ISSN 2704-7407

UNIVERSITÀ CATTOLICA DEL SACRO CUORE
Dipartimento di Economia e Finanza

Working Paper Series

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Working Paper n. 102

April 2021

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Firms' Margins of Adjustment to Wage Growth

The Case of Italian Collective Bargaining*

Francesco Devicienti† Bernardo Fanfani‡

Abstract

This paper studies firms' adjustment behavior to the growth in labor costs induced by Italian collective bargaining institutions. Our research design compares several firms' outcomes across collective agreements within the same sector and geographic location, exploiting discontinuities in contractual wages' growth as a source of variation in labor costs. Results show that on average employment, revenues, profits and investments fall, wages increase, while firms' productivity and workers' average quality do not change in response to higher labor costs. These effects are highly heterogeneous across the firms' productivity distribution. Employment, revenues, productivity, profits and investments are positively or not related to contractual wage growth among relatively more efficient firms, while they are negatively related to this shock at less productive companies. More efficient firms tend to substitute high- with low-skilled workers, which are instead more likely to be laid off by less efficient employers. These results suggest that more efficient companies adjust to the generalized growth in labor costs through cost-saving strategies and they may benefit from cleansing effects that tend to increase their product market shares.

JEL Codes: J00, J23, J24, J31, J38, J58, L13.

Keywords: Collective Bargaining; Minimum Wage; Productivity; Employment; Matched Employer-Employee Data.

*We would like to thank John Addison, Alex Bryson, Pierre Cahuc, Lorenzo Cappellari, Pietro Garibaldi, Claudio Lucifora, the Visitinps staff, members of CRILDA and LABORatorio Revelli, seminar participants at INPS, University of Torino, Workshop on Labour Market Policies and Dynamics (Collegio Carlo Alberto), EALE/SOLE/AASLE World Conference 2020 for their useful comments. Bernardo Fanfani aknowledges funding from Università Cattolica D.3.2 Strategic Project "Evidence Based Anti-Poverty Policies". The data used in this paper are property of the Italian Social Security Institute (INPS) and are accessible by researchers at the INPS premises through the VisitInps program. To access data for replication purposes researchers should contact INPS DC Research (`dcstudiericerche@inps.it`).

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1 Introduction

The problem of predicting firm's adjustment behavior to labor scarcity has been long debated in economics (see *e.g.* Acemoglu [2002]). Labor scarcity is relevant to firms since it typically takes the form of an increase in labor costs or of a reduction in the relative price of other production factors. Moreover, it is a quite recurrent phenomenon, as it can be triggered by several types of macroeconomic fluctuations, such as migration outflows, unexpected deflationary shocks, availability of cheaper investment goods, but also by institutional factors, such as a growth in labor income taxes or tighter wage regulations.

This paper studies firms' adjustment path to the growth in relative labor costs induced by an institutional mechanism, namely by changes in the level of contractual wages set within the Italian system of industrial relations. Similar wage setting mechanisms can be found in various countries and tend to be quite common in Continental Europe (see OECD [2017]). Our analysis provides evidences on the relative importance of a rich set of adjustment channels to this shock potentially available to firms, such as: productivity, revenues, profits, investments in fixed capital, employment, wages and workforce composition.

The contractual wages considered in our analysis work similarly to a minimum wage, but, rather than being regulated by the government, they are collectively bargained by trade unions and employers' associations. In many countries such negotiations are typically carried out at a quite centralized level. Italy is an illustrative case for such an institutional setup and provides a unique opportunity for studying firms' margins of adjustments to labor shocks. In 2016 the 150 largest collective contracts alone covered around 92% of all private sector workers in the country, affecting the pay levels of more than 15 millions employees. Another peculiarity of Italian contractual wages is that they are sector- and occupation-specific. Moreover, their growth tends to affect all workers covered by the contract, not only those with a pay level close to the minimum or at the bottom of the wage distribution. Indeed, these contractual wages represent both a minimum and also a fixed component of the wage for those paid above the minimum.

In our empirical analysis, we have adopted a fixed effects estimation strategy that exploits

changes in the level of contractual wages in order to analyze employers' adjustment behavior. In this model, the parameters of interest are identified by comparing firms' outcomes before and after a growth in contractual wages, conditional on a rich set of non-parametric time effects specific for each sector in each geographic location. In other words, through our estimation method we have compared firms' outcomes within the same industry and geographic location, exploiting discontinuities in labor costs across time determined by collective contracts and conditioning on time-constant heterogeneity across firms.

Our study is based on the most comprehensive panel of incorporated businesses' balance sheets available for Italy, which is provided by CERVED. We have matched this database to social security records on the population of private-sector employees provided by the Italian Social Security Institute (INPS) and to a comprehensive hand-collected dataset on contractual wages set by the majority of Italian collective bargaining agreements. The final sample of analysis comprises almost 400,000 firms per year over the period 2006-2015, virtually covering the universe of Italian incorporated businesses in the private sector.

Simple theoretical considerations provide several predictions on potential firms' adjustment channels to a growth in labor costs, among which: profits, managerial slack and workforce reductions, capital-labor substitution and output price increases. These mechanisms, and the limited available evidence on them, is recently discussed by Clemens [2021] with reference to the minimum wage literature.[1] As he points out, assessing the relative importance of each of these mechanisms and uncovering heterogeneities in adjustment behavior across firms remain empirical questions, on which this paper provides new evidences.

The main dimension that we have considered to characterize the heterogeneity in adjustment behavior across firms is productivity.[2] This is an interesting dimension for several reasons. First, the recent empirical literature has stressed that centralized wage setting may have highly heterogeneous employment and welfare effects because it induces a dis-

[1] Other studies analyzing the effects of direct and indirect labor costs on firms' performance and employment have focused on the role of union density (*e.g.* Addison and Hirsch [1989]; Barth et al. [2020]) and the tax burden (*e.g.* Cahuc et al. [2018]).

[2] In particular, we have divided the sample into time-constant value added per worker quartiles or, alternatively, in terms of total factor productivity.

alignment between productivity and wages (Boeri et al. [2020]; Manacorda and Petrongolo [2006]). While this literature has focused mostly on regional productivity differences and on geographic misallocation, by relying on firm-level productivity measures and on direct observations of contractual wage dynamics we have been able to uncover this mechanism at a more granular level using a causal identification strategy.

Second, in the more theoretical literature the role of productivity differences is often emphasized when characterizing the effects of collective bargaining. For instance, Moene and Wallerstein [1997] and Barth et al. [2014] show that centralized wage setting in the presence of heterogeneous productivity induces reallocation effects toward more efficient firms, while Haucap et al. [2001] shows that collective bargaining can protect incumbent firms from the competition of less efficient new entrants. Finally, reallocation effects of higher wage floor along the productivity distribution are emphasized also by the recent minimum wage literature, in particular Dustmann et al. [2020], who show that the German minimum wage has induced a shift of employment toward more efficient firms.

In our empirical analysis, we have first studied the effects of higher labor costs on productivity, defined both as value added per worker or as residual total factor productivity (TFP). These results point out to an overall null effect of higher wages on efficiency, irrespective of which among several measures of a firm's productivity was adopted. However, the effect of higher contractual wages on efficiency was heterogeneous along its distribution, as it was found to be strongly negative in the quartile of relatively least productive firms and slightly positive in the two highest productivity quartiles.[3]

A change in average productivity can be interpreted as driven by a change in managerial slack, by technology adoption or by better training (*e.g.* Riley and Bondibene [2017], Mayneris et al. [2018] and Coviello et al. [2020]). Reductions in quantities produced and workforce size, as well as positive selection among firms, workers and production units surviving to a labor cost shock could be other possible drivers of a growth in efficiency (*e.g.* Hibbs and Locking [2000]). Our concurrent analysis of several firms' adjustment

[3]As mentioned, these quartiles were time-constant for each firm. Moreover, we have defined them considering the collective contract-specific distribution of value added per worker. For example, a metal-manufacturing firm was included in the highest quartile of productivity if it was among the highest value-added per worker companies in the metal-manufacturing collective contract.

channels allows us to shed more light on the relevance of each of these and related mechanisms.

By analyzing the relationship between contractual wage growth and employment, we show that there were sizable negative effects of higher labor costs on firms' workforce size. On this respect, we also document that the employment effects of collective bargaining were not uniform across firms, as the highest quartile of more productive establishments did not cut employment, while the effect was more negative the lower the value-added per worker.

We have exploited the availability of information on the entire firms' workforce derived from the social security records in order to further characterize which employees were more likely to be kept by firms despite the growth in labor costs. First, we found a growth in the average level of wages within firms in response to higher contractual pay levels, which was slightly stronger among most productive firms. While a growth in average wages could be in part mechanical, as wages need to be raised whenever pay floors increase, it could also be driven by workforce selection mechanisms.

To better test for the relevance of workforce selection mechanisms, we have estimated a measure of employees' quality derived from an AKM regression model (see Abowd et al. [1999] and Card et al. [2013]), which estimates workers' fixed effects conditional on firm-specific pay policies and on other observable characteristics. AKM workers' fixed effects provide a measure of employees' quality that is, by definition, constant across time. Therefore, companies can influence the average level of workers' fixed effects only through hiring and firing channels. The results from this analysis show that higher labor costs did not induce firms to improve the quality of their workforce, as on average this was unaffected by contractual wage shocks. However, also in this case the effect was heterogeneous across the firms' productivity distribution. Indeed, the average quality of workers actually tends to decrease at more efficient companies and to increase at least efficient firms after a growth in labor costs.

When jointly considered, the results on employment and workforce quality indicate that most of the employment losses related to higher labor costs hit less productive workers at

firms that cut employment, namely the less productive ones, generating a process that increases their share of high quality employees. Instead, productive companies seem able to retain and even increase the share of relatively less-skilled workers, while keeping overall employment levels relatively stable.[4] Two mechanisms are consistent with this result. On one hand, low quality workers may be more easily available in the labor market after the labor cost shock, as they are laid off by least efficient firms. In this context, our results could be interpreted as a reallocation effect of less skilled workers toward better firms, an effect potentially consistent with evidences uncovered by Dustmann et al. [2020] in the context of the German minimum wage. On the other hand, using more extensively low quality workers may be a cost-saving strategy adopted by productive companies, which is the group of firms that does not cut production levels after a growth in labor costs.

