitative dimension of the process of substitution between base wage flexibility and flexibility of other wage components, employment and hours.

[2] The WDN project was promoted by 25 National Central Banks of euro and non-euro area EU Member States. WDN carried out three firm-level surveys (in 2007, 2009 and 2014) with information on labour market adjustments following the 2007 Great Recession. For further details on WDN, see https://www.ecb.europa.eu/pub/economic-research/research-networks/html/researcher_wdn.en.html

Quantitative evidence concerning wage adjustment comes from US research based on detailed information on individual wages from payroll records, but with mixed results. On one side, there is evidence that nominal wage flexibility (measured by the share of job stayers experiencing nominal wage reductions over a certain period of time) is more common in the US compared to Europe, also due to differences in labor market institutions between the two areas, especially related to collective wage bargaining (Kurmann and McEntarfer, 2019; Jardim et al., 2019).[3] On the other side, studies that focus on changes in the base wage find that this wage component in the US is as rigid as in most European countries (with only 2% of US job stayers experiencing nominal base wage cuts during a given year), confirming that wage adjustments occur manly through changes in flexible, usually performance-related wage components or adjustment in working hours (Grisby et al., 2021). One drawback of most studies using payroll records is that, while they provide accurate information on wage, employment and hours, they are a sort of "black box" for what concerns other firm characteristics, such as firm performance, work organization and industrial relations.

In order to bridge these two strands of the literature, this paper uses a unique firm-level panel data of metal engineering firms in Italy (from 2009 to 2015), providing detailed information on wages, employment as well as firm's performance indicators. In particular, we analyse firms' margins of adjustments to firm-level product demand shocks (i.e. changes in real sales) and use an Instrumental Variable approach to address endogeneity of firm's sales. We investigate both the "extensive" and the "intensive" margins of adjustment by estimating the elasticities to real sales of the total wage bill, and of the different wage and employment components. In terms of the "extensive" margin, we consider per-capita annual wages and total employment as outcomes variables. We further delve into the "extensive margin" of adjustment analyzing the sensitivity of different wage (base wage and wage cushion) and employment components (permanent full-time, permanent part-time and temporary employment) to changes in sales. Given firm's extensive use of furlough schemes and short-time

[3] Elsby and Solon (2019) provide similar evidence on the basis of different studies on payroll records for a number of countries, including the United States.

work measures during the recent crises (Arpaia et al, 2010; Boeri and Bruckner, 2011), we also extend the analysis of the intensive margin of adjustment computing an accurate measure of the number of hours worked and estimate the contribution of such schemes. In this respect, Italy provides an interesting case study, since it is the country in Europe with the highest share of workers on furlough and short-time work schemes, and because it is the country with the most generous scheme, whose eligibility was (temporarily) extended over the recent crises to both firms and workers previously excluded (Eurofound, 2010 and 2020).

We exploit rich information available on firm-level union density and collective bargaining to investigate how they influence the choice of margins of adjustment in presence of nominal wage rigidity caused by multi-period collective bargaining (Cardoso and Portela, 2009; Cardoso and Portugal, 2005; Dickens et al., 2007; Du Caju et al., 2015; Messina et al., 2010). Finally, since in an industry open to international competition, such as the metal engineering sector, increases in labour (and capital) costs cannot be easily passed onto prices, we investigate whether there is any effect on other margins, such as firm's profitability (Bertola et al. 2012).

We find that the total wage bill is sensitive to changes in firm's real sales, though the estimated elasticity is rather small: a 10% increase in sales determines an increase in the wage bill of approximately 1.5%, which is almost entirely driven by employment changes, while wages remain largely unaffected. We show that the elasticity of total employment conceals heterogeneous effects across different margins of adjustment, such as permanent and temporary contract, part-time employment and working hours. Still, given the prevalence of full-time permanent employment in the metal-engineering industry, much of the employment adjustment to changes in sales is driven by changes in full-time permanent employment. In firms where unions are powerful, the adjustment in permanent employment is much lower, compared to firms in which unions are not present or are weak. The counterpart of strong union power and the associated constraints to labour (re)allocation is a higher flexibility of profits' margins.

The remainder of the paper is organized as follows. In Section 2 we discuss the main institutional features influencing labour costs adjustments (in terms of wages, employment and working hours) in Italy. In Section 3 we present the dataset, the main variables of interests and some preliminary descriptive evidence. In Section 4 we discuss the empirical strategy, while the main econometric estimates, as well as a number of robustness checks and further estimates, are reported in Section 5. In Section 6 we investigate the role of local unions and firm-level bargaining in influencing the menu of margins od adjustments. The last Section concludes.

2. The institutional setting

Italy does not rank among the OECD countries with the strictest labour market regulation; nonetheless, labour utilization and reallocation is hindered by a rigid wage bargaining system coupled with asymmetric employment protection regulation between permanent and temporary contracts (Schindler, 2009).

Collective bargaining in Italy operates within a relatively weak legal regulation and is centered around the role of the most representative employers and workers' organizations. The main labour law, the so-called *Statuto dei lavoratori* of 1970[4], voluntarily did not regulate industrial relations, leaving to social partners responsibility for setting the rules through collective bargaining. Although information on union membership and employers' associations in Italy is rather uncertain, recent available estimates set union membership, in the private sector, around 30-40%, and employers' association close to 50% (Visser, 2019). Since the first half of 1990s, collective wage bargaining is organized in a two-tier system: base wages are set in industry-level collective agreements (*Contratto Collettivo Nazionale di Lavoro, CCNL*) and indexed to inflation, with the aim to preserve purchasing power, while additional wage components linked to specific indicators of productivity, profitability or other measures of firm performance can be bargained at the firm or local level. A collective agreement is

[4] The Italian *Statuto dei lavoratori* has been in force for almost 50 years, only partially modified over time in some respects.

in general only binding for the partners who sign the contract, as there are no formal extension mechanisms to other firms or workers. However, a surrogate of an *erga omnes* extension exists, as Labour Courts take wage levels set in collective agreements as reference for the application of Art. 36 of the Italian Constitution (e.g. stating that workers have the right to a 'fair wage'). This second tier of collective bargaining has always been subordinated to the national level, and it is subject to the *in melius* or favorability principle: that is, wages and working conditions cannot be worse than those agreed at the sector-level. Furthermore, since collective agreements cannot be typically derogated, they were blamed to cause excessive wage rigidity during the 2008 economic crisis (IMF 2016). New rules were then introduced, allowing firms in economic distress to temporarily opt-out from industry-level collective agreement - though wages have been excluded from the issues that could be derogated. In this setting, even if industry-level base wage cannot be adjusted downward, the overall responsiveness of wages can count on the adjustment of the flexible wage components linked to firm's productivity or to other indicators of firm performance (e.g. wage cushion) in companies with a firm-level agreement. Despite the progressive diffusion of collectively negotiated performance-related-pay schemes, their actual incidence on the total wage is rather small (e.g. close to 5-6% of the total gross wage; Casadio, 2003; Brandolini et al., 2007; Lucifora and Origo 2015). Furthermore, firm-level bargaining is still largely confined to the largest firms and in the Northern regions (D'Amuri and Giorgiantonio, 2014).[5]

Workers with an open-ended contract also enjoy considerable employment protection due to a combination of severance payment and reinstatements rights in case of labour disputes which makes firing extremely costly for firms (Sestito and Viviano, 2018). The "Jobs Act", introduced in 2015, reformed substantially firing rules for new hires, allowing employers greater discretion in workforce reduction in order to increase labour market overall flexibility and extending passive and active policies.

[5] Available data from the Survey of Industrial and Service Firms (INVIND) by the Bank of Italy suggest that in 2010 only 21 percent of firms had some form of second-level agreement.

