Unions, Two-Tier Bargaining and Physical Capital Investment: Theory and Firm-Level Evidence from Italy*

Gabriele Cardullo   Maurizio Conti   Giovanni Sulis

April 3, 2019

Abstract

In this paper we present a search and matching model in which firms invest in sunk capital equipment. By comparing two wage setting scenarios, we show that a two-tier bargaining scheme, where a fraction of the salary is negotiated at firm level, raises the amount of investment per worker in the economy compared to a one-tier bargaining scheme, in which earnings are entirely negotiated at sectoral level. The model's main result is consistent with the positive correlation between investment per worker and the presence of a two-tier bargaining agreement that we find in a representative sample of Italian firms.

Keywords: Unions, Investment, Hold-up, Two-Tier Bargaining, Control Function.

J.E.L. Classification: J51, J64, E22.

1   Introduction

In this paper, we consider the role of unions and decentralized labour contracts as possible determinants of firms' investment decisions in physical capital. By increasing workers' bargaining power, unions may raise wages and generate additional adjustment costs in labour inputs, thus generating allocative inefficiency through an hold-up mechanism (Grout, 1984; Malcomson, 1997). However, a decentralized wage bargaining structure may increase wage flexibility, thus aligning wages to productivity and increasing investment in physical capital.

To address these issues, we build up a search and matching model in which the investment in capital equipment is made before a job vacancy is posted and the wage negotiation occurs, so that an hold-up problem arises.[1] In such a setting we consider two different wage scenarios. In the first one, that we call one-tier wage bargaining, earnings are uniquely determined by workers' unions and firms' representatives at sectoral level. In the second one, a fraction of the wage is negotiated at firm level after the sectoral negotiation has taken place. This second scenario aims to represent that particular kind of two-tier wage schemes, widespread in Continental Europe, in which the so-called "favorability principle" (Boeri, 2014) applies: under this institutional framework, firm or plant-level agreements (the second tier of the negotiation) cannot envisage conditions that would make workers worse off than they are under the higher, sectoral, level of bargaining.

By comparing the two scenarios, we obtain that, under certain conditions, a two-tier wage negotiation raises the amount of investment per worker in the economy. The reason goes as follows. While under one-tier bargaining wages are affected by the average productivity in the sector, in a two-tier bargaining scenario the salary partially depends on the productivity of the single firm. This has a twofold effect on firms that make large capital investments. On the one hand, as more capital translates into higher productivity, these firms pay higher salaries, compared to the one-tier scheme. On the other hand, their job vacancies get filled more

---

[1]The model is related to previous work by Cardullo et al. (2015), who study the effect of union power on physical capital investment in a model with sectoral level differences in the degree of sunk capital investment.

quickly, as better earnings attract more job seekers. In turn, this reduces the opportunity cost of capital, as the equipment remains unused for less time. This second effect outweighs the first one when the elasticity of the expected duration of a vacancy is sufficiently large (so that a given percentage increase in the number of applicants has a strong impact on the job filling rate) and the bargaining power of workers' unions is weak (so that labour costs are a relatively small proportion of firms' revenues). A larger share of high-capital firms will enter the market, thus raising the average level of investment per worker in the economy.

We support our theoretical findings providing some motivating evidence. In particular, we consider a representative sample of Italian firms for the year 2010 and estimate a set of investment equations using Poisson quasi-maximum likelihood techniques, controlling for industry and region fixed effects as well as for a standard set of firm level demographics. We consistently find a robust positive correlation between the level of investment per worker and the existence of a two-tier bargaining agreement within the firm that, however, we refrain to interpret as a causal relationship because of the lack of a quasi natural experiment. Interestingly, our results also show that the presence of a decentralized agreement tends to exactly offset the negative effect that unions per se seem to exert on investment per worker.

The paper is related to different strands of literature. First, it is related to studies that deal with the effects of unions on investment in physical and intangible capital (see Menezes-Filho and Van Reenen (2003) for a review). For the US case, Hirsch (2004) suggests the existence of negative effects of unions on investment in physical capital, while Addison et al. (2007) and Addison et al. (2017), in the case of Germany, find non-negative effects of unions on investment in physical and intangible capital, respectively. Moreover, a recent paper by Card et al. (2014), using Italian data, finds a very small role for the hold-up mechanism. Conversely, Cardullo et al. (2015) find, using cross-country cross-sector data, that powerful unions reduce investment per worker particularly in sunk capital intensive industries.[2]

---

[2]A recent paper by Devicienti et al. (2017) studies the role of unions and decentralized labour contracts on technical efficiency in Italy.

Second, the paper can be associated with theoretical studies that analyze the effects of different bargaining mechanism (centralized and decentralized) on labour market outcomes.

The seminal work of Calmfors and Driffil (1988) has perhaps influenced the subsequent literature on the subject. In their paper, sectoral level bargaining implies higher wages and a lower employment level compared to a firm/local negotiation because competition across sectors is less fierce than competition within sectors. So, under sectoral bargaining, upward wage pressures have a weaker impact on firms' revenues.

As de Pinto (2017) shows, this result can be offset once we consider heterogeneous firms and endogenous entry/exit. Under this richer setup, a unique wage decided at sectoral level raises average profits, as the increase in revenues for the more productive firms is larger than the decrease experienced by the less productive ones. In turn this attracts new firms into the market. Competition gets fiercer, productivity and labor demand increase, thereby outweighing the negative employment effect outlined by Calmfors and Driffil.

Using a search and matching framework, Krusell and Rudanko (2016) also analyze the effect of different bargaining agreements on unemployment. They show that, under centralization, when there is commitment by firms and unions, unemployment is at the its efficient level. However, when there is no commitment, unions raise wages and unemployment is higher (and output is lower). Adopting the same theoretical framework, Jimeno and Thomas (2013) consider the effects of firm level productivity shocks and find that unemployment is lower under decentralized equilibrium than under sector level bargaining[3].

Finally, the paper is connected with studies that explicitly analyze the role of two-tier bargaining.[4] Boeri (2014) analyzes the effects of two-tier bargaining structures on wages, employment and productivity. He argues that two-tier bargaining, comprising a mixture of centralized and decentralized bargaining regimes, turns out to be inefficient. Under the centralized regime, worker and firms bargain using a right-to-manage mechanism, entailing

---

[3]See also Braun (2011) and Haucap and Wey (2004).