Indeed, the effects of contractual wages on revenues help us further rationalize the findings above. Our results show that revenues were negatively affected by wage shocks on average. However, sales reduced more the lower the firm's productivity, while the effect was small and positive among the top quartile of productive firms. This result implies that the product market share of high value added firms tends to increase in size as a result of higher contractual wages. Consistently, we also document that, while higher contractual wages reduced the level of profits and of investments in physical capital on average, profits actually increased in the case of most productive establishments, while investments in physical capital were not significantly affected in this group of firms. This suggests that the increase in the market share of relatively more efficient companies could be large enough to compensate for the growth in labor costs.

Overall our analysis shows that the effects of higher labor costs on firms' behavior are quite complex and heterogeneous, depending on the relative efficiency of firms that are hit by this shock. On average, higher labor costs have a null effect on productivity and workforce quality, they reduce revenues, profits, employment and investments, while they tend to increase wages. However, the profits of firms that are more efficient slightly increase as

[4]Consistently with these results, we also find that the share of open-ended contracts increases at less productive firms, while it decreases at more productive firms. Moreover, the average age of the workforce increases at less productive firms and it decreases at more productive firms. See Daruich et al. [2020] and Acabbi and Alati [2021] for a discussion on the use of temporary contracts by Italian firms.

a result of this shock. Indeed, such firms are able to improve their efficiency, they employ more extensively less skilled workers (potentially as a cost-saving strategy), while they also avoid employment and revenues losses when the relative cost of labor grows.

These results are novel for Italy, but they are relevant also for several other countries, such as Spain and France, where similar wage setting institutions are in place (OECD [2017]). They contribute to the literature on firms' margin of adjustments in the presence of higher labor costs, which has typically focused on the analysis of minimum wage policies,[5] but on which the evidence is still not abundant. The shock to labor costs from contractual wages that we are studying is expected to be stronger than that from a standard minimum wage change, as contractual wages are typically binding across the entire pay distribution, and not just at the bottom of it. This setting offers a fertile ground to better understand the elusive impacts of the minimum wage (e.g., Manning [2021]), as well as the relevance of the various adjustment margins to large labor cost shocks. Finally, our results are relevant for the recent literature analyzing cleansing effects, reallocation and labor hoarding hypotheses in the presence of adverse shocks to the firm (see *e.g.* Foster et al. [2016], Giroud and Mueller [2017], Berton et al. [2018], Faia and Pezone [2020] and Dustmann et al. [2020]). On this respect, we show that a potential channel of heterogeneity in firms' adjustment behavior to a market-wide growth in relative input costs is given by its potentially relevant effects on product market shares, which tend to increase for firms that are more resourceful and able to cope with this shock.

2 Institutional Context

According to the Italian Constitution, each employee is entitled to a pay level that is adequate to the tasks that he/she performs. Italian courts have interpreted this provision as a disposition to apply to each worker the minimum contractual wage that is bargained by the most representative collective agreement. This representativeness criterion is established by labor courts and labor inspectors based on the characteristics of

[5]See in particular Aaronson and French [2007] and MaCurdy [2015] for a discussion of product market price effects, Draca et al. [2011] for a discussion of the effects on profits, Riley and Bondibene [2017] for a discussion of the effects on productivity and Harasztosi and Lindner [2019] for a joint analysis of several firms' adjustment margins. A detailed literature review is provided by Clemens [2021].

the employer and on the structure of collective bargaining. Thus, contractual wages set within the Italian system of industrial relations represent statutory pay floors that apply to all private-sector employees.

Italian employers' association and trade unions tend to negotiate contractual wages at a quite centralized level. There are several hundreds of collective contracts, but the 150 largest contracts cover most of private sector employees, as they are applied to more than 15 millions workers, representing more than 90% of the workforce. The 2017 classification of the National Social Security Institute included around 300 collective agreements. There are also several other contracts (typically those with an extremely small coverage and often a dubious legal basis for their applicability) that are not included in this classification, but the proportion of workers falling into this group of un-registered agreements was always below 2% during the years covered by our study.[6]

Contractual wages are considered by the Italian legislation not only as a wage floor, below which an employee in the relevant occupation and sector cannot be paid. They are indeed also a fixed component of the wage. This implies that whenever a contractual wage grows by a given amount, all pay levels in the relevant occupation must be increased by the same fixed amount, also those already above the new minimum level. There are clauses called *superminimi assorbibili* according to which employees that are paid above the minimum can agree to give up this fixed pay rise, as long as their wage remains above the relevant contractual wage. Even if there is no systematic evidence on the incidence of these clauses, they tend to be not very common. Indirect evidences on this phenomenon are provided by Adamopoulou and Villanueva [2020]. This study shows that Italian wages in the metal-manufacturing sector tend to increase across the entire within-contract earning distribution in response to the growth of negotiated pay levels, while, in recent years, the "wage cushion" (*i.e.* the difference between actual and minimum wages) has always been quite stable across time. Importantly, the same study also documents negligible levels of non-compliance to contractual wage growth.

The influence of collective bargaining on wage differentials and inequality has been stressed

[6]See Lucifora and Vigani [2020] for a discussion on these so-called "pirate" agreements.

in many studies, in particular by Belloc et al. [2018] and Boeri et al. [2020] for what concerns geographic wage dispersion, by Devicienti et al. [2008] and Faia and Pezone [2020] for what concerns wage rigidity and by Erickson and Ichino [1995], Manacorda [2004] and Devicienti et al. [2019] for what concerns wage inequality and its evolution.[7] These studies also provide detailed discussions of the institutional framework.[8] In a complementary study, Fanfani [2020] analyzes employment losses and wage effects associated to contractual wage growth. While that study focuses on aggregate employment and wage effects across demographic and industry groups, the present analysis considers instead a large set of firm-level margins of adjustment to contractual wage growth, exploiting a richer and more comprehensive balance-sheet database.

3 Data

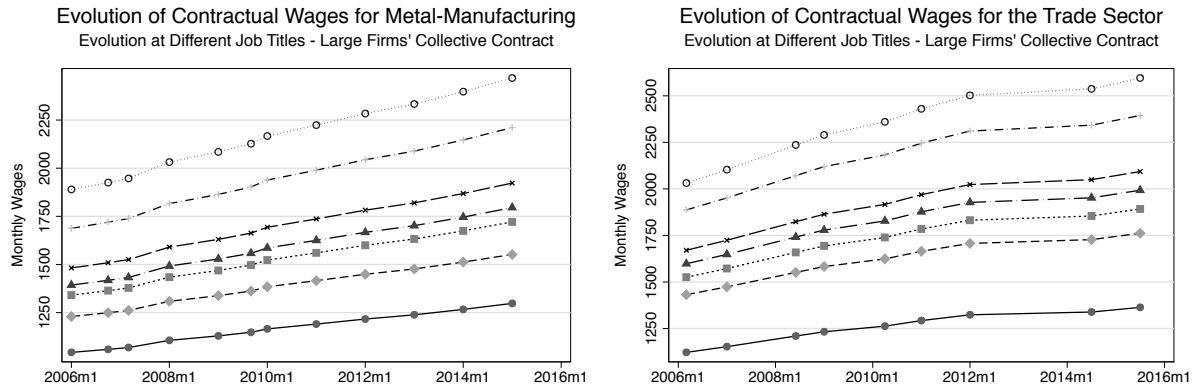
Our empirical analysis was based on three main sources of information. First, we relied on the CERVED database on Italian incorporated businesses balance sheets for the years 2006-2015. These data cover virtually all Italian incorporated companies, and we were able to match each of these firms to the population of its employees registered in the INPS social security records archives, our second source. The INPS records are based on compulsory information compiled by all employers in the private sector that hire at least one employee, thus they cover the universe of workers to which the dispositions of collective bargaining apply. Finally, our third source of information was a hand-collected database on Italian contractual wages settled in around 160 nation-wide agreements periodically renewed between 2006 and 2015. Since the INPS archives contain information on the collective agreement applied to each worker, we have been able to match almost 80% of the private-sector employees' population to a contractual wage.[9]

[7] Italian wage inequality has been recently analyzed also by Franzini and Raitano [2019] and by Hoffmann et al. [2020], while historical evidences on the effects of wage compression induced by collective bargaining have been recently re-evaluated by Leonardi et al. [2019].

[8] For a comprehensive institutional framework on Italian collective bargaining see D'amuri and Nizzi [2017].

[9] Contractual wages observable in our sample are the same available to INPS labor inspectors (applicativo "Vela") and to bookkeepers (Il Sole 24 ore archive). We have hand-collected and re-organized the data from these archives, where they are available only at the disaggregated collective contract-period of validity level. Contracts for which information on wages was unavailable tend to be the less representative ones, which often have a dubious legal validity for what concerns wage setting dispositions.