In a context of nominal wage rigidity and strict employment protection of permanent contracts, working time flexibility, especially under the form of short-time work schemes, have been extensively used by firms to adjust employment to negative demand shocks.[6] Particularly in the years following the 2008-2009 economic crisis and in the current Covid-19 pandemic crisis, Italy features as one of the EU Member States with the highest share of workers on short-time work schemes (Eurofound, 2010 and 2020), and the country with the most generous scheme (corresponding to 80% of the previous gross earnings and lasting up to three years). Furthermore, before the adoption of the "Jobs Act" in 2015, this benefit was significantly higher than ordinary unemployment benefit and hence it was very attractive for both employers and workers. Finally, in 2009 its coverage was temporarily extended to firms and workers previously excluded (Arpaia et al, 2010; Giupponi and Landais, 2018). Quite interestingly, using data for 20 EU Member States from the third wave of the WDN survey, Lydon et al. (2018) find that the take up rate of short-time work schemes is higher in firms operating in countries with stringent Employment Protection Legislation or in sectors where wages are more rigid. Hence, short-time work schemes appear as a relevant margin of adjustment, especially where both wage and employment are difficult to adjust due to institutional constraints.

The current debate in Italy is still centred around the role of collective bargaining and wage rigidity preventing labour reallocation, particularly in times of economic crises when the need for wage adjustments is higher. Moreover, given the existing large productivity differentials across firms and

[6] *Cassa Integrazione Guadagni* (CIG) is the main short-time work scheme in Italy. CIG is made of three main programmes: Ordinary CIG (*CIG ordinaria*), Extraordinary CIG (*CIG straordinaria*) and Derogatory CIG (*CIG in deroga*). The Ordinary CIG is used in case of product demand declines in manufacturing companies due to temporary events that cannot be ascribed to the company, such as adverse weather conditions. The maximum duration is 13 weeks, which can be extended up to 52 weeks. The Extraordinary CIG is used in case of business crisis or restructuring by manufacturing companies with more than 15 employees (or 50 employees in services sectors). Derogatory CIG was introduced in 2009 to cover firms and workers (such as small firms and temporary workers) not covered by the previous two schemes. In all these schemes, public subsidy covers 80% of forgone earnings up to a threshold (the highest benefit amounts to around 1200 Euros). The use of these schemes has been further potentiated and extended during the COVID-19 crisis. For more institutional details, see: https://www.eurofound.europa.eu/it/observatories/emcc/erm/support-instrument/short-time-allowances-ordinary-wages-guarantee-fund-cigo-and-extraordinary-wages-guarantee-fund-cigs#

regions in Italy, another issue hotly debated is whether industry-level collective bargaining, by compressing the wage distribution, might be another source of inefficiency due to biased incentives for worker job mobility, factors misallocation, higher unemployment and lower resilience across regions (Boeri et al. 2019). This paper contributes to the above debate providing an empirical framework to analyse the different margins of adjustment and firms' reaction to product demand shocks.

3. Data and descriptive statistics

Data and sample selection

The empirical analysis is based on a unique firm-level panel dataset combining detailed survey information with balance sheet data for a representative sample of metal engineering firms in Italy. This industry accounts for almost 40% of the firms and employment in manufacturing in Italy and is a leading industry for issues related to industrial relations and collective bargaining. While the focus on a single industry may limit the external validity of the results when applied to other industries, there are also beneficial effects, since the lower (within) industry heterogeneity may reduce the role of confounding factors in the empirical analysis. The survey is carried out by the main national employers' association of this industry, with the aim to collect information on issues related to the labour market, firm-level bargaining and industrial relations. It is run every year since 2009; for our analysis, we could access data referred to the 2009-2015 period. On average, approximately 1,500 firms employing around 225,000 workers are surveyed each year, corresponding to almost one fifth of the employees in this industry. Overall almost 5,000 different firms took part to the survey in at least one of the years considered. Since three quarters of the firms participated to the survey more than once, we have an unbalanced panel covering a large number of firms over the period considered. The survey provides information for each firm on: employment levels, composition and changes (with some information by skill, gender, education and type of contract); working hours and absenteeism;

wage levels and composition by skill (*qualifica*) and job title (*livello di inquadramento*); firm-level bargaining and industrial relations.[7]

We also merged the survey data, using a unique firm identifier, with balance-sheet data drawn from AIDA dataset (*Analisi Informatizzata delle Aziende Italiane* - Computerized Analysis of Italian Firms) for the 2006-2015 period.[8] With this procedure we successfully merged information for 3,392 different firms, corresponding to around 68% of the firms in the initial sample. To select the final sample used in the empirical analysis, we dropped observations with missing or negative values for the main variables of interest (sales, wage components and employment), and trimmed each wage component dropping observations below and above the 1st and 99th percentile of the corresponding distribution. The final sample consists of around 2,300 firms, corresponding to almost 70% of the merged sample.[9]

Main variables of interest and descriptive evidence

The empirical analysis investigates firms' margins of adjustment to demand shocks, using detailed information on wage levels and composition, employment and working hours. Demand shocks are defined as changes in firm-level sales at 2015 prices. We deflated accounting nominal sales using production prices indexes computed at the fourth digit of industry classification. Trends in real sales of the metal-engineering industry mirror the Italian business cycle after the 2008-2009 economic crisis, characterized by a short recovery in 2010-2011, followed by a decline in sales in 2012-2013 (corresponding to the "double-dip" recession caused by the sovereign debt crisis) and the subsequent recovery since 2014.

[7] In specific waves, there are also additional questions on specific policies related to human resources management or labour market reforms implemented over the period covered by the survey.

[8] The AIDA database is updated and distributed by Bureau van Dijk and it contains the financial statements of all the active and bankrupt Italian companies (excluding banks, insurance companies and public bodies). AIDA is the main Italian source feeding Amadeus, the international Bureau van Dijk's dataset containing similar comparable information on public and private companies across Europe.

[9] The comparison of the average observable characteristics between the final sample and, respectively, the initial and the merged samples does not reveal any systematic difference between groups. Differences in observable characteristics are small and usually not statistically significant, except for a few variables (such as the number of temporary employees, the wage cushion and the unionization rate). Estimates and standard t-tests are available upon request.

Regarding wages of full-time permanent employees, the survey provides information on total gross monthly wages, annual collective performance-related-pay and other annual bonuses. Detailed information on different components of the monthly wage is also available: base wage (set by industry-wide collective agreements), seniority premia and other individual monthly premia (that may be either fixed or variable). This is a considerable advantage compared to household and administrative datasets, which usually do not contain details about the different components of total pay. As pointed out by Grigsby et al (2021), this is a crucial issue, especially when firms and workers are interested in long-term employment relationships. In this context, it is not the spot wage of new hires that matters, but rather the user cost of labour defined as the expected present value of costs to the firm associated with a new hire in current period compared to wait and hire the worker in the following period (Kudlyak, 2014). Grigsby et al (2021) show that base wages are a better proxy of the user cost of labour relative to measures of compensation inclusive of bonuses.