[4]Barth et al. (2014) provide a theoretical framework to study the Scandinavian model of production and industrial relations. In their setting, two-tier bargaining structures and unions favour worker involvement and wage compression, with positive productivity effects related to workers effort and firm level investment.

inefficiency; on the other hand, fully decentralized structures allow for efficient contracts when bargaining over wages and employment. However, under two-tier regimes, first stage centralized bargaining imposes wage floors that cannot be neutralized in the second stage, thus limiting the range of efficient contracts available to workers and firms. Moreover, decentralization in the second tier can improve unions's but not firm's utility. The paper also provides some descriptive evidence in this respect. A recent study by Garnero et al. (2018) empirically analyses the effects of firm level agreements on wages and productivity using matched employer-employee panel data from Belgium. When there is rent sharing, wages are shown to increase more than productivity, thus partially reducing profitability, at least in manufacturing. They also point out towards heterogeneous effects of rent sharing across firms, depending on the sectoral degree of competition. Their bottom line is that two-tier systems, by increasing both wages and productivity, benefit both workers and firms.[5]

We contribute to the literature in two main directions. First, we propose a theoretical model with unions and two-tier bargaining that is able to deliver general empirical predictions on physical capital investment. To the best of our knowledge, this is one of the very few attempts to model two-tier bargaining structures available in the literature. Second, we provide descriptive evidence on the effects of unions and decentralized labour contracts on investment for a country, as Italy, traditionally characterized by high union power and highly centralized wage bargaining, while most of the available evidence is for the US or a very limited number of EU countries, as the UK and Germany.

The remainder of the study is organized as follows. In Section 2 we provide motivating evidence, in Section 3 we present the theoretical model, while Section 4 concludes. We gather information on the institutional background and the data in the Appendix, where we also include theoretical proofs.

---

[5]Recently, **?** find a positive effect of union density on firm productivity and wages using Norwegian firm data.

2   Motivating evidence

In order to evaluate the relationship between two-tier bargaining and firm level investment, we estimate various versions of the following reduced-form equation for investment per worker:

$$InvestmentWorker_i = \alpha + \beta Union_i + \gamma TTB_i + \delta X_i + u_{si} + u_{se} + u_{re} + \nu_i, \qquad (1)$$

where $InvestmentWorker$ is the level of investment per worker at firm i.[6] TTB is a dummy variable equal to 1 in the case of firms where a two-tier bargaining agreement was in place, $Union$ is a dummy variable equal to one for unionized firms (see Appendix A.1) and X_i is a set of controls at the firm level.[7] Finally, u_{si} is a firm size fixed effect, u_{se} is a sector fixed effect (77 sectors at Ateco 2007 level), u_{re} is a set of 20 region fixed effects, while ν_i is a standard error term. Standard errors are clustered at the industry level and all regressions are run using sample weights in order to ensure that regression results are representative of the population of firms.

The estimation of (1) by OLS would raise an important econometric problem, associated to the presence of a mass point at zero in the distribution of investment per worker: indeed, about one third of firms in our sample reports a zero level of investment, a proportion that reaches 40 per cent in the case of firms in the 16-49 employees category. It is however well known that, when facing a corner solution outcome, using OLS might lead to biased and inconsistent parameter estimates.

Recently, a number of authors (see, for instance, (Santos Silva and Tenreyro, 2006) or (Wooldridge, 2010)) have proposed to deal with corner solution outcomes by assuming an exponential distribution for the conditional mean and estimating the model by Poisson quasi-

---

[6]We consider investment per worker, rather than the investment rate (i.e. investment per unit of capital) because in models of unions and hold up (Cardullo et al., 2015) unions are expected to affect investment per worker (see also (Cingano et al., 2010).

[7]In the vector X_i we consider various firms characteristics that could be important to control for in a reduced-form investment equation, such as dummies for exporting firms or for firms that had already offshored some of their activities; dummies for workers human capital, etc. See section A.2 in the Appendix for a description of the data and main variables.

maximum likelihood techniques. It is important to note that, in this case, it is not necessary that the dependent variable follows a Poisson distribution at all (provided the dependent variable is non negative and with no upper bound). What is needed for a Poisson quasi maximum likelihood model to deliver consistent parameter estimates is simply that the conditional mean of the outcome variable is correctly specified.

It is important to note at the outset that we refrain from interpreting our results as causal for a number of reasons. First, it is possible that firms with unobserved shocks to productivity and profitability are more likely to invest but also to have a decentralized agreement, introducing a possibly spurious positive correlation between TTB and investment per worker. Second, firms can be heterogeneous along various unobserved dimensions, which could be related to the propensity to invest and to sign a decentralized agreement. In the case of $Union$, in turn, endogeneity concerns might be perhaps less important. In fact, we tend to agree with Devicienti et al. (2017) who argue that, in the Italian institutional context, it is unlikely that unions target the most profitable firms, especially when firm heterogeneity has already being controlled for. [8] Similarly, union membership within the firm tends to be more related to particular sectors, area of the country and size of the firm, or historical reasons, rather than actual or perspective firm conditions.

We begin in column 1 of Table 1 with a parsimonious specification including a dummy equal to 1 for those firms where a two-tier bargaining was in place and a unionization dummy.[9] The presence of unions is associated to a lower level of investment per worker of about 24%, while in firms with of a two-tier bargaining agreement we note that investment per worker is higher by a similar amount. In other words, because firms with a decentralized agreement are generally also unionized, these results suggest that the presence of a decentralized agreement tends to exactly counteract the negative effect that unions seem to exert on investment per

---

[8]Indeed, in Italy setting up union representation just requires the willingness of a single employee to act as union representative; as a result, unionization does not entail important fixed costs, as it happens in the US, where unions need to win a majority in a Certificate Election. We refer to section A.1 in the Appendix for an overview of the institutional background.

[9]Our results hold also when we measure union power with standard union density measures.

worker.

In the next regressions we probe the robustness of these results along various dimensions. First, in columns 2 we include a full set of collective agreements fixed effects. Indeed, there is no exact correspondence between the industry a firm belongs to and the collective agreement a firm decides to apply; in other words, firms active in very different industries could apply the same national collective contract. Reassuringly, our main results are confirmed. In column 3 we include an interaction term between unionization and the existence of a two-tier bargaining agreement: regression results suggest that the interaction term is positive and statistically significant. Unions seem to exert a negative effect on investment per worker only when there is no two-tier agreement within the firm; in turn, the positive effect of a two-tier agreement seems to exist only in unionized firms. In other words, decentralized agreements seem to affect investment per worker only by modifying the negative effects associated to the hold-up problems that might exist in unionized firms; by way of contrast, in the not-unionized firms the existence of a decentralized contract does not seem to have any significant effect on investment per worker.