Figure 1: **Evolution of Contractual Wages in Selected Collective Agreements**

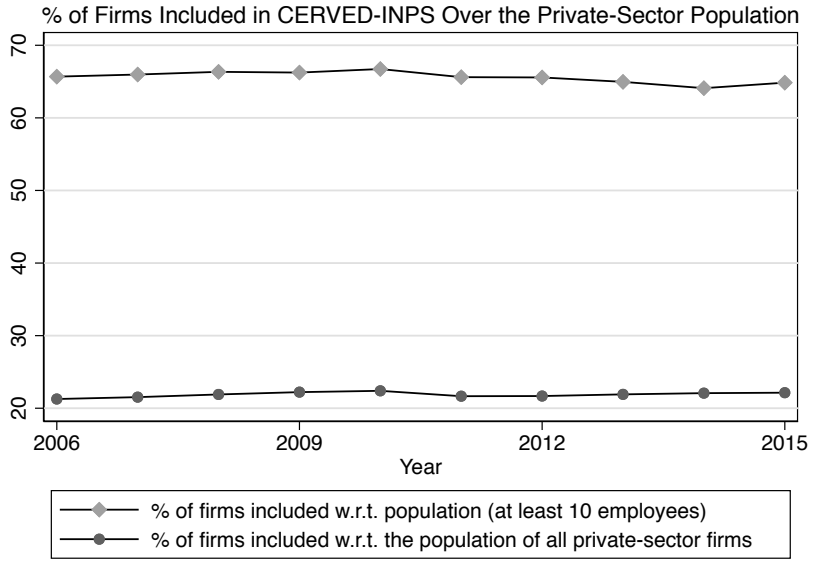


To better understand how contractual wages work in Italy, Figure 1 plots the evolution of these wage floors over the period 2006-2015 within the two largest collective agreements, the metal-manufacturing and trade sector ones. Each contract sets more than one pay floor for different job titles. Which pay level applies depends on the occupation and sometimes on the seniority levels, but the INPS data does not contain information on the specific job title of each worker within collective contracts. As can be noticed, contractual wages are renewed at different dates, with changes that appear to be more frequent in the metal-manufacturing contract. As mentioned, contractual wages represent both a wage floor and a fixed component of the pay, so that their growth typically implies that all wages in the relevant job title have to be adjusted. Our empirical analysis exploits variations in the timing and size of these shocks across collective agreements in order to identify firms' adjustment behavior.

Since our unit of analysis is the firm, we have identified for each company which was the *most expensive* collective contract, that is, which collective contract covered the largest proportion of its wage bill.[10] Using this information, we have assigned each firm to a treatment, defined as the median contractual wage of the *most expensive* agreement. This value approximates quite well the actual growth observed among all job titles within

[10]The average share of the wage bill covered by the largest contract within firms was 0.93 in our sample. While cases where a firm applies only one collective contract tend to be the vast majority (the 75th percentile of the main collective contract share is 1, while the 90th percentile is 0.94), in several instances a company may also apply different contracts to part of its employees. For example, managers' wages are sometimes negotiated in separate nation-wide collective agreements, while large firms may apply different contracts depending on the activities of its production units.

Figure 2: **Representativeness of the CERVED-INPS Matched Saple**



an agreement. The correlation coefficient of the contractual wage growth across pay levels within the same contract at renewal dates was around 0.74 during the years covered in our sample. This feature is also visible from Figure 1, where the relative distance across different pay levels is always quite stable for different job titles within the same collective contract. Thus, a growth in our treatment variable can be considered a good approximation to a shock in labor costs affecting most workers within the firm, even if the precise magnitude of this shock is potentially measured with error.

Our final sample of analysis includes only CERVED firms with at least one employee in the INPS archives, and whose most expensive collective agreement was present in our database on contractual wages. The number of firm-year observations in this sample amounted to almost 400,000. Figure 2 provides descriptive statistics on the representativeness of the CERVED-INPS-contractual wage matched sample across years, with respect to the universe of private-sector firms with at least one employee, which is observable through INPS' social security archives. The same statistic is computed also among firms with at least 10 employees.

As can be noticed from Figure 2, our sample of analysis includes slightly more that 20% of all Italian firms with at least one employee, and this coverage rate grows to around 65%

Table 1: **Summary Statistics Weighted by Firms' Size (2006-2015)**

Variables	**Mean**	**St.dev.**	**Available Observations**
Log median contractual wage	4.099	0.109	3,515,332
Log median contractual wage growth	0.024	0.014	2,650,312
Main coll. contract share in wage bill	0.928	0.138	3,515,299
Change in coll. contract	3.4%		3,382,248
Firms' closure	1.5%		3,515,332
Log full time eq. employees	4.367	2.358	3,515,332
Log firms' avg. wages	4.358	0.315	3,515,277
Firms' avg. AKM worker fixed effects	0.000	0.188	3,515,332
Log value added p.w.	3.913	0.655	3,306,862
Log TFP	4.555	0.808	3,150,643
Log revenues	9.442	2.604	3,489,167
Log profits	6.838	2.647	2,795,499
Log fixed capital	7.074	3.094	3,334,557
Total Number of Firms	603,855		
Total Number of Observations	3,515,332		

All means and standard deviations are computed weighting by the number of workers observed in the firm each year. Contractual wages refer to the nominal median pay level of the collective contract that covers the greatest proportion of the wage bill. Change in collective contract refers to the proportion of firms changing their main collective contract across years. Firms' closure is defined as a permanent exit from INPS' social security archives in the subsequent year. Balance sheet variables are derived from CERVED and are not always available for all firms in every year. AKM workers' fixed effects were computed using the Abowd et al. [1999] regression model and standardized as the difference from their mean value. TFP was derived from the Levinsohn and Petrin [2003] regression model.

when considering the population of firms with at least 10 employees.[11] The over-sampling of larger firms is due to the fact that the CERVED data include only incorporated businesses, which are mandated to maintain balance sheets and make them publicly available via the Chambers of Commerce. The CERVED data, instead, do not include unincorporated enterprises, which are typically very small family-run businesses that are not subject to the above dispositions concerning balance sheets. Importantly, Figure 2 shows that the coverage rate with respect to the underlying population was quite stable across time, which suggests that firms' selection into the sample is relatively homogeneous in all years.

[11]The proportion of workers employed by firms included in the sample over the population of private sector employees is instead close to 60% in all years.

Table 1 provides descriptive statistics for our sample of analysis computed weighting for the number of workers in each firm. Overall, we were able to analyze an unbalanced panel of more than 600,000 firms and around 3.5 million firm-year observations. The average size of firms, measured in full-time equivalent number of workers (FTE) was of around 77 employees.[12] Median daily contractual wages were on average 30% lower and three times less dispersed than firms' actual daily average wages. The yearly average contractual wage growth was 2.4%. For each firm, we have computed also the average of its workers' fixed effects derived from an AKM regression model (Abowd et al. [1999]), which we have expressed as a difference from their mean value in the sample.[13] Appendix B provides more details on the AKM estimation procedure and its results. AKM worker fixed effects are only useful to rank employees time-constant relative earning abilities, conditional on employers' and on observable time-varying characteristics. From Table 1, it can be noticed that the standard deviation of this measure of average workers' quality is of 0.188. This dispersion accounts for around 60% of the total dispersion in firms' average wages, whose standard deviation amounts to 0.315.

For each firm, we have estimated total factor productivity (TFP) using the Levinsohn and Petrin [2003] method and adopting the value added-based regression approach. This method is based on the use of lagged intermediate goods to instrument for the choice of capital and labor levels, and allows to recover a measure of a firms' efficiency conditional on the amount of production factors employed. As can be noticed, balance sheet variables are not always available due to missing variable problems arising in the CERVED database. The variable that is most affected by this problem is profits, defined as earnings before taxes, interest and depreciation.

Finally, the percentage of firms that change their main collective contract (potentially starting to use a contract not included in our contractual wage sample) is of 3.4%. Appendix C provides a regression analysis on whether a firm's selection out of collective

[12]FTE workers are obtained as the total days worked in a year at the firm divided by 312, the standard length of full-time contracts.

[13]AKM worker fixed effects represent the difference in conditional wages with respect to an arbitrary reference worker, thus expressing them as a deviation from their mean value does not represent a loss of information.

contracts is related to contractual wage growth, thereby assessing the relevance of this potentially endogenous sample selection mechanism. The percentage of firms that permanently disappear from INPS' archives in the subsequent year, typically because they run out of business or stop hiring any employee, is of only 1.5%. Appendix C also assesses to what extent such firm exits are related to the wage growth stipulated by collective bargaining.

4 Regression Approach

In order to study the effects of higher labor costs on various firms' outcomes, we have exploited statutory changes in pay levels induced by collective bargaining. Since these shocks typically imply that firms need to adjust the wage of most of their workforce, contractual wage growth can be considered as a generalized growth in the cost of labor that hit all companies applying the same collective agreement.

We denote by w^c_{jt} the median contractual wage bargained by a collective agreement c (that is, the median pay scale among the job titles defined by a given contract). As mentioned, in cases were a firm applies more than one collective agreement to its employees, we have assigned this firm to the most expensive contract, *i.e.* the one that covers the majority of its wage bill. The subscript j is a firm identifier, while t denotes the year. Whenever contractual wages were renewed in the middle of a year, w^c_{jt} was defined as the weighted average of the two (or more) pay levels applied during the year, with weights representing the number of months during which each level was in place.

The baseline specification of our regression model reads as

$$y_{jt} = \beta w^c_{jt} + \phi^c_j + \alpha_{sl} * \tau_t + e_{jt} \tag{1}$$

where ϕ^c_j is a firm by collective contract fixed effect,[14] α_{sl} is a Isic 38-sectors (s) fixed effect, specific for 107 administrative provinces (l), τ_t is a year fixed effect and e_{jt} is the residual. In the above equation, the symbol $*$ denotes an interaction operator, so that all

[14]In order to account for cases where the number of pay scales set within a collective contract had changed across time, we have also included in all specifications a collective contract by number of pay scales fixed effect. Results were qualitatively similar when excluding this further set of fixed effects.

time effects included in the model are specific for each sector in each geographic location. Notice that sector and collective contracts are not overlapping categories. Indeed, many collective agreements are often specific for given firms' characteristics within sectors, such as their size or corporate structure. Similarly, several contracts cover either heterogeneous activities that can be found in more than one industry, or very specific tasks within a single sector.[15]

The main firm-level outcomes considered in our analysis are the following

$$y_{jt} = \begin{cases} \text{log value added per worker} \\ \text{log TFP} \\ \text{log FTE number of workers} \\ \text{log average daily wages} \\ \text{average AKM worker fixed effects} \\ \text{log revenues} \\ \text{log profits} \\ \text{log physical capital} \end{cases}$$

Total factor productivity was computed using the Levinsohn and Petrin [2003] approach and adopting the value added-based regression approach. Profits were defined as earnings before interests, taxes and depreciations. In the appendixes, we present complementary evidences on further outcomes, namely: firms' closure, firms' switches in the collective contract applied to workers, the share of fixed-term employees and the average age of the workforce.