We compute firm-level annual gross wages adding up base pay, variable pay and annual bonuses. To gain insights into the role of different pay components, we also separately consider the base wage and the wage cushion. Finally, we compute the overall wage bill, as the product between the average wage and total number of employees by skill. [10]

Concerning firm's employment levels and composition, we distinguish between temporary and permanent employees and, within the latter, between full-time and part-time workers. Information on employment by type of contract is relevant because firms may use temporary employment as a buffer stock to cope with changes in product demand, especially in presence of high firing costs of permanent workers caused by strict employment protection legislation (Bertola et al., 1999; Kugler and Pica, 2008). Furthermore, resorting to part-time contracts has been used by firms during the crisis to prevent excessive employment cuts (Horemans et al., 2016). It should be noticed that both

[10] In practice, we compute total annual gross wage by skill and job title as follows: monthly wage*13 + bargained performance-related pay + other annual bonuses. The corresponding firm-level wage is computed using as weights the distribution of full-time permanent employees. The wage cushion is computed as the difference between total wage and base wage. Variable pay components include different wage premia set by the employer or negotiated with the employee at the time of employment, or other skill-specific components defined by the employment contract.

temporary and part-time employment, in the metal engineering industry, represent only a small share of total employment (around 5% of total workforce for each type of atypical contract).

Finally, detailed information on contractual weekly hours, annual hours of short-time work schemes and absenteeism are also available, allowing to compute two accurate measures of annual working hours per employee, where the difference between the two is given by the exclusion of short-time work schemes per employee (see Appendix I). Given the relevance of short-time work schemes in the Italian context, we also consider the total number of hours of short-time work schemes used by the firm as a further margin of adjustment to demand shocks.

As a first descriptive evidence on variation of the different margins of adjustment, Figure 1 plots percentage annual changes in base wage, wage cushion, total employment and per-capita working hours (net of short-time work hours) by firm and year. In each panel, a solid red line indicates the zero change, while for the two wage components the dashed green line indicates the target inflation rate defined in the industry collective agreement, which may be considered the threshold for real wage rigidity. However, since the years on the analysis are characterised by very low inflation, it is difficult to statistically distinguish between nominal and real wage rigidities (Adamopoulou et al. 2016). Hence, we shall interpret any spike between 0 and the inflation rate as a signal of wage rigidity, without distinguishing between nominal and real one.

The two upper panels of the figure confirm that wage rigidity is relevant mainly when we consider the base wage, given the mass of the distribution between zero and the inflation rate. Such mass is less evident when we consider the wage cushion, which is characterized by a longer and thicker left tail compared to the other wage component.

On the whole, descriptive evidence suggests that rigidity of total annual wage is due to the rigidity of the base wage set by industry collective agreements, which on average accounts for almost 80% of total wage, but with great variability across firms (ranging from 60% at the 1st percentile to 100% at the 99th one).

The two bottom panels show also in the case of total employment a mass at zero, implying some rigidity also in terms of employment adjustment. Nonetheless, the overall distribution looks less skewed than those reported for wages. Much more variation emerges when we consider annual per-capita working hours, whose distribution is also characterized by a relatively long tail driven by the reduction in the use of short-time work during the recent recovery years.

(FIGURE 1 AROUND HERE)

4. Empirical strategy

To estimate the elasticity of the wage bill to demand shocks, we specify the following baseline model:

$$\log(Y)_{it} = \alpha + \beta_1 \log(sales)_{it} + \tau_t + \mu_i + \varepsilon_{it} \qquad [1]$$

where Y_{it} represents wage or labour input indicators, as previously discussed, in firm *i* at time *t*, τ_t are time fixed effects, μ_i are firm fixed effects and ε_{it} is the error term.[11] The coefficient of interest is β_1, which measures the elasticity of the margin of adjustment considered to changes in real sales. The baseline specification is parsimonious in the number of covariates included; however, in the robustness section we check the sensitivity of our main results to the inclusion of firm-level time-varying controls or industry-specific time fixed effects.

Identification of β_1 as a causal effect requires conditional exogeneity of real sales. In our specification, firm fixed effects control for unobserved time invariant firm characteristics correlated with both demand shocks and firm's margins of adjustment, while time fixed effects control for time varying common shocks. Since other sources of endogeneity may be relevant, such as reverse

[11] Since we are using an unbalanced panel dataset, we prefer to estimate the model in levels rather than in first differences because the latter may significantly reduce sample size and exacerbate measurement error in the independent variables, introducing bias in the coefficients (Pozzi and Schivardi, 2016).

causality (for example, in a production function framework, changes in employment reflect into changes in output) or firm-level time-varying unobserved factors (such as a new management who simultaneously changes both sales, hiring and compensation policies)[12], we complement the previous analysis with an IV estimator using as instrument the pre-determined firm's market shares (defined at the 4-digit industry level and measured before the time period covered by our analysis) interacted with industry-wide sales shocks.

More specifically, the instrument is defined as follows:

$$\text{IV}\log(sales)_{it} = share_{ij2007} * \log(sales_{jt}) \qquad [2]$$

where $share_{ij2007}$ is the market share of the i-th firm in industry j in the pre-estimation period (i.e. 2007) and $sales_{jt}$ are total real sales in industry j at time t. Since we use a Fixed Effects estimator, identification in the first stage comes from deviation of industry sales from the corresponding (long-term) average. This is our measure of industry-wide shock. This empirical strategy implies an exposure research design, where market shares measure the differential exposure of different firms to a common industry-wide shock (Goldsmith-Pinkham et al, 2020). We then assume that a differential exposure to a common shock should differently affect outcome variables at the firm level. In our preferred specification, instrument validity requires exogeneity of the industry-wide shock conditional on firm and time fixed effects. This implies that each firm should be relatively small compared to the whole industry. Indeed, in our sample the average share of firm's sales is around 7.5% of total industry sales, and the share at the 90th percentile is 17.5%. In the robustness checks we shall provide further evidence using as instrument industry-level sales excluding the *i-th* firm sales (the so called "leave-one-out" instrument, Borusyak et al., 2022).

[12] The issue of reverse causality may be less relevant in the years of the crisis, when severe demand shocks were initially driven by external demand and were further exacerbated by credit crunch, especially in smaller firms. These shocks fell disproportionally strongly on manufacturing firms (Fabiani et al 2015).

5. Results

Baseline estimates

As a first step, we estimate the elasticity of the annual wage bill and its main components (i.e. per-capita annual wage and total employment) to changes in real sales. The main estimates are reported in Table 1, where the various columns refer to the different estimation methods -- fixed effects (FE) or Instrumental Variables (IV-FE), respectively -- and the dependent variable used: total wage bill (columns 1 and 2), per-capita annual wage (columns 3 and 4) and total employment (columns 5 and 6).[13] The estimated elasticities show that the total wage bill is significantly correlated with changes in real sales, but the size of the elasticity is rather small, even accounting for the potential endogeneity of real sales: IV estimates show that a 10% increase in sales causes an increase in the wage bill of approximately 1.5%, slightly higher than the corresponding FE estimate (1.37%). Quite interestingly, when we look separately at the two main components of the wage bill, we find that wages are largely unaffected by changes in sales, while total employment appears more resilient: a 10% increase in sales is associated to around 1% increases in total employment (IV estimates). These results overall confirm that firms partly adjust labour costs when facing a demand shock and that, given the substantial rigidity of wages, the adjustment falls onto employment and on other factors not fully captured by these aggregate variables.

(TABLE 1 AROUND HERE)

One explanation for the lack of adjustment of total wages to changes in sales may be related to the large incidence of the base wage set in multi-period industry-wide collective agreements, which are renewed every three years. However, there are other pay components that should be more responsive

[13] Table A1 in Appendix reports first stage estimates. The F statistics confirms the relevance of the instruments.

to changes in demand, such as collective performance-related pay, which are typically set in firm-level agreements and are aligned to indicators of firm's performance. Similarly, the relatively small estimated elasticity of total employment may hide heterogeneous effects across different types of employment contracts. For example, much of the employment adjustment may occur through the use of temporary employment or changes in working hours acting as a buffer stock.