In columns 4-7 we show that these results are robust to including additional control variables that could explain investment per worker. First, in column 4 we include controls related to the firm workforce composition, such as the share of workers by age group, education level, gender, training provisions and presence of fixed-term contracts. Then, in column 5 we add dummies equal to one for firms applying a national collective contract and for firms that belong to an employee confederation. Finally, we consider additional controls, such as a dummy for whether the firm has already off-shored some of its activities, a dummy for exporting firms, a dummy for firms that are run by a manager and not by family members and, finally, a dummy equal to one for firms where a "Cassa integrazione" schemes applies, which is a proxy for firms that have been facing tough economic and financial conditions.[10]

---

[10]The "Cassa integrazione" (CIG) is a short-time work (STW) benefit scheme comprising a wage guarantee for redundant workers (about 80% of previous earnings) that covers both blue and white collar workers in both manufacturing and service sectors for firms facing restructuring, reorganization or bankruptcy procedures. Depending on the nature of the redundancy problem the firm is facing, there are different CIG categories.

Table 1: Poisson regression models for investment per worker

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
union	-0.237*	-0.349***	-0.315**	-0.271**	-0.272**	-0.229*	-0.327**	-0.578*
	(0.136)	(0.112)	(0.161)	(0.131)	(0.128)	(0.139)	(0.160)	(0.325)
two-tier bargaining (TTB)	0.246***	0.224**	-0.101	0.244**	0.241**	0.253**	-0.150	0.742
	(0.0956)	(0.105)	(0.197)	(0.111)	(0.111)	(0.112)	(0.256)	(0.677)
union × two-tier bargaining			0.474*				0.563*	
			(0.268)				(0.331)	
share of workers younger than 25				-0.126	-0.0780	-0.184	-0.165	
				(0.653)	(0.598)	(0.571)	(0.562)	
share of workers 26-34				0.0160	0.0363	0.00914	-0.00917	
				(0.349)	(0.341)	(0.326)	(0.331)	
share of workers 35-49				-0.145	-0.110	-0.0563	-0.0558	
				(0.360)	(0.349)	(0.339)	(0.344)	
share of high skilled				0.542	0.568	0.512	0.533	
				(0.385)	(0.376)	(0.391)	(0.395)	
share of medium skilled				-0.00913	0.00233	-0.0364	-0.0362	
				(0.253)	(0.245)	(0.228)	(0.225)	
share of female workers				-0.424	-0.451	-0.430	-0.414	
				(0.421)	(0.417)	(0.411)	(0.412)	
share of trained workers				0.265	0.255	0.256	0.255	
				(0.172)	(0.175)	(0.172)	(0.167)	
share of fixed term contracts				0.559*	0.554**	0.536**	0.533**	
				(0.290)	(0.268)	(0.263)	(0.260)	
national contract					-0.409	-0.390	-0.372	
					(0.390)	(0.393)	(0.389)	
employers' association					0.0201	0.0150	0.0137	
					(0.116)	(0.116)	(0.115)	
management						-0.134	-0.144	
						(0.133)	(0.130)	
offshoring						0.242	0.239	
						(0.274)	(0.278)	
export						0.121	0.119	
						(0.123)	(0.125)	
workers in *cassaintegrazione*						-0.323**	-0.318**	
						(0.135)	(0.134)	
residual union								0.230
								(0.367)
residual two-tier bargaining								-0.403
								(0.694)
Size dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Collective contract dummies	No	Yes	No	No	No	No	No	No
Constant	9.390***	9.642***	9.370***	9.247***	9.584***	9.615***	9.585***	
	(0.293)	(0.435)	(0.292)	(0.547)	(0.806)	(0.787)	(0.781)	
Observations	5,986	5,515	5,986	3,955	3,946	3,912	3,912	3,009

Notes: Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Dependent variable is the level of investment per worker. All regressions include sample weights. Number of sectors in column 8 is equal to 69. See Table A1 and Section A.2 in the Appendix for more details concerning the sample selection and definition of variables.

As long as these variable are both correlated to investment per worker as well as to the firm unionization status and/or the existence of a two-tier bargaining agreement within the firm, their omission might generate and omitted variable problem.[11] Regression results in column 6 show that these regressors are generally not statistically significant, with the exception of the "Cassa Integrazione" dummy which, unsurprisingly, displays a negative coefficient, and the share of workers under a fixed term contract, which in turn seems to be positively correlated to investment per worker. Reassuringly, our coefficients of interest are barely altered, both in magnitude as well as statistical significance.[12]

Finally, in columns 8 we address possible endogeneity concerns discussed above by using a control function approach.[13] Unfortunately, we do not have clear cut exclusion restrictions for TTB and $Union$ following from a quasi natural experiment deriving from the institutional rules: therefore, the ensuing results should be taken with extreme care. Following Devicienti et al. (2018) and Jirjahn and Mohrenweiser (2016), we have experimented using, as instruments, the average probability of union presence in each industry-region cell as of 2007, and the average probability of a firm applying a two-tier decentralized agreement in each industry-region cell as of 2007. The rationale of using these instruments is that past two-tier decentralized agreements (presence of a union) in a given industry-region cell positively predict current presence of a two-tier decentralized agreement (union) within the firm and affect investment only indirectly by influencing current unionization and presence of a two-tier agreement.

Regression results confirm that unionization has a negative and statistically significant

See Boeri and Bruecker (2011) for the effects of the STW during the economic crisis and further discussion.

[11]However, if they are endogenous, a bad control problem might arise and the bias could be transmitted to our regressors of interest. It is for this reasons that our baseline regressions do not include these firms characteristics.

[12]In column 7 we report results for regressions in which we include all controls and the interaction term between unions and two-tier bargaining: our results are broadly confirmed.

[13]Wooldridge (2010) shows that a two step control function approach is easy to implement. First, one needs to regress using OLS each endogenous variable on the exogenous variables plus one or more instruments; second, the residuals are added to the original Poisson regression. If the exclusion restrictions are valid and the instruments are significant in the "first stage" regressions, the presence of the residuals should correct for possible endogeneity. Moreover, if one cannot reject the null hypothesis that residuals are equal to zero, this is sign that regressors might not be endogenous

impact on investment per worker, while the coefficient of the two-tier bargaining agreement dummy is positive but imprecisely estimated. However, the two residual terms are individually and jointly statistically insignificant, possibly suggesting that the both the unionization and two-tier bargaining dummies might be exogenous in our model. All in all, we think that these results provide at least suggestive empirical evidence on a possible positive correlation between the existence of a two-tier bargaining agreement and the firm propensity to invest in physical capital.