Our treatment effect of interest (β) captures the effect of contractual wage growth on the above firms' outcomes. Since equation (1) contains a firm by contract fixed effect and a year fixed effect that is interacted by 38 sectors' (using the Isic rev. 4 classification) and 107 Italian provinces' fixed effects, β is identified using only within firm-contract variations in y_{jt} across time, conditional on average variations in the outcome observed

[15]For example, professional counselors are typically hired under the trade collective agreement, but they are classified in the support service activities and not in the trade sector. Similarly, airlines' employees are covered by different agreements depending on whether a carrier is Italian or foreign.

within the same sector and geographic location. Therefore, the regression model allows to control for a rich set of unobservable factors, such as business cycle fluctuations.

In order to describe heterogeneities in the response to contractual wage shocks, in a second specification of the regression model provided in equation (1) we have also interacted w^c_{jt} with an indicator variable denoting a time-constant quartile of productivity to which firm j belongs. More specifically, these quartiles were defined using the contract- and year-specific distribution of value added per worker. For example, firms with the highest level of value added per worker, compared to the average of their collective agreement in a given year, were assigned to the fourth quartile. We constructed each quartile as always time-invariant for a given firm, by assigning each firm to its most common quartile across years. Results were qualitatively similar when using TFP (instead of value added per worker) in order to characterize the firms' efficiency distribution.

Identification Concerns and Interpretative Issues

Endogenous adjustments in contractual wages could be potentially relevant. For example, Matano et al. [2019] documented that Italian contractual wages were slightly negatively affected by sector-wide import penetration during the late 1990s and early 2000s. However, the effects of a similar shock on any of the outcomes y_{jt} that we have considered would be well accounted for by the non-parametric sector- and geographic-specific time fixed effects included in our regression model. In general, contractual wages are uniformly set at the industry nation-wide level, while the granularity of our data allows us to control for a rich set of local industy-specific shocks that would be difficult to incorporate into centralized wage negotiations. The adjusted R-squared for outcomes such as employment and revenues was above 0.97 in our main specification, which suggests that the most relevant demand and supply shocks are well accounted for.

An interpretative issue concerning several outcomes derived from balance-sheet variables involves the role of output and input prices. Firms could indeed pass-through the higher cost of labor on consumers, or they may cope with this shock by relying on cheaper in-

termediate inputs.[16] In principle, the dynamics in such prices have an influence on most balance-sheet variables, including productivity. Our regression model accounts for output and input price shocks as long as they are common for each industry in each specific province. Moreover, it also accounts for differences in prices across firms, as long as such differences remain stable across time among companies belonging to the same industry and province. Any residual variation in prices is nevertheless going to affect our results, even if quantifying the relative importance of such price dynamics in driving our result is difficult, given the unavailability of firm-level price data.

On this respect, the joint availability of information on the entire workforce for all firms often allows to provide a more solid interpretative framework to characterize which mechanisms may be driving the treatment effects observed for balance sheet outcomes. For example, a reduction in revenues that coincides with a reduction in physical employment can be more easily interpreted as an effect driven by a reduction in production levels, even if residual output price dynamics may in principle mitigate or strengthen the size of the treatment effect on revenues.

Another identification concern is related to the potential strategic behavior of firms, which may decide to apply different collective agreements whenever a given contractual wage is raised. However, this possibility is typically limited by the law, according to which firms must apply the most representative collective contract given their activity. Moreover, the inclusion of firm by contract fixed effects in the regression model ensures that the parameter of interest is identified only by variations in the outcome of interest within firms whose most expensive contractual wage did not change across time.

In Appendix C we explicitly account for the potential role of firms' self selection across collective contracts. In particular, we have estimated a model were the outcome of interest is an indicator for firms that change the main collective contract applied to their workforce in the subsequent year.[17] Results from this test show that firms' propensity to switch collective contract is not influenced by contractual wage growth.

[16] See MaCurdy [2015] for a discussion on output price adjustments in the context of minimum wage hikes and on their welfare effects.

[17] As can be noticed from Table 1, around 3.4% of the firms switch collective contract in the subsequent year when considering our sample of analysis.

A related issue concerns the possibility that firms may decide to apply more extensively a less expensive collective contract to part of their workforce, even if without changing the main one. On this respect, notice that all our outcomes of interest (including also employment) are measured at the firm level and not at the contract-firm level. For example, if a decrease in employment in the main collective contract is compensated by a corresponding growth of workers hired under a secondary collective contract applied within the firm, this change in workforce composition would have no influence on our firm-level employment measure. This consideration also suggests that, in the presence of similar endogenous reshuffling of workers across collective contracts, our results can be interpreted as a lower bound of the policy effects that would be observed if non-compliance opportunities were completely absent.

Finally, the model of equation (1) includes only a contemporaneous contractual wage term w^c_{jt}, even if adjustments to the wage shock may take time to materialize (see *e.g.* Baker et al. [1999] and Sorkin [2015]). Since our treatment variable is continuous and relatively persistent across time, the treatment effect estimated in this static specification is going to pick up also longer run adjustments to the contractual wage growth, as the omitted relevant lagged values of w^c_{jt} tend to be highly correlated with the included contemporaneous term. This bias toward the cumulative effect of the policy is going to be stronger, the stronger the serial correlation among lags and leads of the treatment variable.[18] Appendix D discusses the results obtained using a dynamic specification of equation (1), where also leads and lags of w^c_{jt} are included.

5 Results

Baseline Regression Results

Table 2 provides the results obtained from the regression model of equation (1), which estimates the effect of the growth in contractual wages on several firms' outcomes. As mentioned, all regressions include year fixed effects interacted by 38 industry - 107 provinces

[18] As discussed in Fanfani [2020], the bias toward the cumulative effect of the policy in a static fixed effect specification with continuous treatment can be conceptualized as an omitted variable bias problem.

Table 2: **Effect of Contractual Wages on Firm's Outcomes - Baseline Regression Results**

	Dependent variable: log median contractual wage				
Outcomes	**Coeff.**	**St.err.**	**Adj.R^2**	**RMSE**	**Obs.**
Log value added p.w.	−0.052	0.128	0.726	0.337	3,053M.
Log TFP	−0.163	0.101	0.829	0.331	2,911M.
Log full time eq. employees	−0.785**	0.255	0.977	0.356	3,257M.
Log firms' avg. wages	0.262**	0.043	0.909	0.094	3,257M.
Firms' avg. AKM worker f.e.	0.025	0.014	0.948	0.043	3,186M.
Log revenues	−0.900**	0.171	0.975	0.409	3,232M.
Log profits	−1.033**	0.361	0.935	0.672	2,542M.
Log fixed capital	−1.020*	0.453	0.966	0.571	3,092M.

*Significance levels: ** 1%; * 5%*

Results obtained by estimating the regression model of equation (1) *on several firms' outcomes. All regressions are weighted by the number of workers in the firm. Standard errors are clustered at the firm level. The number of observations in each model is computed excluding singleton groups, i.e. units that are perfectly identified by the fixed effects included in the regression. AKM workers' fixed effects were computed using the Abowd et al. [1999] regression model. TFP was derived from the Levinsohn and Petrin [2003] regression model.*

fixed effects. Standard errors were always clustered at the firm level and regressions were weighted by the number of workers in the firm.

As can be noticed, the baseline regression results show that on average the effect of higher contractual wages on value added per worker was not significant. A similar result was found also when using a different definition of productivity as dependent variable, namely TFP, which better accounts for heterogeneity in fixed costs across firms and for endogenous adjustments in the quantity of labor employed.[19] Overall, our results suggest that higher labor costs do not trigger a generalised improvement in efficiency, a result that is consistent with previous findings in the context of the minimum wage by Draca et al. [2011], but which differs from other evidences on UK (Riley and Bondibene [2017]) and China (Mayneris et al. [2018]).

In principle, higher wage levels could potentially affect productivity through several channels. On one hand, there could be a reduction in managerial slack, which could be used

[19] As mentioned, TFP was computed using the value-added based Levinsohn and Petrin [2003] approach.

to align workers' marginal product to the new pay levels, or an improvement in workers' effort (*e.g.* Coviello et al. [2020]). On the other hand, there could be indirect effects on productivity triggered by firms' reliance on other adjustment margins, such as selective changes in the employment composition (*e.g* Horton [2017] and Clemens et al. [2021]), size reductions, output price increases, or higher investments in capital. Thus, it is interesting to investigate on which other adjustment margins firms relied when facing higher labor costs.

The third row of Table 2 shows that the average effects of higher labor costs on firms' employment were negative and sizable. Indeed, a one percent growth in contractual wages is associated to reductions in employment by almost 0.8 percent. The fourth row shows that the elasticity of firms' average wages to the growth in contractual wages is positive and significant, but also smaller in magnitude to the respective employment elasticity, which suggest that employment losses related to higher labor costs can be more than proportional than the wage gains.

Notice however that a growth in a firms' average wages cannot be ascribed only to a mechanical effect of the policy under study, determined by the fact that higher wage floors must translate into higher pay levels. On this respect, the wage elasticity to contractual wage growth is indeed well below one. Several mechanisms are at work behind this result. First, actual wages have to be adjusted by a fixed amount to the bargained minimum. That is, for workers that are paid exactly the minimum level of their job title, the wage change induced by collective agreements should be exactly proportional to the change in their contractual pay level. Instead, employees that are paid above the minimum are generally entitled to a pay rise that is only equal to (therefore less than proportional than) the contractual wage change. Second, our treatment variable is an approximation to the relevant contractual wage, as it is defined as the median of the pay levels that are set within a collective agreement. Thus, even if the growth among these pay levels within contracts is highly correlated, some measurement error may attenuate the estimated wage elasticity toward zero. Similarly, since some firms do not apply the same collective contract to their entire workforce, while average firms' wages are computed considering all

workers within each company, this form of partial compliance with the policy further biases the coefficient toward zero. Finally, and perhaps more importantly, changes in actual pay levels across time can also be influenced by a different selection of workers after the policy change. Indeed, firms may start to rely more on high-quality employees, or, on the contrary, they may keep only relatively less costly workers.