In order to test the elasticity of specific wage and employment components, we estimated equation [1] separately for the base wage and the wage cushion; while for total employment, we differentiate between extensive (permanent full-time, permanent part-time and temporary workers) and intensive labour margins (per-capita annual contractual working hours and hours of short-time work).

Table 2 reports the main coefficients of interest estimated with the IV-FE estimator. Figures in the table confirms a relatively higher elasticity to changes in real sales of the wage cushion compared to the base wage, but both estimated coefficients are not statistically significant and smaller than those estimated for almost all the employment components. Among the latter, a much larger elasticity is estimated for both part-time and temporary employment compared to permanent employment, though for temporary employment the estimated coefficient is less precise (and not statistically significant). Since both these forms of atypical labour contracts represent only a small share of total employment in the metal-engineering industry (5.7% of total employees are part-time workers 4.4% are temporary ones), changes in total employment are mainly driven by full-time permanent employment. The estimated elasticity for permanent full-time employment is indeed very close in magnitude to that estimated for total employment.

Despite part-time work has been widely used in Italy as a mean to reduce working hours and prevent lay-offs during the 2008-2009 crisis and afterwards, metal-engineering firms typically relied on other forms of working hours flexibility, such as overtime during recoveries and short-time work schemes during downturns. As discussed in Section 2, short-time work was actually one of the main instruments used by large manufacturing firms to cope with the 2008-2009 crisis, as well as during the early phase of the Covid-19 pandemic crisis.

In light of these features, it is crucial to consider also changes in total working hours, and especially in short-time work hours, in order to get a full picture on the margins of adjustments that firms can use to react to demand shocks. Results in the last two columns of Table 2 clearly show that working hours set in collective agreements are rather insensitive to demand shocks: a 10% increase in real sales is associated to 0.23% increase in contractual per-capita working hours. Conversely, total short-time work hours display a much larger elasticity: a one percent increase in real sales causes a 3.7% decline in total hours of short-time work. The latter, in line with the institutional context previously discussed, proves to be the most reactive margin of adjustment to changes in real sales.

(TABLE 2 AROUND HERE)

Robustness checks and further estimates

In this Section we present a set of further estimates we carried out to test the robustness of the baseline estimates. The main results are reported in Table 3.

Each cell displays the estimated IV-FE elasticity to real sales of the dependent variable reported in each column. Rows differ for the empirical strategy or model specification used.

First, in order to control for time-varying factors that may be correlated with changes in sales and have a direct effect on either wages or employment components, we estimated a richer model specification, controlling for a vector of firm-level characteristics, including workforce composition, union density and the presence of a firm-level agreement. Alternatively, to take into account of time varying industry-specific confounders, we re-estimated our models including industry-specific time fixed effects, defined at either 2- or 3-digit level. Corresponding estimates reported in rows 1 and 2 of Table 3 show that our results are robust to the inclusion of time varying controls or different sets of fixed effects. Compared with the baseline estimates, in most cases the estimated elasticities are larger and more precisely estimated. Regardless of model specification, we obtain a statistically significant elasticity of temporary employment to real sales, whose magnitude is similar to the one

estimated with our baseline model, or even larger when we control for industry-specific time fixed effects. The estimated elasticities in column 5 for models 1-2 show that a 10% increase in real sales causes a 2.5%-4% increase in temporary employment, compared to a 0.8%-1.8% increase in permanent employment (column 4).

To assess the sensitivity of our estimates to the inclusion of own-observation information when computing the industry-wide shocks, we re-estimated our baseline specification using the "leave-one-out" instrument. Estimates reported in the last rows of Table 3 are very similar to our baseline estimates, especially for employment and working hours margins of adjustment. The only difference is that the estimated wage elasticity with the "leave-one-out" instrument is larger and statistically significant, but smaller than the employment effect: a 10% increase in sales causes a 0.7% increase in per-capita wages, 1.1% increase in total employment. The estimated elasticities for different wage components confirm that much of the adjustment is driven by changes of the wage cushion, but the estimated coefficients remain not statistically significant.[14]

(TABLE 3 AROUND HERE)

Finally, as noted by Jaeger et al. (2018), we should consider that adjustment to shocks may take some time. In this case, the error term of equation [1] can also include factors that reflect the ongoing adjustment to past shocks. If this is the case, our baseline estimates may mix quite different short-term and long-term responses, such as a fall in wages in the short term caused by declining real sales, followed by an increase in wages once other factors, such as capital, have time to adjust. In order to account for potential adjustment dynamics, Jaeger et al. (2018) propose to enrich the model

[14] The estimated coefficient for the wage cushion is 0.276 (s.e.: 0.358) and for the base wage is 0.045 (s.e.: 0.042). This result is coherent with recent evidence based on more granular matched employer-employee data for the manufacturing industry in Italy provided by Adamopolou et al (2021), who find a relatively larger responsiveness of wages to firm-specific labor-demand shocks in the case of workers whose wages are far from the base wage set by industry-wide collective agreements.

specification with a lagged term for the shock (in our case, real sales), instrumenting this term with a lagged analogous instrument as the one used for current real sales.

IV-FE estimates of this dynamic model are reported in Table 4. The estimated elasticities for current sales confirm all the results we obtained with our baseline model. However, the estimated elasticities for the lagged sales reveal also a slow although small responsiveness in the case of wages, which seems driven by adjustment in the base wage.

(TABLE 4 AROUND HERE)

As a further step of the analysis, we test the existence of asymmetries in the adjustment to, respectively, positive and negative shocks. In presence of downward nominal wage rigidity, it may be the case that firms cannot reduce wages as they would like when they face a negative shock, but in principle they can fully adjust in case of a positive shock. When base wages are rigid because they are set by industry-wide collective agreements, this may occur through adjustment of the wage cushion, especially of bargained performance-related pay components depending on firm's productivity or profitability. To test the presence of asymmetries in the elasticity to demand shocks, we interact our measure of sales with two dummies capturing the sign, either positive or negative, of changes in sales. Estimates, reported in Table A2 in Appendix, do not reveal large and statistically significant asymmetries in the magnitude and significance of the margins of adjustment, with the only exception of wages. The latter seem to react slightly more to changes in sales when firms have to cope with negative shocks and this asymmetric behaviour is found mainly in the wage cushion. However, the size of the asymmetry in total wages is rather small and the estimated elasticities of the wage cushion are both not statistically significant.[15]

[15] We obtain similar results (available upon request) even if we further split positive and negative shocks into mild and large shocks More specifically, we used the distribution of changes in real sales and considered as a negative large shock a negative change in sales below the 25th percentile, a negative mild shock between the 25th percentile and 0, a positive mild shock between 0 and the 75th percentile and a large positive shock above the 75th percentile.

6. The role of unions

The results shown so far provide interesting insights on how firms rely on the different margins of labour adjustment to cope with changes in sales, but they do not explicitly consider that firms' behaviour may be influenced by specific institutional constraints.

As discussed in the introductory Section, both union power and collective bargaining at the firm level are likely to play a crucial role in determining the actual menu of margins of adjustment. To preserve employment and purchasing power of the incumbent (i.e., full-time permanent) workers they represent, strong unions are more likely to support working time flexibility, also through an extensive use of short-time work, and to use their bargaining power to limit firm's ability to adjust wages.

In this Section, we investigate how the presence and bargaining power of local unions significantly affect the menu of margins of adjustment that firms can use to react to sales shocks. To minimize endogeneity issues, we define unions' power on the basis of the time-invariant average of firm-level union density. More specifically, we measure the presence of strong unions with a dummy equal to 1 for firms with union density greater than the 75th percentile of this indicator in unionized firms (i.e., 40%); similarly, we group firms with weak unions using a dummy equal to 1 when union density is lower or equal to this threshold.[16] We then interact these two dummy variables with the logarithm of real sales in our main equation (and with the instrument we used to get our baseline estimates).