3   The Model

3.1   Production and Matching Technology

Consider a continuous-time model with a continuum of infinitely-lived and risk-neutral workers who have perfect foresight and a common discount rate r. The economy is composed by one final consumption good Y, whose price is normalised to 1, and two intermediate goods. The final good production function takes a CES form:

$$Y = \left[Y_a^{\frac{\sigma-1}{\sigma}} + Y_b^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{2}$$

in which Y_a (Y_b) is the amount of the intermediate good a (b) used in the production process of the final good. The elasticity of substitution σ is imposed to be greater than 1, to allow for a situation in which one of the intermediate goods is equal to zero. Perfect competition is assumed in both intermediate and final good markets. So cost minimisation in the final good sector leads to the following inverse demand function for each intermediate good:

$$p_i \equiv \frac{\partial Y}{\partial Y_i} = \left(\frac{Y_i}{Y} \right)^{-\frac{1}{\sigma}}; \quad \text{for } i \in \{a, b\}. \tag{3}$$

The only exogenous difference between firms in markets a and b concerns the capital equipment. Following Acemoglu (2001), we assume that, before entering the labour market, a

firm has to buy a certain amount of capital, k_i, and that $k_a > k_b$. Firms producing the intermediate good a need making a larger investment beforehand. A hold-up problem arises because employers must invest k_i before the wage negotiation takes place.

Following the standard search and matching framework (Pissarides, 2000), we assume that, in each intermediate industry, a firm is composed of a single (filled or vacant) job. Each worker produces $1 + \ell$ units of the intermediate good. The sum $1 + \ell$ stands for the amount of working hours devoted by each employee. The reason for this particular formulation will be clear as we present the two different wage scenarios assumed in the paper. So we have $Y_i = (1 + \ell) \cdot e_i$, for $i \in \{a, b\}$, with e_i denoting the measure of workers producing the intermediate good i.

Labour force is normalized to 1. There are frictions in the labour markets. We assume directed search, meaning that each unemployed worker chooses to search either for a job of type a or for a job of type b: u_a and u_b respectively denote the amount of job seekers in a and b. We rule out on-the-job search. The matching functions give the measure of matches for certain values of unemployment u_i and vacancies v_i: $m_i = m(v_i, u_i)$, for $i \in \{a, b\}$. Function $m(., .)$ has constant returns to scale and it is increasing and concave in each argument. As usual in the search and matching literature (see Petrongolo and Pissarides, 2001), we consider a Cobb-Douglas technology: $m_i = v_i^{1-\eta} u_i^{\eta}$, with $0 < \eta < 1$. Labour market tightness is defined as $\theta_i \equiv v_i/u_i$, for $i \in \{a, b\}$. A vacancy is filled according to a Poisson process with rate $q(\theta_i) \equiv m_i/v_i = \theta_i^{-\eta}$, $q'(\theta_i) < 0$, for $i \in \{a, b\}$. A job-seeker gets employed at rate $f(\theta_i) \equiv m_i/u_i = \theta_i q(\theta_i) = \theta_i^{1-\eta}$, increasing in θ_i for $i \in \{a, b\}$. Notice that parameter η is the elasticity of the expected duration of a vacancy $1/q(\theta_i)$ with respect to tightness. At a certain exogenous rate δ, a filled job breaks down and the worker becomes unemployed.

Let ϕ denote the share e_a/e, with e_i denoting the employment level of type $i \in \{a, b\}$ and $e = e_a + e_b$ being the total level of employment in the economy. In steady-state, in each labour market the amount of new jobs created must be equal to the number of jobs destroyed: $\phi e \cdot \delta = u_a \cdot f(\theta_a)$ and $(1 - \phi)e \cdot \delta = u_b \cdot f(\theta_b)$. Knowing that $1 = e + u_a + u_b$,

the steady state level of employment is equal to:

$$e = \frac{f(\theta_a)f(\theta_b)}{f(\theta_a)f(\theta_b) + \phi\delta f(\theta_b) + (1-\phi)\delta f(\theta_a)}. \tag{4}$$

Notice also that the prices of the intermediate goods (3) can be written as

$$p_a = \left[1 + \left(\frac{1-\phi}{\phi}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}} \quad ; \quad p_b = \left[1 + \left(\frac{\phi}{1-\phi}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}}. \tag{5}$$

3.2 Investment decision and free-entry condition

The expected discounted value of a filled job verifies the following Bellman equation:

$$r\Pi_i^E = (1+\ell)p_i - w_i + \delta\left[\Pi_i^V - \Pi_i^E\right] \tag{6}$$

for $i \in \{a,b\}$. Firms' revenues are equal to amount of the intermediate good produced, multiplied by corresponding the price, net of the wage, w_i. At a rate δ, the firm-worker pair splits apart and employers get a capital loss equal to the difference between the value of a filled job and the expected value of a job vacancy, Π_i^V. In turn, this value reads as

$$r\Pi_i^V = q(\theta_i)\left[\Pi_i^E - \Pi_i^V\right] \tag{7}$$

for $i \in \{a,b\}$. As in Acemoglu (2001), we assume for simplicity that there are no flow vacancy costs[14]. So the expected discounted value of a vacancy is just the capital gain in case a match is formed, multiplied by the job filling rate $q(\theta_i)$.

There is free-entry of vacancies. Firms enter the labour market as long as expected profits are nonnegative. Since they have to buy k_i in advance, this implies $\Pi_i^V = k_i$ for $i \in \{a,b\}$.

---

[14]This does not imply that keeping a vacancy open is for free, as firms face the opportunity cost of idle capital equipment, $r\,k_i$.

So, rearranging eqs. (6) and (7) yields:

$$\frac{(1+\ell)\,p_i - w_i}{r + \delta + q(\theta_i)} = \frac{r k_i}{q(\theta_i)} \tag{8}$$

for $i \in \{a,b\}$. At the LHS we have the expected discounted revenues of a filled job. In equilibrium they must be equal to the expected costs of a vacancy: the instantaneous opportunity cost of capital $r k_i$ multiplied by the expected duration of a vacancy, $1/q(\theta_i)$. We impose $r k_i$ to be sufficiently small. In particular, we assume $r k_i < \frac{\ell}{2}$ for $i \in \{a,b\}$. We need this to avoid that θ_i $(i \in \{a,b\})$ takes an excessively high value to satisfy equation (8), that means a rental cost of capital so expensive that almost no job vacancy is posted.