In order to shed more light on the adjustment channel of employee selection, we have estimated a measure of workers' quality based on the AKM regression model. This technique, which is presented in Appendix B, allows to recover an estimate of worker fixed effects that is conditional on observable characteristics and on firm-specific pay policies. Thus, these fixed effects can be interpreted as a measure of employees time-constant earning abilities. Since they are, by definition, constant across time, a firm can change the average level of its employees fixed effects only through selective hiring and firing.

The fifth row of Table 2 shows that the average quality of the workforce (defined using AKM workers' fixed effects) was actually unaffected by higher labor costs. However, the next section further characterizes and discusses this result, by showing that the treatment effect was instead highly heterogeneous and different from zero across the distribution of firms' productivity, suggesting that companies relied on selective employment adjustments, but using differentiated strategies depending on their efficiency levels.

The sixth row of Table 2 shows that firms' revenues were negatively affected by the growth in contractual wages. This result shows that the employment losses previously discussed translated also into lower sales. As discussed above, revenues are made up of two components, output prices and quantities. In our context, the presence of negative revenues effects seems likely to be driven mostly by quantity reductions, as the regression model controls for sector-wide price shocks at a quite granular level through sector- and geographic-specific time fixed effects, as well as for time-constant firms' heterogeneity in market power. Moreover, the reductions in physical employment that we have documented appear to be consistent with a drop in physical production levels. On this respect, the presence of potential pass-through mechanisms of higher wage floors to consumers via increases in product market prices would actually characterise the elasticity of revenues to

contractual wages as a downward biased measure of the true effect on output quantities. Finally, the last two rows of Table 2 show that profits and investments in physical capital reduced in response to the growth in the cost of labor. The magnitude of both effects seems quite large. The evidence on profits reductions is consistent with the findings of Draca et al. [2011] and Harasztosi and Lindner [2019] in the context of minimum wage hikes. Instead, the negative effects on investments suggests that there were limited possibilities for firms to adopt more capital-intensive (and potentially more productive) production processes (see *e.g* Acemoglu [2003] for a theoretical discussion of this point). Instead, in the presence of wage shocks exogenous to the firm, as contractual wages are set through a rather centralized negotiation processes, scale effects seem to prevail, so that on average investments are reduced together with employment and production levels.

Overall, results from our baseline regression model show that on average firms responded to higher contractual wages by decreasing production levels, employment, profits and investments. Average firms' wages were instead increased by this shock. Moreover, there were no effects on firms' productivity and on employees' quality. From an aggregate perspective, these results suggest that growing contractual wages contribute to higher unit labor costs (given the positive effect on wages and the null effect on productivity), reducing total output and, more generally, the international competitiveness of Italian companies (see Dustmann et al. [2014]). On the other hand, the same results are also indicative of a modest growth in the labor share as a result of this type of shock. The next section further characterize these results, by uncovering the heterogeneity in adjustment behavior along the distribution of firms' productivity.

Effects of Contractual Wages Across the Firms' Productivity Distribution

We now discuss the result obtained by studying the heterogeneity in the effects of contractual wages across the distribution of firms' productivity, which we define as value added per worker. Results were qualitatively very similar when using instead TFP to rank firms. As mentioned, we have constructed a time-invariant ranking of firms according to their relative position in the year- and collective-contract specific distribution of

value added per worker. In this way, we have divided all firms belonging to a given collective agreement into four time-constant groups, which we call *quartiles* of the (year-contract-specific) productivity distribution for brevity.

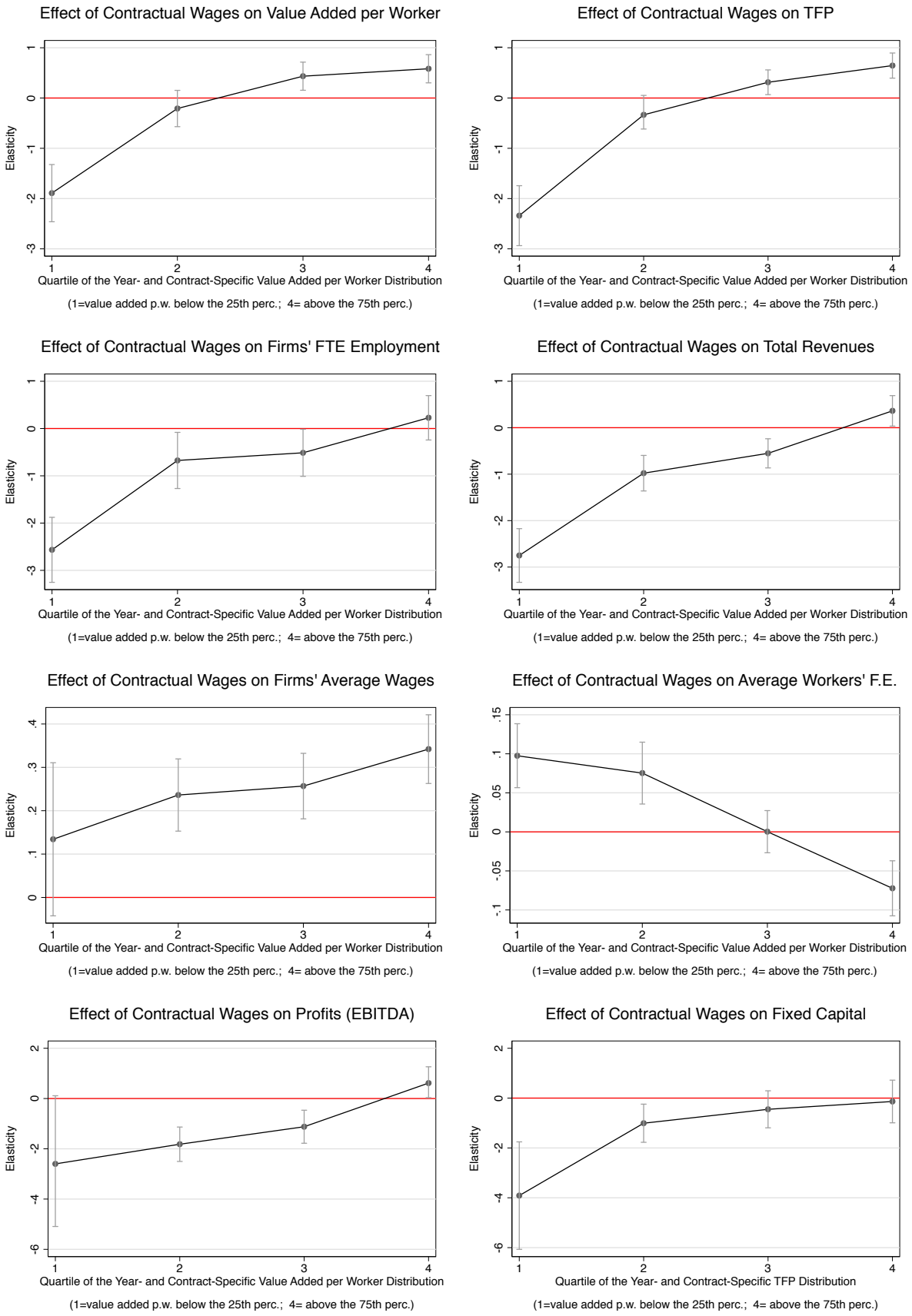
Figure 3 presents the results obtained by interacting the policy variable in equation (1) (contractual wages) to an indicator variable for each quartile of the productivity distribution. In each panel, the first quartile refers to the lowest productivity group of firms, while the fourth refers to the most efficient one. Each panel in the figure shows the marginal effect of higher contractual wages for each quartile, together with the 95% confidence interval.

It can be noticed from the top panels in Figure 3 that the overall null effect of higher labor costs on productivity is actually heterogeneous along its distribution, as it is strongly negative for less efficient firms and small and positive for the two highest quartiles of the productivity distribution. Our joint analysis on several outcomes allows us to uncover more precisely how most efficient firms' adjustment margins differed from low productive ones.

As can be noticed, the negative employment effects of higher labor costs were mostly beard by low-productivity firms, while they were not significantly different from zero in the highest quartile. These results suggest that firms that were more efficient were also more resourceful or paying wages below a competitive level, as they were able to absorb the cost shock without incurring in employment losses. Vintage models of firms' survival in the context of centralized wage setting, as developed by Moene and Wallerstein [1997] and Barth et al. [2014], actually suggest that a similar employment reallocation toward more productive firms could emerge in a context where wage moderation imposes similar pay levels to an heterogeneously efficient population of firms. Also according to the recent literature on regional misallocation, wage compression tends to produce perverse welfare effects and excess rents among employers in the most productive regions (see in particular Boeri et al. [2020]).

Figure 3 also shows that while revenues reduced as a consequence of contractual wage growth for less efficient firms, they actually slightly increased in the highest quartile of

Figure 3: **Heterogeneity of Wage Growth Effects Across the Contract-Specific Distribution of Value Added per Worker**



most efficient companies. As mentioned, revenues are made up of prices and quantities. On one hand, it is reasonable to assume that heterogeneities in the marginal effect of contractual wages on firms' earnings across the contract-specific productivity distribution were mostly driven by relative differences in quantities produced. If this was the case, our evidence would be consistent with an increase in the product market shares of more productive companies, as long as firms belonging to the same collective agreement were likely to share the same product market. On the other hand, the hypothesis that efficient companies systematically select into segmented product markets characterized by a rigid demand or by monopolistic power, where price or markups adjustments are possible, can not be completed ruled out.

On this last respect, it should be noticed that the drop in revenues and employment are very similar in shape and relative magnitude across the productivity distribution. This suggests that employment changes largely map into output quantity changes, rather than in changes in output prices. The similarity in the pattern found for these two outcomes among both more and less efficient firms provides us with some indirect evidence that differential cost-price pass-through across firms is not the major mechanism driving our results. Unfortunately, lacking firm-level data on output prices, we are unable to provide a more direct test for this hypothesis.