The main estimated IV-FE elasticities are reported in Figure 2, which shows interesting differences between the two groups. More specifically, we find that, in firms with strong unions, the elasticity of the wage bill to demand shocks is significantly lower than in the other firms, mainly due to the lower sensitivity of the full-time permanent employment component. This does not happen at the cost of higher elasticity of either wages or working hours. Strong unions seem then to resist any form of adjustment that can affect incumbent workers (i.e. the insiders). In other words, firms with strong

[16] We experimented with other cut-offs along the union density distribution to define strong unions. While results are qualitatively the same, the estimated elasticity become larger in size and more statistically significant when we move the cut-off towards higher percentiles.

unions manage to reduce overall employment fluctuations (both positive and negative), reinforcing the effect of employment protection in the firm, in line with the empirical evidence documented at the macro level (Checchi and Lucifora, 2002; Bertola and Rogerson, 1997).

(FIGURE 2 AROUND HERE)

We then perform a similar exercise interacting sales with two dummy variables capturing, respectively, the presence and the lack of a firm-level agreement.[17] Estimates depicted in panel A of Figure 3 do not reveal significant differences in the margins of adjustment adopted by firms with a local agreement compared to non-bargaining firms, except for the lower elasticity of permanent part-time employment. As expected, the presence of a firm-level agreement increases the elasticity of the wage cushion, mainly through the adoption of bargained performance-related pay schemes, but the estimated difference between the two groups of firms is not statistically significant. However, this result is more clear-cut (and the difference between the two groups is statistically significant) when we condition on the presence of strong unions (see the graph on the wage cushion in panel B of figure 3). Notice that in most countries, including Italy, there is evidence of a non-liner relationship between the adoption of flexible pay schemes set at the firm level and workforce unionization, with a higher incidence of these wage components in firms with either a relatively low or high share of unionized workers (Bryson et al, 2013). While in the first group of firms it is likely that management unilaterally introduces or change flexible wage components paid on top of the minimum wages set by industry collective agreement, where unions are more powerful it is more realistic to assume that any substantial change in wages (or other working conditions) is bargained between the firm and local union representatives (Origo, 2009). Our estimates show that, conditional on the presence of strong

[17] More precisely, we classified as firms with a firm-level agreement those with an overall (time-invariant) mean of the dummy measuring the presence of a firm-level agreement equal to 1. This implies that the dummy is capturing firms which adopted a firm-level agreement for the entire period of observation. We obtain similar results if we set the dummy equal to one when the time invariant presence of a firm-level agreement is greater than 0.5.

unions at the firm level, local bargaining may provide firms with more degrees of freedom in terms of wage flexibility to partly adjust to demand shocks through the adoption of bargained performance-related pay.

(FIGURE 3 AROUND HERE)

Discussion

Powerful unions seem to be successful in moderating the impact of sales shocks on employment or wage changes. One explanation for the above results may be associated with an "insider effect", suggesting that strong unions reinforce the effect of institutional constraints in protecting incumbent workers (i.e. who are their members). In other words, working time flexibility through short-time work is used to protect employees with a permanent contract when demand is contracting. An additional institutional margin of adjustment may be at work in firms with a firm-level collective performance-related pay agreement, which increases wage flexibility in a context of downward (base) wage rigidity caused by large coverage of industry-wide collective bargaining.[18] Quite interestingly, we found a relatively larger flexibility of the wage cushion to changes in sales in highly unionized firms adopting a firm-level agreement, confirming that the actual menu of margins of adjustment may depend on the complex interactions between firm-level institutions and economic shocks.

Despite the larger elasticity of the wage cushion prompted by the adoption of bargained performance-related pay schemes, total wages remain substantially rigid because these wage components typically represent a negligible share of total compensation. The incidence of bargained performance-related pay in the total wage cushion is less than 10% and it is rather negligible (around 3%) in total wages.

[18] Wage rigidity caused by collective bargaining has progressively caused a declining coverage of industry-wide agreements and the diffusion of pirate agreements (Garnero, 2018; Garnero and Lucifora, 2020). However, these phenomena should be less relevant for the sample of firms used in our analysis, since they are affiliated to the main national employer association of the metal-engineering sector and hence they should comply with the industry-wide collective agreement.

Simple back-of-the-envelope calculations suggest that a higher share of the wage cushion in total wages, coupled with a larger elasticity of this wage component to real sales, are needed to deliver a sizable adjustment of wages to real sales.

To assess the range of the adjustment, we explore the potential effects of a policy mandating tax cut on the variable components of pay (i.e. performance-related-pay). Such policy is likely to increase the share of the wage cushion in total wage and its elasticity to real sales. We evaluate the effects of these changes on the overall elasticity of total wage under three main counterfactual scenarios. First, we consider an increase in the share of the wage cushion in total wage from the mean to the 75th percentile (i.e., from 21% to 28%), while keeping the elasticity of the wage cushion constant at the mean value reported in Table 2 (i.e., 0.08). Second, we introduce a higher elasticity of the wage cushion to real sales, considering the estimated coefficient on the sample of companies with a firm-level agreement (i.e., 0.15 in Figure 3), while we keep the share of the wage cushion constant at its mean value (i.e. 21%). Finally, we combine these two scenarios and simultaneously increase both the share of the wage cushion in total wage and its elasticity to real sales. In all the three scenarios, we estimate the elasticity of total wage to real sales as a weighted average of the elasticity of, respectively, the base wage and the wage cushion to real sales, using as weights the share of the two wage components in total wage. The baseline wage elasticity estimated using the mean share of the wage cushion and the elasticities of the two wage components reported in Table 2 is equal to 0.045. Under the first policy scenario –an increase in the share of the wage cushion – the baseline wage elasticity is hardly changed (i.e. it is estimated to be 0.048). Under the second policy scenario, when we simulate a larger elasticity of the wage cushion to real sales, we obtain a much larger elasticity of total wage, close to 0.059 (i.e. an increase of about 30% compared to the baseline). Finally, when we combine the two policy scenarios, as expected the total wage becomes substantially more flexible to sales shocks (i.e. the estimated elasticity is 0.067, almost 50% higher than in the baseline).

Notice also that the higher rigidity of both wages and employment in highly unionized firms is likely to shift the burden of the adjustment cost onto the employers, who may react by changing output

prices or profit margins. Since the metal-engineering industry is highly exposed to international competition, changes in output prices are less likely than changes in profit margins. While we have no direct information on firm-level prices in our data, we do exploit information drawn from firms' balance sheets to check whether firm's profitability is sensitive to changes in sales and if the estimated elasticity varies along with higher union power. To this end, we estimate our baseline specification for firms with, respectively, strong and weak unions (as in Figure 2), using different profitability indicators (ROA, ROE and ROI) as dependent variables. IV-FE estimates reported in Table 5 show that the estimated coefficient of profitability margins to sales is larger (and statistically significant) in firms with strong unions compared to firms with weak unions.

(TABLE 5 AROUND HERE)

This suggestive evidence is coherent with declining profit shares registered at the aggregate level in the last decades in the manufacturing sector where, due to the weak economic environment prevailing for most of the period since 2008, increases in labour and capital costs could not be passed onto selling prices (ECB, 2015). Furthermore, our estimates complement the firm-level qualitative evidence based of WDN data, showing that adjustment of profit margins is a relevant strategy to cope with a demand shock for a lower share of firms compared to those adjusting costs or prices (Bertola et al., 2012).[19] In this respect, our results suggest that this strategy is more likely in highly unionized firms that are characterized by a stronger protection of incumbent workers' employment and wages.