3.3 Workers' preferences and no arbitrage condition

The expected discounted value of being unemployed and searching for a job in $i \in \{a,\,b\}$ is equal to:

$$r J_i^U = z + f(\theta_i)\left[\, J_i^E - J_i^U \,\right]. \tag{9}$$

Being unemployed is like holding an asset that pays you a dividend z, the value of home production, and at a rate $f(\theta)$ ensures a capital gain $J_i^E - J_i^U$. We impose $z < 1$. From eq. 5, workers' productivity is always greater than 1. This is sufficient to ensure that, at the equilibrium, workers find employment always more attractive than unemployment. The term J_i^E denotes the expected discounted value of working in a firm of type $i \in \{a,\,b\}$ and it reads as follows:

$$r J_i^E = w_i + \delta\left[\, J_i^U - J_i^E \,\right] \tag{10}$$

The term w_i stands for the real wage paid by firms in $i \in \{a,\,b\}$. Its precise formulation will be explained in the next section. At a rate δ the match gets destroyed and the worker becomes unemployed.

Unemployed workers are free to search for either a job of type a or a job of type b, so a

non-arbitrage condition ensures that $J_a^U = J_b^U$. Using (9) and (10) we have:

$$\frac{f(\theta_a)}{r + \delta + f(\theta_a)} (w_a - z) = \frac{f(\theta_b)}{r + \delta + f(\theta_b)} (w_b - z) \tag{11}$$

The fractions in both sides of the equation are increasing in $f(\theta_i)$, $i \in \{a, b\}$. A labour market cannot exhibit both a higher job finding rate and better earnings, otherwise no worker would search for a job in the other market.

3.4 Wage formation

The purpose of this paper is to evaluate the effects on investment of two different wage setting processes: a two-tier set-up, and a one-tier scheme.

We convey this difference in a quite simple manner, by assuming that the real wage is given by

$$w_i \equiv \omega + d_i \cdot \ell, \tag{12}$$

for $i \in \{a, b\}$. Recall we assume employees work $1 + \ell$ hours. Firms pay an amount equal to ω for a fraction (normalized to 1) of the working hours. The term d_i denotes the hourly remuneration employees receive for the remaining ℓ working hours. The fraction ω of the total salary is negotiated at sectoral level. This is the case for both the one-tier and the two-tier scenario[15]. The two settings differ in the determination of the term d_i. In the one-tier setup, d_i is also decided at sectoral level and imposing $d_a = d_b$, whereas in the two-tier scheme it is bargained at firm level.

Under this formulation we are able to maintain one the crucial features of two-tier bargaining schemes present in Continental Europe and that is called "favorability principle" (see Boeri (2014)). Under this framework, firm or plant-level agreements (the second tier of the negotiation) cannot envisage conditions that would make workers worse off than they are under the higher, sectoral, level of bargaining. In our model, a single firm-worker pair

---

[15]Of course the fact that ω is decided at sectoral level in both scenarios does not imply that it would take the same value in the one-tier and in the two-tier scheme. The choice of d_i affects the value of ω.

negotiates over the wage to be paid for the residual ℓ working hours but cannot change the fraction of the salary ω chosen at sectoral level.

3.5   One-Tier Wage Bargaining Scenario

Under one-tier wage bargaining, sectoral unions negotiate simultaneously over ω and d. We assume that unions behaves in a utilitarian way. Workers' union utility U^W is the sum of the utilities of all the employees in the same sector, working either for firms producing the intermediate good a or good b:

$$rU^W = e_a \left(\omega + d \cdot \ell \right) + e_b \left(\omega + d \cdot \ell \right) \tag{13}$$

Similarly, firms' union utility U^F is just the sum of the revenues raised by industries a and b:

$$rU^F = e_a \left[(1 + \ell)p_a - \omega - d \cdot \ell \right] + e_b \left[(1 + \ell)p_b - \omega - d \cdot \ell \right] \tag{14}$$

We assume that, in case of disagreement, workers become unemployed and enjoy an instantaneous utility equal to the value of home production, denoted by z. Therefore the fall-back position of workers' union reads as $r\bar{U}^W = z \cdot e$. By the same token, in case of failure in negotiation, firms do not produce and sell anything. This implies that the fall-back position for the firm's union is $r\bar{U}^F = 0$.

The value of d and ω are determined by assuming axiomatic Nash bargaining, that takes the following form:

$$\max_{\omega, \, d} \left[U^W - \bar{U}^W \right]^{\beta} \cdot \left[U^F - \bar{U}^F \right]^{1-\beta}$$

Parameter β stands for the bargaining power of the workers' union. At the equilibrium, the

negotiation always ends up in an agreement. The F.O.C.s for ω and d are identical:

$$(1 - \beta) \left[U^W - \bar{U}^W \right]^\beta = \beta \left[U^F - \bar{U}^F \right]$$

This means the only possible solution is such that $\omega = d$. This is not surprising. Since ω and d are jointly decided by the same unions, there is no reason any of the total $1 + \ell$ working hours should be paid differently. So, in the one-tier scenario, we have $w = \omega (1 + \ell)$ with $i \in \{a, b\}$. Using equations (13), (14), and the expressions for $\bar{U}^W$ and $\bar{U}^F$ yields:

$$w \cdot e = \beta (1 + \ell) \left[e_a \, p_a + e_b \, p_b \right] + (1 - \beta) z \cdot e \tag{15}$$

Unions at sectoral level choose a value for w such that the total wage bill (the LHS of 15) is a weighted average between the total revenues raised in the intermediate industries and the aggregate amount of home production (the RHS of 15). The weight is given by workers' union bargaining power β. Dividing both sides of (15) by e, we have:

$$w = \beta (1 + \ell) \left[\phi \, p_a + (1 - \phi) \, p_b \right] + (1 - \beta) z \tag{16}$$

Thanks to the wage equation (16), we are able to close the model under one-tier bargaining. Indeed, after inserting (16) into the zero profit conditions (8) and the no arbitrage condition (11), we get a system of three equations in three unknowns, ϕ, θ_a and θ_b. If this system admits at least one solution, all the remaining endogenous variables (prices p_a and p_b, the amount of the final good Y, the level of employment e, the discounted utilities for workers and firms) are trivially obtained. The following Proposition summarizes the results.

Proposition 1 *There exists at least one steady-state equilibrium for the one-tier bargaining model. If $\beta \leq \min \left[\frac{1}{2}, \frac{1}{\sigma} \right]$, the equilibrium is unique.*

The formal proof is Appendix B. Here we simply present the main features of the equilibrium. Notice first that, for the no arbitrage condition (11), an identical pay ($w_a = w_b = w$)

16

leads to an identical labour market tightness: $\theta_a = \theta_b = \theta$. This in turn implies greater vacancy costs for firms of type a, that make a large investment beforehand: $\frac{r\,k_a}{q(\theta)} > \frac{r\,k_b}{q(\theta)}$. Then, both zero profit conditions (8) are satisfied only if firms in a earn higher revenues, that is $p_a > p_b$. For the demand equations in (5), this means that $\phi < \frac{1}{2}$. In the one-tier wage bargaining scenario, the number of firms with large capital equipment is lower than the ones with small capital equipment.