Notice that also when considering profits, the effect of higher labor costs appears to be negative only for relatively less productive firms, while the effect is instead slightly positive among the most efficient ones. This further indicates that companies that are better equipped for dealing with higher labor costs may actually increase their profits due to a cleansing effect on less productive competitors. The recent literature on cleansing effects during recessions (see in particular Foster et al. [2016] and Osotimehin and Pappadà [2016]) has shown that this positive selection of firms can be limited during severe downturns, due to potential distortions in the credit market. On this respect, our evidence suggests that input cost shocks, as opposed to negative movements in the product market demand, tend to be more cleansing as they provide a competitive advantage to more productive firms.

Appendix C provides an analysis of the impact of contractual wage growth on firms' exit rates. Overall, we did not find significant changes in firms' closure rates in response to higher labor costs in our sample of analysis. This evidence suggests that companies reduced output levels on the intensive margin, but the cost shock was not strong enough to drive employers out of the market. However, when extending this analysis on the entire INPS archives covering the private sector, we found significant increases in firms' exit rates among very small companies, *i.e.* those with less than five employees. These firms were less likely to be included in our main sample of analysis, given that they tend to be unincorporated, while on the other hand they represent the group for which the wage bill tends to be more relevant in proportion to total costs. Thus, even if the more extreme event of a firms' closure was not affected by contractual wages in our sample, this mechanism appears to be relevant when focusing on a sub-group of firms that are more intensively hit by the labor cost shock. In turn, this channel could further contribute to the determination of cleansing effects.

Figure 3 also shows that investments in physical capital were negatively affected by wage growth among less productive firms, but they were not affected by wage growth among most efficient companies.[20] Also this evidence suggests that capital allocation tends to improve, as it becomes more concentrated toward most efficient companies as a consequence of the wage shock. However, this process goes along with an overall reduction in the stock of capital within the collective contract that is affected by the pay rise. Therefore, whether reallocation mechanisms induced by contractual wages may have overall positive effect on the economy seems rather dubious, considering that productivity gains to contractual wage growth appear to be very moderate and concentrated only among most productive firms. On this respect, from an aggregate perspective capital misallocation tends to be particularly relevant in the Italian case (*e.g.* Cardullo et al. [2015] and Calligaris et al. [2018]), which further suggests that the role of centralized wage setting on this outcome may not be particularly positive.

[20]This evidence is not consistent with theories emphasizing the role of productivity-enhancing investments in capital as a mechanism to adjust to higher labor costs (see *e.g.* Acemoglu [2003]). However, potential qualitative changes in investment decisions consistent with this hypothesis can not be ruled out.

The left panel in the third row of Figure 3 shows that higher contractual wages had a positive effect on average pay levels for all types of firms. However, this marginal effect was imprecisely estimated among least productive firms. On the right panel, the evidence on employee quality, measured through AKM workers' fixed effects, provides an interesting pattern. While workforce quality tends to increase among least efficient companies, which also reduce employment, the quality of workers actually drops among most productive firms. Further evidences on this pattern are provided in Appendix A, where we consider as outcomes of interest the average age of employees and the proportion of fixed-term employees.[21] Figure A1 shows that, consistently with the pattern emerging from the analysis of AKM workers' fixed effects, average workers' age drops at more productive firms and it increases at less productive ones, while the share of fixed-term workers increases at efficient firms, while it decreases elsewhere.

The patterns of workforce selection described above are consistent with several mechanisms. First, low-productivity firms may concentrate their production in more profitable market segments, so that most of the employment losses observed at these companies hit lower-quality and marginal workers. Evidences on similar mechanisms are provided in the context of the minimum wage by Horton [2017] and Clemens et al. [2021]. On the other hand, productive firms hit by the wage shock do not cut overall employment, so that their more intensive reliance on low-quality workers could be a cost-saving strategy. Indeed, the reduction in the average age of the workforce among efficient companies seems consistent with a "young-in old-out" strategy, where typically more expensive older workers with open-ended contracts are pushed to retire, while firms start relying more on cheaper young and fixed-term workers.[22] Finally, when considering general equilibrium effects,

[21] Table A1 shows that on average there was a significant growth in the average age of the workers and a negative, but statistically not significant effect on the share of fixed-term contracts in response to higher contractual wages. Notice that a growth in the average share of fixed-term contracts does not necessarily imply a growth in fixed-term employment, as this depends also on whether fixed-term intensive firms adjust their employment differently from other companies. On this respect, in a complementary analysis of the employment effects of collective bargaining, Fanfani [2020] shows that employment losses associated with this policy are stronger among young- and fixed-term workers.

[22] The relationship between employment selection and institutional mechanisms has been often emphasized in the Italian context with reference to tax credits and firing costs (*e.g.* Ardito et al. [2019]) or pension rules (*e.g.* Bianchi et al. [2021]). Evidences on the influence of collective bargaining are much less abundant (see Fanfani [2020]).

it is also possible that productive companies are able to absorb part of the job losses observed at their less efficient competitors. In this context, as low quality workers may be more easily available in the labor market, reallocation mechanisms (emphasized also in the context of minimum wage policies by Dustmann et al. [2020]) could be a relevant channel through which less productive employees sort toward more productive firms.

6 Conclusions

We have studied the effects of higher contractual wages set by Italian collective bargaining on firms' behavior. This type of shock tends to affect most workers within the firm, increasing labor costs. On average, the growth in contractual wages induced firms to cut employment, revenues, investments in physical capital and it reduced their profits. Instead, companies' average wages increased, while workers' quality and productivity were not affected by this policy.

When looking at the heterogeneity in adjustment behavior across the productivity distribution, higher labor costs induced a small growth in efficiency for more productive firms and a strong decline for least efficient ones. We have shown that this heterogeneity in efficiency effects may be driven by cleansing mechanisms that increase the product market share of relatively more productive firms. Consistently with this hypothesis, we have found that relatively more efficient companies within a collective agreement increase their revenues, they do not cut employment and investments and they slightly increase their profits in response to higher contractual wages. We did not find differences in exit rates among incorporated companies after a growth in labor costs, but we have found evidences of higher firms' closures when extending the sample of analysis to the entire private sector and focusing on very small firms with less than five employees.

Our results have more general implications, as they show that increases in relative labor costs can have nuanced effects on the economy, decreasing production levels, investments in physical capital and employment on average, but providing most productive establishments with a competitive advantage and with potentially larger profits due to greater product market shares. Cleansing mechanisms have been discussed with reference to

other kinds of firm-level shocks. They have been linked to the presence of credit market imperfections, which tend to hit firms relying more on external finance (see *e.g.* Pagano and Pica [2012] and Giroud and Mueller [2017]) and which induce companies to increase workers' quality (*e.g.* Berton et al. [2018]). Instead, cleansing mechanisms have been found to be potentially weaker in the context of strong negative demand shocks (*e.g.* Foster et al. [2016] and Osotimehin and Pappadà [2016]). On this respect, the statutory increases in wage levels considered in our analysis seem to generate a more pronounced positive selection in the underlying composition of firms.

Our results are consistent with hypotheses linking average productivity to wage setting structures, such as that developed by Acemoglu [2003] to explain cross-country heterogeneities in inequality and productivity, or the vintage approach theories that explain differential survival rates of firms across the efficiency distribution in the context of collective bargaining (see in particular Moene and Wallerstein [1997] and Barth et al. [2014]). However, our results show that productivity gains related to higher wage floors are not significant on average. Moreover, reallocation effects toward more productive firms are accompanied by overall reductions in employment levels. Less skilled workers tend to suffer most of the employment losses at less efficient companies, but, consistently with workers' reallocation evidences documented by Dustmann et al. [2020] in the context of the German minimum wage, we also find that their employment share at most efficient firms increases.

These evidences contribute to the literature on the Southern European productivity puzzle (see Calligaris et al. [2018] and Schivardi and Schmitz [2020]), as they show that labor market institutions have a relevant effect on the allocation of resources and market shares, which could potentially influence also management practices. Moreover, our results further support the conclusions of studies on the relationship between centralized wage setting and regional misallocation (see in particular Manacorda and Petrongolo [2006] and Boeri et al. [2020]), as we have shown the relevance of several mechanisms emphasized by this literature using granular data and a causal research design. Finally, by documenting the presence of rather sizable adjustments while analyzing wage shocks

that were more extensive than those typically arising in the context of minimum wage hikes, where instead pay rises tend to affect only the bottom of the income distribution, we have provided novel evidences that could help rationalizing the elusive effects of the minimum wage discussed by Manning [2021].

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Appendix

A Other Figures and Tables

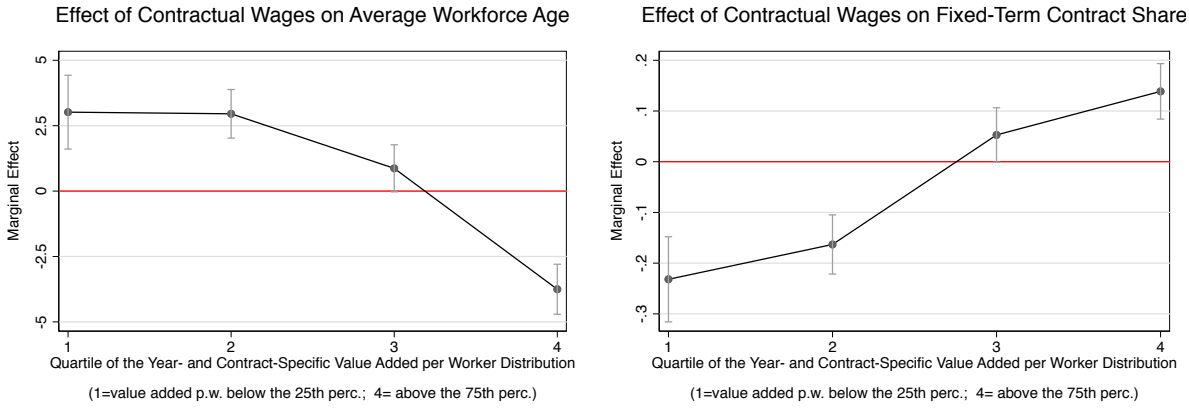
Table A1: **Effect of Contractual Wages on Average Workforce Age and Fixed-Term Share**

	Dependent variable: log median contractual wage				
Outcomes	**Coeff.**	**St.err.**	**Adj.R^2**	**RMSE**	**Obs.**
Workers' avg. age	0.827*	0.370	0.916	1.473	3,257M.
Fixed-term share	−0.030	0.023	0.830	0.107	3,257M.