[19] At the EU level, approximately 70% of the respondents indicate that a reduction of other costs and price increases are "very relevant" or "relevant" options, while around 57% declare that a reduction in profit margins is a relevant response.

7. Conclusions

In this paper we have investigated firms' margins of adjustments to sales shocks, when both wages and employment determination are regulated.

Our results, based on firm-level panel data for the Italian metal engineering industry over 2009-2015, confirm that firms have a number of margins of adjustments to cope with demand shocks, but they are significantly influenced by the strictness of labour market institutions and firm-level union power.

More specifically, our estimates show that the total wage bill is influenced by sales shocks, but such sensitivity is mainly driven by changes in working hours and partly by changes in employment, while total wages are largely unaffected. Wage rigidity is found to depend largely on the rigidity of the base wage set in multi-annual collective agreements at the industry level. While the latter prevent from cutting base wages, firms can adjust other variable flexible wage components bargained at the firm-level and linked to firm's performance. However, such channel of adjustment is shown to be largely insufficient if it accounts for only a negligible share of total wage compensation, as it is the case in the Italian metal engineering industry, and its buffering effect on employment reduction is limited.

When we turn to employment components, we find that the elasticity to sales is larger for temporary employment compared to permanent one. However, since the first represents a small share of total employment in the metal-engineering industry, the estimated elasticity of total employment to sales is economically small and mainly driven by changes in full-time permanent employment.

Working hours and the activation of short-time work schemes remain the main adjustment mechanisms firms rely upon to cope with declining sales.

Besides labour market regulation, strong unions at the workplace represent an additional source of rigidity, reinforcing the effect of institutional constraints that protect employment of incumbent workers with a permanent contract (i.e. the "insiders" who are union members). This is reflected on firm's profitability margins which, in line with a rent-sharing behaviour, appear to respond more to sales in firms with strong unions compared with firms in which unions are weaker.

The policy implications of our results suggest the need of measures to improve firms' flexibility, particularly balancing the insurance effect of sector-level collective bargaining with the productivity-enhancing effect of variable pay set in decentralised agreements, and reducing the divide between permanent employment *vis-à-vis* part-time and temporary employment. A back-of-the envelope calculation suggests that policies targeted to increase the share of wage cushion in total wages and wage elasticity to real sales represent the ideal mix to support firm's resilience to business cycle fluctuations. Notwithstanding, also during the recent Covid crisis, the role of short-time work compensation schemes proves to be an effective adjustment margin that firms rely upon to cope with sales shocks, while most other channels are shut either by rigid regulations or by strong unions.

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Table 1 – Elasticity of the wage bill to real sales

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	wage bill		wage		employment	
	FE	IV-FE	FE	IV-FE	FE	IV-FE
log(sales)	0.137***	0.148***	0.006	0.037	0.154***	0.104**
	[0.027]	[0.052]	[0.004]	[0.026]	[0.026]	[0.047]
Observations	5691	5691	5691	5691	5691	5691
N firms	2293	2293	2293	2293	2293	2293

NOTE: all dependent variables are logarithms; models include also time fixed effects. Robust standard errors clustered at the firm level in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 2 – Elasticity of wage and employment components to real sales
IV-FE estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Wage		Employment				
			Extensive margin			Intensive margin	
	Base	Cushion	Permanent full time	Permanent part-time	Temporary	Per capita contractual hours	Short-time work (total hours)
log(sales)	0.035	0.082	0.105***	0.239**	0.218	0.023***	-3.652***
	[0.030]	[0.212]	[0.039]	[0.122]	[0.144]	[0.008]	[0.843]
Observations	5691	5691	5691	5691	5691	5691	5691
N firms	2293	2293	2293	2293	2293	2293	2293

NOTE: all dependent variables are logarithms; models include also time fixed effects. Robust standard errors clustered at the firm level in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 3 – Robustness checks
IV-FE estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Employment		Working hours		
VARIABLES	wage bill	wage	employment	Permanent	Temporary	anual per-capita hours	short-time work	N obs [N firms]
1) Time varying controls (a)	0.150**	0.035	0.114**	0.114***	0.254**	0.024***	-3.699***	5598
	[0.059]	[0.024]	[0.049]	[0.043]	[0.130]	[0.007]	[0.868]	[2261]
2) Industry-specific time FE								
2 digit	0.225***	0.069***	0.190***	0.180***	0.386**	0.020***	-3.160***	5691
	[0.043]	[0.021]	[0.038]	[0.037]	[0.178]	[0.008]	[0.874]	[2293]
3 digit	0.126**	0.084***	0.104**	0.081*	0.399**	0.023***	-2.751***	5691
	[0.054]	[0.022]	[0.044]	[0.048]	[0.166]	[0.008]	[0.733]	[2293]
3) Leave-one-out instrument	0.233**	0.072**	0.106*	0.107**	0.380	0.035***	-3.074***	5691
	[0.100]	[0.032]	[0.060]	[0.048]	[0.259]	[0.011]	[1.183]	[2293]

NOTE: all dependent variables are logarithms; models include also time fixed effects. Robust standard errors clustered at the firm level in brackets
*** p<0.01, ** p<0.05, * p<0.1
(a) Time varying controls include: %females, %blue collars, % managers, %graduates, union density, union density squared, firm-level agreement (dummy)

Table 4 – Estimated elasticities to current and lagged sales
IV-FE estimates

	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)
				Wage components		Employment		Working hours	
VARIABLES	wage bill	wage	employment	base wage	wage cushion	Permanent full-time	Temporary	anual per-capita hours	short-time work
$\log(sales)_t$	0.161*	0.003	0.092*	0.008	0.264	0.099**	0.199	0.028***	-4.275***
	[0.084]	[0.013]	[0.056]	[0.017]	[0.306]	[0.049]	[0.164]	[0.008]	[0.699]
$\log(sales)_{t-1}$	-0.022	0.052***	0.017	0.042**	-0.282	0.008	0.002	-0.009	1.092**
	[0.066]	[0.018]	[0.042]	[0.017]	[0.402]	[0.039]	[0.107]	[0.007]	[0.497]
Observations	5650	5650	5650	5650	5650	5650	5650	5650	5650
Number of firms	2282	2282	2282	2282	2282	2282	2282	2282	2282

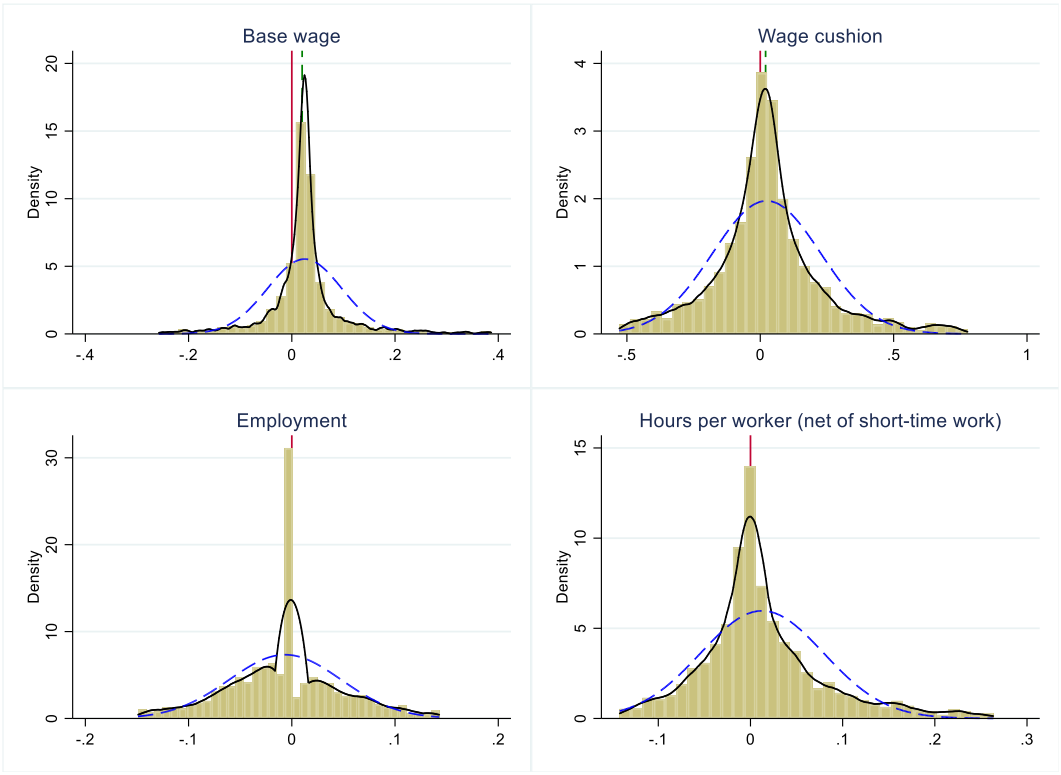
NOTE: all dependent variables are logarithms; models include also time fixed effects. Robust standard errors clustered at the firm level in brackets.
*** p<0.01, ** p<0.05, * p<0.1