Studying the model at the limit cases $\phi \to 0$ and $\phi \to 1$, we easily show that at least one equilibrium exists. The reason we need to impose $\beta \leq \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$ for the uniqueness of the equilibrium depends on the wage equation (16) obtained in this scenario. The wage is a function of the average productivity in the entire sector $\phi\,p_a, +(1-\phi)\,p_b$, that is increasing in ϕ.[16] So, a larger share of large capital high-productivity firms a, ϕ, has ambiguous effects on the expected revenues net of the wage costs for low-capital low-productivity firms. The wage increase may be stronger than the surge in productivity p_b.[17] This is not the case when workers' bargaining power β is weak, so that the upward pressure on wage is modest. Under a low elasticity of substitution, σ, multiple equilibria are also less likely, as the increase in the price p_b when ϕ goes up is greater the smaller the degree of substitutability between the intermediate goods.

3.6 Two-Tier Wage Bargaining Scenario

Let focus on the two-tier scheme. First, unions representing all the firms in industries a and b with a filled position and all the workers negotiate over ω. In a second stage, each firm-worker pair bargains over d_i for $i \in \{a, b\}$.

We proceed backward and consider the negotiation at firm level. The value of d_i is

---

[16]See Appendix B.

[17]This ambiguity would not occur the wage paid in labour market b were just a fraction β of the productivity of jobs of type b, as in a standard search and matching setup with Nash bargaining at firm level.

determined via Nash bargaining:

$$d_i = \operatorname{argmax} \left[J_i^E - \bar{J}_i^E \right]^\epsilon \cdot \left[\Pi_i^E - \bar{\Pi}_i^E \right]^{1-\epsilon},$$

for $i \in \{a, b\}$. Parameter ϵ stands for the worker's exogenous bargaining power at local level and it is different from β, that captures the strength of employees' union at sectoral level. The terms $\bar{J}_i^E$ and $\bar{\Pi}_i^E$ stand for the expected utilities pay-offs for workers and firms respectively, in case of disagreement. They are equal to:

$$r\bar{J}_i^E = \omega + \delta \left[J_i^U - \bar{J}_i^E \right], \qquad r\bar{\Pi}_i^E = p_i - \omega + \delta \left[\Pi_i^V - \bar{\Pi}_i^E \right] \tag{17}$$

These two equations imply that, in case of disagreement in the second tier of the negotiation, workers remain employed but earn only the fraction ω of the salary decided at sectoral level, and firms produce less. Indeed, in the light of what discussed before about the "favorability principle" and the residual nature of the second level of the negotiation in most European countries, it does not seem plausible to imagine that a disagreement over a fraction of the total pay implies lay-offs or quits.

The F.O.C. of the above problem is:

$$\epsilon \cdot \left(\Pi_i^E - \bar{\Pi}_i^E \right) = (1 - \epsilon) \cdot \left(J_i^E - \bar{J}_i^E \right) \tag{18}$$

for $i \in \{a, b\}$. Using eqs. (6), (10), and (17), we get:

$$d_i = \epsilon \, p_i \tag{19}$$

for $i \in \{a, b\}$. The hourly wage d_i is a share ϵ of firms' productivity.

At the first tier of the bargaining scheme, unions of workers and firms negotiate over ω.

The Nash bargaining problem is identical to the one studied in the one-tier scheme:

$$\omega \ = \ \text{argmax} \ \left[\, U^W - \bar{U}^W \,\right]^{\beta} \cdot \left[\, U^F - \bar{U}^F \,\right]^{1-\beta}$$

Computing the F.O.C. and using equations (13), (14), and the expressions for $\bar{U}^W$ and $\bar{U}^F$, we get:

$$e_a\, w_a \ + \ e_b\, w_b \ = \ \beta\,(1+\ell)\,[\,e_a\, p_a \ + \ e_b\, p_b\,] \ + \ (1-\beta)\, z \cdot e \tag{20}$$

As in the one-tier scenario, unions at sectoral level choose a value of ω such that the total wage bill is a weighted average between total revenues and the aggregate amount of home production. Dividing both sides of equation (20) by e and using equations (12) and (19) we get:

$$w_a \ = \ \beta\,(1+\ell)\,[\,\phi\, p_a \ + \ (1-\phi)\, p_b\,] \ + \ (1-\beta)\, z \ + \ \epsilon(1-\phi)\,\ell\,(\,p_a - p_b\,) \tag{21}$$

$$w_b \ = \ \beta\,(1+\ell)\,[\,\phi\, p_a \ + \ (1-\phi)\, p_b\,] \ + \ (1-\beta)\, z \ + \ \epsilon\phi\,\ell\,(\,p_b - p_a\,) \tag{22}$$

The first two terms at the RHS in (21) and (22) are identical and coincide with the wage equation (16) obtained under the one-tier bargaining scenario. This is the result of the equalizing role played by unions in the first tier of the negotiation[18]. Wage differences depend on the third terms at the RHS of (21) and (22). Workers employed in firms of type a (respectively, b) are paid more than workers in b (resp. a) only if the price of the intermediate good they produce is higher: $p_a > p_b$ (resp. $p_b > p_a$). The second level of the negotiation creates a wedge in the workers' earnings. Such a gap is wider the stronger is workers' bargaining power at firm level ϵ and the larger the amount of hours worked ℓ whose pay is decided at sectoral level.

As in the previous scenario, the wage equations (21) and (22) allow us to close the system and find the equilibrium of the model.

---

[18]Indeed, it is easy to see that the average wage in the economy, $\phi\, w_a + (1-\phi)\, w_b$, is equal to the sum of the first two terms in (21) and (22).