*Significance levels: ** 1%; * 5%*

Results obtained by estimating the regression model of equation (1) *on several firms' outcomes. All regressions are weighted by the number of workers in the firm. Standard errors are clustered at the firm level. The number of observations in each model is computed excluding singleton groups, i.e. units that are perfectly identified by the fixed effects included in the regression. The specification of the regression model is provided in equation* (1).

Figure A1: **Heterogeneity of Wage Growth Effects Across the Contract-Specific Distribution of Value Added per Worker - Workforce Age and Fixed-Term Contract Share**



B AKM Regression Results

In order to build a time-constant measure of workers' quality, we have estimated an AKM regression model of the form

$$w_{ijt} = x_{ijt}\gamma + \eta_i + \psi_{j=\iota(i,t)} + \epsilon_{ijt}$$

on two panels created using the universe of social security records (including both men and women). The two datasets cover the years 2006-2010 and 2011-2015 respectively. The set of controls in x_{ijt} consisted of: three occupation dummies; a cubic polynomial in age interacted by sex and occupation; a part-time dummy interacted by sex; a fixed-term contract dummy; year fixed effects. Table B1 summarizes the AKM wage variance decomposition computed in the two panels, considering both, the full sample and the matched CERVED sample of incorporated businesses.

Notice that the AKM variance decomposition results provided by Table B1 look well identified. All covariances are positive and indicate that better paid workers are positively sorted in better paying firms, while more endowed workers in terms of observables also tend to have higher workers' fixed effects, as one would expect. The relative contributions of firm fixed effects and of worker fixed effects to the total wage variance are always in a reasonable range, which is consistent with previous results on Italy (see *e.g.* Devicienti et al. [2019]). Notice also that the wage variance and its components are very stable across time, despite of the economic recession. In this regression model, workers' fixed effects η_i measure an employee's earning ability controlling for non-random selection of workers across firms and on time-varying characteristics. Thus, it can be considered a time-constant, comprehensive measure of workers' quality. In order to include the average level of workers' fixed effects as an outcome of our main regression model in equation 1, we have first normalized these parameters across the 2006-2010 and 2011-2015 panels. In particular, we have defined $\bar{\eta}_i$ as the difference from the panel-specific mean of η_i and considered for each worker the average of these normalized fixed effects $\bar{\eta}_i$ over the period

Table B1: **AKM Decomposition of the Wage Variance**

	$\text{Var}(\phi_j)$	$\text{Var}(\eta_i)$	$\text{Var}(x_{ijt}\beta)$	$\text{Var}(\epsilon_{ijt})$	$2\text{C}(\phi_j, \eta_i)$	$2\text{C}(\phi_j, x_{ijt}\beta)$	$2\text{C}(\eta_i, x_{ijt}\beta)$	$\mathbf{Var(w_{ijt})}$
ALL SAMPLE								
2006-2010	0.041	0.101	0.007	0.017	0.006	0.002	0.011	**0.186**
% of Total	*22.2*	*54.6*	*3.8*	*9.2*	*3.2*	*1.1*	*5.9*	***100***
2011-2015	0.048	0.104	0.007	0.016	0.001	0.002	0.008	**0.187**
% of Total	*25.8*	*55.9*	*3.8*	*8.6*	*0.5*	*1.1*	*4.3*	***100***
INPS - CERVED SAMPLE								
2006-2010	0.027	0.097	0.007	0.017	0.009	0.001	0.011	**0.169**
% of Total	*16*	*57.4*	*4.1*	*10.1*	*5.3*	*0.5*	*6.5*	***100***
2011-2015	0.030	0.100	0.007	0.016	0.004	0.001	0.007	**0.165**
% of Total	*18.2*	*60.6*	*4.2*	*9.7*	*2.4*	*0.6*	*4.2*	***100***

Percentage changes for a given quantity z from z_{t-1} to z_t are computed as $100(z_t - z_{t-1})/z_r$, where $z_r = (|z_t| + |z_{t-1}|)/2$

2006-2015, in order to make them time constant throughout these years.[23]

[23]See Card et al. [2016] for a discussion on normalization issues concerning firm and worker fixed effects in the context of AKM regression models.

C An Analysis on Firms' Exit and Contract Switching Behavior

In this section, we analyze two outcomes that could be potentially relevant in the context of contractual wage growth. First, we consider firms' exit from the labor market, defined as a permanent loss of all employees registered in the INPS archives. Second, we consider firms' change in the main collective contract applied to the workforce. Both outcomes allow us to quantify the importance of alternative adjustment mechanisms available to firms. On one hand, firms could shut down production completely, outsource production or rely on the black market when facing higher labor costs and, as a consequence, they could disappear from the archives covering formal employment relationships.[24] On the other hand, they could decide to not comply to contractual wage standards, by self-selecting into less expensive collective agreements after a growth in labor costs.

For what concern firms' closure, the outcome variable was defined as equal to one if a firm had zero employees registered in the INPS archives during the following three consecutive years. Contract switching was defined as an indicator variable for firms whose main collective contract applied to its workforce was different during the following year (including also changes to collective contracts whose contractual wage was unavailable in our hand-collected database on minimum wages).

We have adopted a different specification of equation (1) when studying these two outcomes, omitting firm fixed effects and replacing them with two-digit sector fixed effects. Indeed, only exiting or contract-switching companies would otherwise contribute to the identification of the parameter of interest if we were exploiting only within-firm variation in the outcomes. The regression model that we have adopted included also a cubic polynomial in firms' age in order to control for differences in the likelihood of closing down or switching contract along this dimension. Finally, year by 38 industry and 107 provinces fixed effects were also included, in order to account for general shocks in the probabilities of closing down or switching contract. We have estimated the regression model using OLS, so that the treatment effect associated log contractual wages can be interpreted as

[24] The relevance of firms' closure has been considered by several studies analyzing the impact of minimum wages, *e.g.* Draca et al. [2011], Luca and Luca [2019] and Alexandre et al. [2020].

Table C1: **Effect of Contractual Wages on Firms' Closure and Change of Contract - CERVED-INPS Sample**

	Treatment variable: log median contractual wage				
Outcomes	**Coeff.**	**St.err.**	**Adj.R^2**	**RMSE**	**Obs.**
Firm exit	0.013	0.013	0.019	0.075	2,635M.
Change of contract	−0.060	0.059	0.052	0.149	2,179M.

*Significance levels: ** 1%; * 5%*

Results obtained by estimating the effect of contractual wages on an indicator of firms' permanent exit from INPS archives and on an indicator for firms changing the main collective contract applied to its workers. The estimation method is OLS controlling for a cubic polynomial in firms' age, log of firms' size, collective contract and two-digit sector fixed effects, 38-industry by 107 province fixed effects interacted with year fixed effects. All regressions are weighted by the number of workers in the firm. Standard errors are clustered at the firm level. The number of observations in each model is computed excluding singleton groups, i.e. units that are perfectly identified by the fixed effects included in the regression.

an additive effect on the probability of closing down or switching contract.

Table C1 summarizes the results for the two regression models described above. The sample of analysis was composed of all firms included in the marched INPS-CERVED-contractual wage database. As can be noticed, contractual wage growth had no significant effects on the probability of shutting down employment, nor on the probability of changing the main collective contract applied to the workforce. This last result is reassuring when interpreted as a robustness test on sample selection into our database of analysis. Indeed, endogenous changes in the collective contract applied to workers do not seem to play a relevant role. Instead, the result on firms' mortality suggests that this "hard" outcome is not relevant, at least for what concern our sample of analysis, which consists of incorporated businesses only. Thus, the employment losses associated to contractual wage growth, which we have documented, were driven mostly by generalized adjustments in the intensive margin of production, rather than by complete shut-downs of selected companies. Results were not significantly different from zero also when estimated across the distribution of value added per worker, although this output has been omitted for brevity.

We have replicated the same analysis considering the full sample in the INPS archives, in order gain a better understanding on whether focusing on the entire population of private-

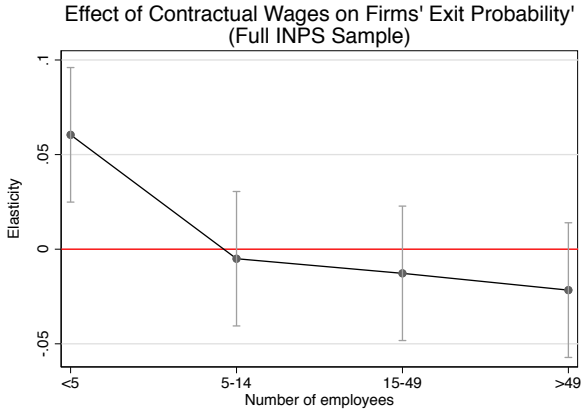
Table C2: **Effect of Contractual Wages on Firms' Closure and Change of Contract - Full INPS Sample**

	Treatment variable: log median contractual wage				
Outcomes	**Coeff.**	**St.err.**	**Adj.R^2**	**RMSE**	**Obs.**
Firm exit	0.073*	0.037	0.019	0.068	8,887M.
Change of contract	−0.016	0.041	0.065	0.143	6,910M.

*Significance levels: ** 1%; * 5%*

Results obtained by estimating the effect of contractual wages on an indicator of firms' permanent exit from INPS archives and on an indicator for firms changing the main collective contract applied to its workers. The estimation method is OLS controlling for a cubic polynomial in firms' age, log of firms' size, collective contract and two-digit sector fixed effects, 38-industry by 107 province fixed effects interacted with year fixed effects. All regressions are weighted by the number of workers in the firm. Standard errors are clustered at the firm level. The number of observations in each model is computed excluding singleton groups, i.e. units that are perfectly identified by the fixed effects included in the regression..