Table 5 – The effect of changes in real sales on profitability by firm-level union power
IV-FE estimates

VARIABLES	(1) ROA	(2) ROE	(3) ROI
log(sales)*strong unions	4.731**	9.666*	5.872**
	[2.012]	[5.663]	[2.426]
log(sales)*weak unions	2.649	4.681	2.685
	[3.358]	[8.735]	[5.915]
Constant	-26.885	-54.986	-28.424
	[23.856]	[62.710]	[41.677]
Observations	5691	5498	4862
Number of firms	2293	2236	2044

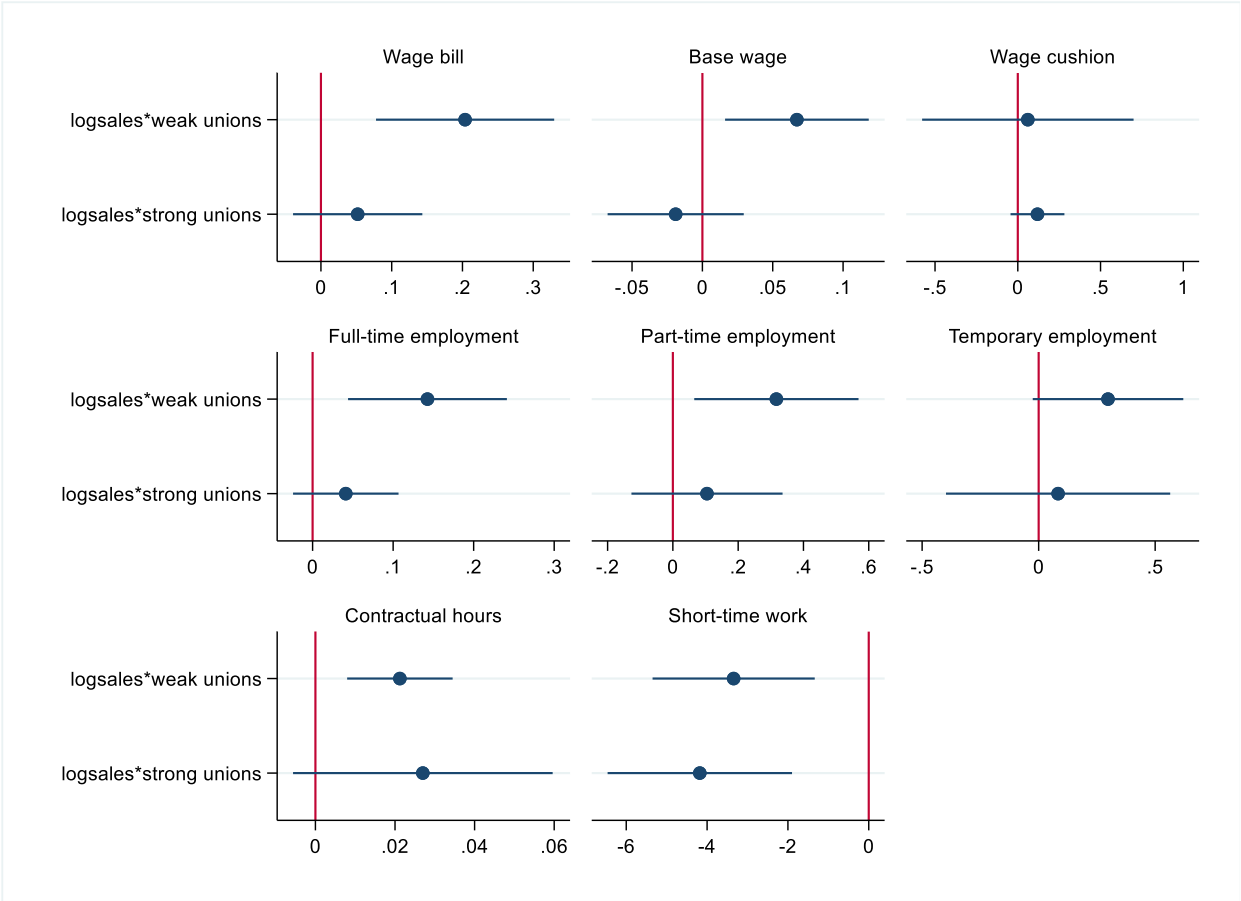
NOTE: models include also time fixed effects. Robust standard errors clustered at the firm level in brackets
*** p<0.01, ** p<0.05, * p<0.1
Strong unions are firms with time-invariant union density greater than the 75^{th} percentile; weak unions are the remaining firms

Figure 1 – Annual changes in main wage and employment components, 2009-2015



Note: the red line corresponds to zero changes, the dotted green line in the two upper panels to the target inflation rate The solid black curve is the kernel density, while the dotted blue curve the normal density function.