Proposition 2 *There exists at least one steady-state equilibrium for the two-tier bargaining model.*

See Appendix C for the formal proof. Here we want to show that all the possible equilibria must exhibit the following features: $\theta_a < \theta_b$, $p_a > p_b$ and $w_a > w_b$. Type a firms with a larger amount of capital equipment exhibit a higher productivity, pay higher salaries but face a lower expected duration for a vacancy compared to firms of type b. To see why, we find convenient to put together the system of three main equations of the model, the two zero profit conditions (8) and the no arbitrage condition (11):

$$
\begin{aligned}
(1+\ell)\, p_a - w_a &= r k_a \frac{r + \delta + q(\theta_a)}{q(\theta_a)} \\
(1+\ell)\, p_b - w_b &= r k_b \frac{r + \delta + q(\theta_b)}{q(\theta_b)} \\
\frac{f(\theta_a)}{r + \delta + f(\theta_a)}\, (w_a - z) &= \frac{f(\theta_b)}{r + \delta + f(\theta_b)}\, (w_b - z)
\end{aligned}
\tag{23}
$$

Let consider the first two equations of the system, that are the zero profit conditions for each type of firm. Suppose the RHS in the first equation is lower than the RHS in the second equation. Since $k_a > k_b$ by assumption and both expressions are increasing in θ_i, this is equivalent to assume that $\theta_b > \theta_a$. Inserting the wage formulas (21) and (22) into the LHS of both equations, we should have $(1+\ell)(p_a - p_b) < \epsilon\ell(p_a - p_b)$, that is the case only if $p_a < p_b$. But this would imply that $w_a < w_b$. So in labour market b workers would earn higher wages and face a higher job finding rate $f(\theta_b) > f(\theta_b)$, that is not possible for the no arbitrage condition (the third equation in 23). Hence at the equilibrium the RHS in the first equation of (23) cannot be lower than the RHS in the second equation of (23).

Suppose instead that the RHS of the first two equations are equal. Again, since $k_a > k_b$ by assumption, this is equivalent to assume that $\theta_b > \theta_a$. But inserting the wage equations (21) and (22) into the LHS, we would obtain $p_a = p_b$ and $w_a = w_b$. This would go against the no arbitrage condition, as identical salaries would lead to identical labour market tightness.

Therefore, the possible equilibria of the system must entail that the RHS in the first

equation is greater than the RHS in the second equation. This implies $p_a > p_b$ and $w_a > w_b$. In labour market a wages are higher. For the no arbitrage condition, labour market tightness must be lower: $\theta_a < \theta_b$. Notice also that, for the demand equations in (5), $p_a > p_b$ means that $\phi < \frac{1}{2}$. As in the one-tier wage bargaining scenario, even under the two-tier bargaining model the number of firms with large capital equipment is lower than the ones with low capital equipment.

3.7 Two-Tier vs One-Tier Bargaining

Each worker is associated with k_i units of capital, so the average level of investment per worker is: $\bar{k} \equiv \phi k_a + (1 - \phi) k_b$. The following Proposition summarizes the results.

Proposition 3 *If $\beta < \min \left[\frac{1}{2}, \frac{1}{\sigma} \right]$ and $\frac{\eta}{1-\eta} > \frac{k_a}{k_b}$, the average level of investment for worker is greater under a two-tier than under a one-tier wage bargaining setting.*

The proof is in Appendix D. Here we provide the basic intuition behind the result and an interpretation for the sufficient conditions above. Passing from a one-tier bargaining system to a two-tier one generates two conflicting effects on the share of firms with large capital equipment in the economy, ϕ. This is because the two different costs faced by type a firms move in opposite direction: the cost of labour increases while the (opportunity) cost of capital goes down.

It is easy to see why, under a two-tier wage system, firms of type a suffer from higher labour costs. Under a one-tier bargaining scheme all workers are paid the same, according to the average productivity in the sector. Conversely, in a two-tier wage setting a fraction of the salary depends on the productivity of the single firm in which the worker is employed. As a comparison between the wage equations (16), (21), and (22) make clear, this means that firms with a larger level of capital and higher productivity have to pay higher wages compared to the less productive firms. Higher labour costs stifle the creation of vacancies of type a and tend to reduce the share of firms with large capital endowment in the economy. The average level of investment per worker should be lower.

On the other hand, a two-tier bargaining scheme lowers the opportunity cost of capital for firms of type a. While under the one-tier scenario wages are equal across markets, under a two-tier mechanism working in firms with a larger capital equipment becomes more enticing, as salaries are higher. More workers are willing to apply for a job of type a, reducing the expected duration of a vacancy and the opportunity cost of keeping capital idle. This second effect tends to raise the share of firms with large capital endowment in the economy, ϕ, and the average investment per worker, $\bar{k}$.

This second effect prevails if the two inequalities in Proposition 3 are fulfilled. Indeed, a large value for the elasticity η means that, given a certain increase in the number of job seekers, employers experience a substantial reduction in the expected duration of a vacancy. Capital remains unused for less time for type a firms. Notice that, since $k_a/k_b > 1$ by assumption, the first sufficient condition of Proposition 3 implies that η must be at least greater than 1/2. Moreover, if the bargaining power of workers' unions β is weak (at least lower than 1/2 according to the second inequality in Proposition 3), labour costs are just a small fraction of firms' revenues and the negative effect of wage costs on the creation of type a is less significant[19].

The empirical literature seems to confirm the plausibility of the conditions in Proposition 3, insofar as they require η being significantly larger (and β significantly lower) than 0.5. Justiniano and Michelacci (2012) obtain a value for η in the range $0.7 - 0.8$ by regressing the log job finding probability on the logged vacancy-unemployment ratio v/u for a group of OECD countries. Amaral and Tasci (2016) reach analogous results for a larger set of OECD countries. Their estimates for η are in the interval $0.58 - 0.78$[20].

As concerns workers' bargaining power β, the empirical findings are more ambiguous

---

[19]Hosios (1990) has shown that the efficiency of a decentralized equilibrium in a large class of search and matching models is guaranteeed by the equality $\eta = \beta$. So, if the sufficient conditions in Proposition 3 are respected, the resulting equilibrium is not efficient. This does not mean that such an outcome is unlikely. As Pissarides (2000, chapter 8) observes, " even with a Cobb-Douglas and constant η, there is no reason why β should be equal to η, since β is determined in a different environment and without reference to the structural properties of the matching technology".

[20]Petrongolo and Pissarides (2001) also conclude that "a plausible range for the empirical elasticity of unemployment η is 0.5 to 0.8", while Shimer (2005) obtains a value of 0.72 for the US labour market.

and a consensus has yet to emerge. If some researchers find convenient to set $\beta = 0.5$, other studies conclude for a much lower value. For instance, Cahuc et al. (2006) estimate a bargaining power between 0% and 20% for low-skilled workers and between 20% and 40% for skilled ones in France. Similarly, Amaral and Tasci (2016), following the same calibration procedure used by Hagedorn and Manovskii (2008) to explain US labour market data via a standard matching model, obtain values for β in twelve OECD countries that range from 0.02 to 0.37.

4 Concluding Remarks

In this paper, we have analyzed the relationship between unions, two-tier bargaining and investment in physical capital. Although two-tier wage bargaining schemes have become one of the most common features in labour markets of Continental Europe, recent research has put into question their efficiency. While most of the criticism concerns the negative effects of this kind of negotiation on employment and wages, our paper looks at the relation between wage formation and investment. We show that, in presence of sunk capital investment, a two-tier wage mechanism may indeed raise the level of investment per worker by pushing a higher number of firms with large capital endowment to enter the market.