Figure C1: **Heterogeneity of Firms' Closure Effects Across the Firm Size Distribution - Full INPS Sample**



sector firms leads to the same conclusions. In particular, we have estimated the same regression model on the full sample of INPS records over the years 2006-2015, matched with the contractual wage database used for the main analyses of the paper. The results are summarized in Table C2. As can be noticed, contract-switching is not significantly affected by the growth in contractual wages. Instead, firms' exit is positively affected by contractual wage growth, with a significance level that is close to 0.05. However, the size of the coefficient is not particularly strong, as a 10% growth in contractual wages increases the probability of firms' closure by 0.7 percentage points only.

One reason why the effect of contractual wage growth on firms' mortality is marginally significant in the full INPS sample could be the inclusion of very small firms with potentially one or few employees, which were much more likely to be excluded from the matched INPS-CERVED data. For these firms, labor costs are more likely to represent a larger share of total costs, so that changes in contractual wages may trigger their closure. To test this hypothesis, Figure C1 shows the heterogeneity in the effects of contractual wage growth across the firms' size distribution. As can be noticed, the positive effect on firms' mortality is driven by very small firms, those with less than five employees. For all other groups, the growth in contractual wages has no significant effects on their probability of exiting from the market. The size of the coefficient associated to the smallest group of firms is similar in size to the one estimated in the full sample, but the parameter is now estimated more precisely and it is significantly different from zero.

D Effects of Contractual Wages Across Time

We have tested the relevance of anticipatory or long-run effects of contractual wages on the outcomes of interest by estimating the following distributed lags regression model

$$y_{jt} = \sum_{i=-1}^{2} \beta_i w^c_{j(t+i)} + \phi^c_j + \alpha_{sl} * \tau_t + e_{jt} \tag{D1}$$

were we include the contemporaneous level of w^c_{jt} together with two leads one lag. In this model, we have adopted a similar specification of equation (1), including firm by contract and year by sector and province fixed effects. However, the inclusion of two leads of contractual wages, allows to estimate anticipatory policy effects, while the lagged term allows to study long-run adjustments one or more years after the change in contractual wages has occurred.

As noted by Fanfani [2020], this model tends to suffer from almost perfect multicollinearity due to the autocorrelation in policy levels, so that its results are often quite volatile. The model's volatility is a consequence of the fact that the same variation that is used to estimate one treatment effect in the specification of equation (1) is now used to estimate four treatment effects. Moreover, the strong persistence in contractual wages, which tend to be adjusted by small increments rather than drastically reduced or increased across time, makes the correlation among the terms $w^c_{j(t+i)}$ quite strong.[25]

The distributed lag model is typically applied in the minimum wage literature not only to measure long-run adjustments to the policy, but also as a placebo to test for the absence of differences in outcome trends across units before the policy change (see *e.g.* Meer and West [2016] and Cengiz et al. [2019]). However, as noted by Cengiz et al. [2019], this model is more demanding than standard falsification tests in event-study analyses, as distributed lags measure also the presence of differences in outcome trends in periods far away before the policy change. Indeed, in this model the first $t + i$ lead and last $t + i$ lag are typically interpreted respectively as the effect of the policy i years *or more* before (after) its level change.

[25] The consequences of near perfect multicollinearity are quite difficult to predict *ex-ante*, see Spanos and McGuirk [2002] and Hill and Adkins [2003].

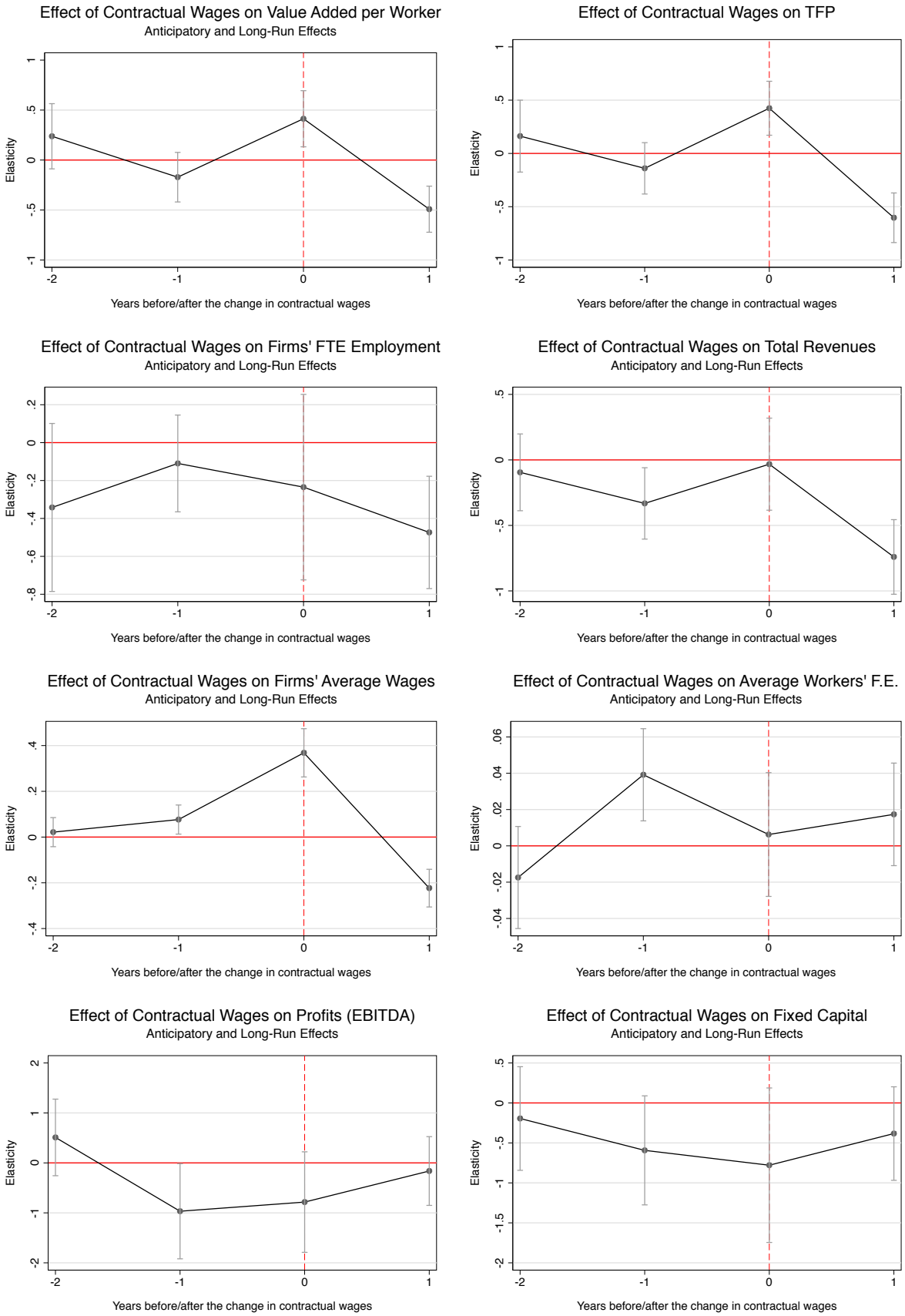
In the context of our analysis, when considering the relevance of anticipatory policy effects to test the robustness of the identification, two considerations should be taken into account. First, contractual wage changes are typically announced and scheduled before their actual implementation. Indeed, negotiations regarding wages take place typically only once every two years, and they tend to set a schedule of future pay rises that is made public well before its implementation. Therefore, policy announcement effects could be potentially relevant. Second, our treatment variable varies at the yearly level, while contractual wages can potentially change in the middle of the year. Since we define w^c_{jt} as the weighted average of the contractual wage in place in each month of the year, policy changes from $t-1$ to t may arise also when the contractual wage change is implemented in the middle of year $t-1$ (generating anticipation effects) and then kept constant throughout year t.

For these two reasons, policy effects taking place the year before the current one should not be considered as evidence against the solidity of our identification. Instead, anticipation effects taking place two or more years before the contractual wage change would be more difficult to interpret as simply driven by announcement mechanisms or anticipatory adjustments to the future policy change. Thus, the significance of the coefficient associated to the two-year lead ($w^c_{j(t+2)}$) provides a more reliable test on the presence of parallel trends between treated and control units before the occurrence of policy discontinuities.

Figure D1 presents the results obtained by estimating the dynamic model of equation (D1) for each of the firm outcomes considered in our main analyses. In all panels, the confidence intervals are computed at the 5% significance level using standard error clustered at the firm level.

Starting from the top part of the figure, it can be noticed that the effects of higher contractual wages on productivity were not significant before the policy change, they were slightly positive in the short run and negative afterwards. In the short run, employment and revenues levels were not affected by the policy change (apart from a small anticipation effect in the case of revenues), which suggests that firms take time to adjust production

Figure D1: **Long-Run and Anticipatory Effects of Wage Growth - 1**



levels when facing higher costs.[26] The effects on wages were instead mostly contemporaneous, and only in part offset by downward adjustments in the longer run. However, part of this effect was also anticipated. Also positive workers' quality selection, measured by the AKM fixed effects, appear to be anticipated, which suggest that firms foreseeing future higher labor costs may become more selective. Finally, for what concern profits and investments, the effects are never statistically significant (apart from a small anticipation effect in profits), although the point estimates are always negative. This suggests that for these two outcomes near perfect multicollinearity and estimation precision problems could be more relevant.

Overall, it appears that none of the outcomes considered is affected by the policy of interest two or more years before its implementation. As mentioned, this marginal effect can be interpreted as a placebo test on the parallel trend hypothesis that should be expected in the presence of a correct identification strategy. Thus, the fact that none of the coefficients associated to the two-years lead was statistically significant can be interpreted as an evidence supporting the validity of our main identifying assumptions.

[26] See Sorkin [2015] for a theoretical discussion on this hypothesis.

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