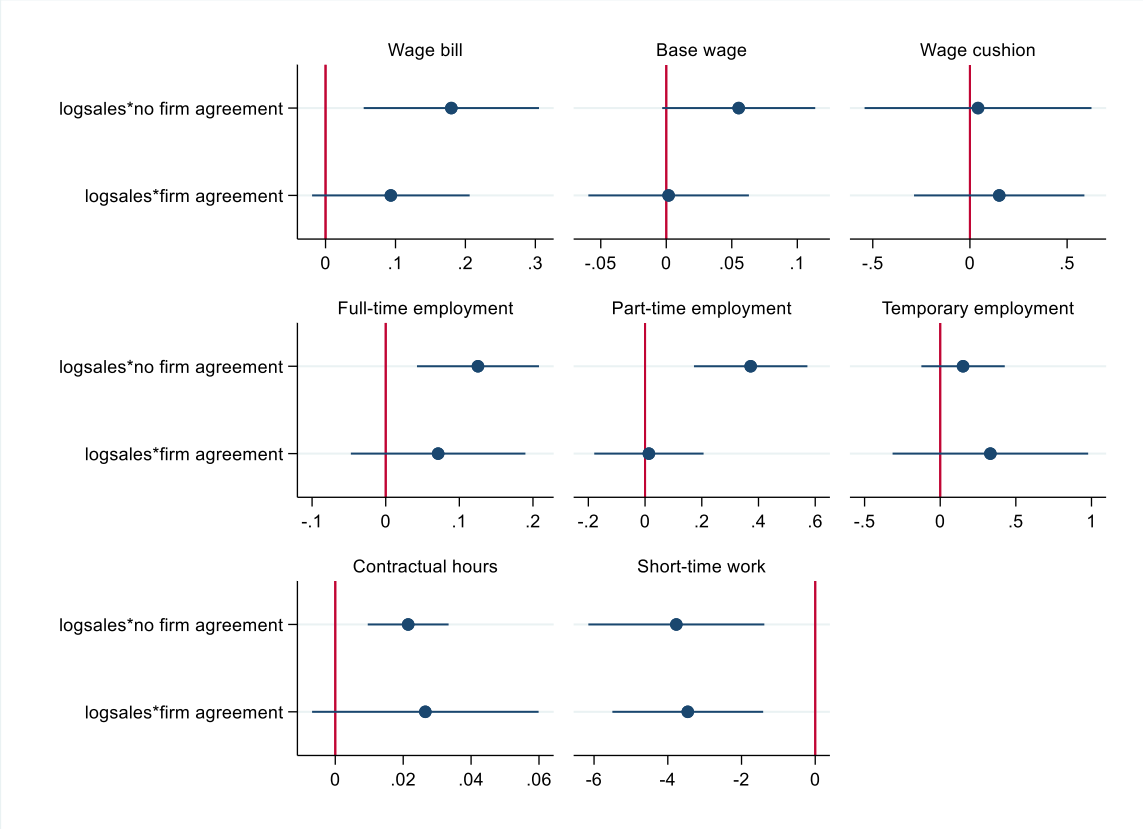
Figure 2 – Elasticity of the wage bill and its main components to real sales by union power. IV-FE estimates.



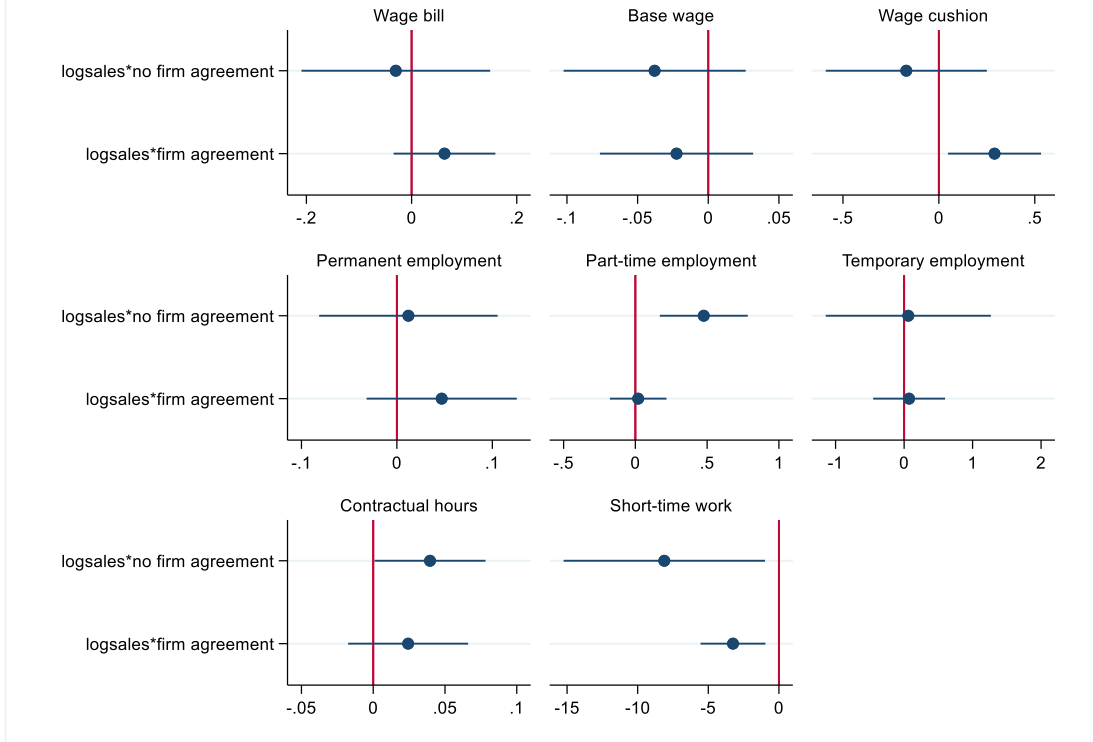
NOTE: Each graph refers to a specific dependent variable. Strong unions are firms with time-invariant union density greater than the 75th percentile; weak unions are the remaining firms.

Figure 3 – Elasticity of the wage bill and its main components to real sales by presence of firm-level collective bargaining. IV-FE estimates.

A) All firms



B) Firms with strong firm-level unions



NOTE: Each graph refers to a specific dependent variable. Strong unions are firms with time-invariant union density greater than the 75th percentile; weak unions are the remaining firms.

APPENDIX I - Estimation of annual working hours

Regarding working time, for blue and white collar full-time permanent employees, the survey provides the following information:

a. Number of days of paid holidays and other days off-work (defined in the industry collective agreement as "reduction of working time", *riduzione dell'orario di lavoro*);
b. Weekly working hours defined by the industry collective agreement;
c. Number of minutes of paid breaks per week;
d. Number of annual hours of short-time work schemes

Furthermore, for each year we reconstructed:

e. Total number of days (365 or 366)
f. Number of Saturdays and Sundays
g. Number of days of bank holidays from Monday to Friday

Using this information, by year and firm we computed annual contractual working hours as follows:

$$\text{Annual contractual working hours} = (e-f-g-a)/5*(b-c/60) \quad [a1]$$

where the first term is the number of actual working weeks in a year and the second one is the number of contractual hours per week.

We then estimated annual working hours net of short-time work schemes as follows:

$$\text{Annual working hours net of short-time work} = \text{Annual contractual working hours} - d \quad [a2]$$

APPENDIX II - TABLES

Table A1 – IV-FE: First stage estimates

VARIABLES	logsales
$shares_{2007}$*log(industry $sales_t$)	1.214***
	[0.167]
Observations	5691
Number of firms	2293
F test (Kleibergen-Paap)	53.019

NOTE: Model specification includes also time fixed effects. Robust standard errors clustered at the firm level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table A2 – The effect of asymmetric shocks

	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)
				Wage components		Employment		Working hours	
VARIABLES	wage bill	wage	employment	base wage	wage cushion	Permanent full-time	Temporary	anual per-capita hours	short-time work
log(sales)*postive shock (a)	0.154***	0.045*	0.107**	0.040	0.152	0.109***	0.199	0.022***	-3.478***
	[0.052]	[0.025]	[0.047]	[0.031]	[0.253]	[0.039]	[0.150]	[0.008]	[0.833]
log(sales)*negative shock (b)	0.156***	0.048*	0.108**	0.041	0.171	0.109***	0.194	0.022***	-3.432***
	[0.053]	[0.026]	[0.048]	[0.031]	[0.262]	[0.040]	[0.153]	[0.008]	[0.853]
F test (a=b)	0.54	6.51	0.19	1.58	2.60	0.27	0.8	1.25	1.67
p-value	0.46	0.01	0.66	0.21	0.11	0.60	0.37	0.26	0.20
Observations	5691	5691	5691	5691	5691	5691	5691	5691	5691
Number of firms	2293	2293	2293	2293	2293	2293	2293	2293	2293

NOTE: Positive shock is a dummy equal to 1 in case of an increase o no change in real sales between year t and year t-1, negative shock is a dummy equal to 1 in case of a reduction in real sales between year t and year t-1. All models include also time fixed effects. Robust standard errors clustered at the firm level in brackets. *** p<0.01, ** p<0.05, * p<0.1