The results of the model are also corroborated by some evidence, that shows, for a representative sample of Italian firms, the existence of a positive and robust correlation between the level of investment per worker and the presence of a two-tier bargaining agreement within the firm which tends to exactly counterbalance the negative correlation between investment and unionization.

Further research should consider the role of unions and different bargaining structures on the efficient allocation of resources. Previous literature has shown that other labour market institutions, as employment protection, have relevant effect on the (mis)allocation of labour inputs with implications for productive efficiency.

A Institutional Background and Data

A.1 Institutional Background

The Italian industrial and labor relations system is characterized by a two-tier bargaining (TTB) structure. The first level of bargaining is the national collective one, with contractual labour agreements that extend virtually *erga omnes* at the sectoral level; the second level is the decentralized one, with firm (or establishment) level agreements that supplement the national collective contracts. Decentralized agreements cannot prevail on national collective contracts, that constitute the minimum requirements (floors) in terms of wage agreements and working conditions. Still, when a decentralized contract is signed, it extends to all workers at the firm level. Second level bargaining has the main scope of increasing flexibility with a more direct link between wages and productivity; in this respect, decentralized contracts deal with other aspects of the employment relation that are not considered in collective contracts as for example the introduction of performance related pay schemes, work organization practices, hours of work arrangements and investment in training for workers. Most importantly, second level bargaining has asymmetric effects on wage flexibility, with the national collective contracts imposing a wage floor which cannot be overcome by downward wage adjustments at the decentralized level.

In this context, unions play a relevant role. The Italian law does not impose particular rules on the formation of unions and their organization structure, and workers can join them on individual voluntary basis. Moreover, for the union to be recognized, it is not necessary the approval of any employer (or of employers' associations), although management at the firm level can decide not to negotiate with them (except in cases explicitly required by the law, as for example in case of collective dismissals in firms above 50 employees). Still, the industrial relation system is very much structured along a corporatist regime, with the main national representative unions (CGIL, CISL and UIL) playing a predominant role in negotiating and

signing national collective agreements at the sectoral level.[21]

Union representation at the firm level takes place through the set up of RSA (Rappresentanze Sindacali Aziendali) or, more recently, RSU (Rappresentanze Sindacali Unitarie). Although the latter partially resemble traditional works councils (see Devicienti et al. (2018)), sharing with them some organizational arrangements, as for example the electoral rules for their constitution within the firm (which extends the right to vote to all employees), they also differ along some important dimensions. In fact, RSA and RSU can be set up in firms/establishments with more than 15 employees following the initiative of workers and support of unions that signed the national collective agreement taking place at the firm level. Moreover, members elected in RSA/RSU boards are chosen from different lists provided by the most representative union organizations at the local and national level, turning in a very strict connection between union representatives and works councils. As a matter of fact, the coordination of activities of works councils and unions is not formally shaped by the law, resulting in a single representation channel comprising both union and employees instances. In this context, both union and workers representative are actively involved in bargaining with firm management on various aspects of the business activities that are not already covered by national collective agreements.

Although RSA and RSU have the possibility to sign decentralized firm level agreements, this has to be done in conjunction with local union representatives within the the framework of the national collective agreement adopted at the firm level. Note also that second level bargaining may also take place at the individual level without considering union representatives.

A.2 Data

We use data from the ISFOL-RIL (Rilevazione Longitudinale su Imprese e Lavoro) Survey. The sample for year 2010 comprises about 22 thousands firms, extracted from the universe

---

[21]Typically, unions are mostly organized at the sectoral level, with union members having industry specific affiliations. Similar structure arrangements are established by employers' associations.

of Italian firms ASIA (Archivio Statistico Imprese Attive), which is made available by IS-
TAT (Italian Statistical Insitutute). The sampling procedure is based on firm size and it is
representative of the population of both the limited liability companies and partnerships in
the private (non-agricultural) sectors.

Table A1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Investment per worker	5,986	8119.205	17959.32	0	182942.8
Unions (RSA-RSU)	5,986	.494	.500	0	1
Two-Tier bargaining	5,986	.277	.447	0	1
National contract	5,982	.980	.140	0	1
Employers' association	5,970	.764	.424	0	1
Family firm	5,832	.687	.464	0	1
Management	5,942	.277	.448	0	1
Offshoring	5,986	.026	.160	0	1
Export	5,986	.372	.483	0	1
Share of workers in *cassaintegrazione*	5,980	.283	.451	0	1
Share of high skilled	4,351	.136	.196	0	1
Share of medium skilled	4,341	.403	.247	0	1
Share of low skilled	4,339	.461	.312	0	1
Share of female workers	5,986	.346	.268	0	1
Share of trained workers	5,727	.289	.354	0	1
Share of fixed term contracts	5,986	.111	.170	0	1
Size between 16 and 49	5,986	.566	.496	0	1
Size between 50 and 249	5,986	.320	.466	0	1
Size between 250 and above	5,986	.114	.318	0	1

Notes: Descriptive statistics have been calculated on the sample used in regression reported in column 1 in Table 1. See
Section A.2 for more details. Investment per worker is expressed in euros. Unions is a dummy for firms with a RSA-RSU in
place; National contract is a dummy for firms applying a national collective contract; Two-tier bargaining is a dummy for firms
with a second level bargaining agreement in place; Employers' association is a dummy for firms belonging to those associations;
Family firm is a dummy for firms run by families, while Management is a dummy for firms run by external managers; Offshoring
and Export are dummies for firms that are offshoring and exporting; Shares are calculated over total number of employees and
firms for size dummies respectively.

We begin with 24,459 observations for the year 2010. We first drop firms that have
negative sales, those that have zero (or below) employees (4,262 observations). From the
20,197 observations we drop 13,509 firms below 15 employees, then we are left with a potential
sample of 6,688 observations. In our regressions we also exclude firms whose investment per
worker is missing or above or equal the 99th percentile, are not operating in the market and
have some missing union information. The above restriction criteria correspond to about six
thousands observations with non missing investment information. Main regressions run on a
sample of 5,986 observations (or less) depending on missing data. Note also that when we
include information for the year 2007, the sample size drops to 4,057 observations.

B Existence of the Equilibrium in the One-Tier Wage Bargaining Case

Under one-tier bargaining, $\theta_a = \theta_b = \theta$. Putting together the two zero profit conditions in (8), we obtain the following expression:

$$\Phi^O(\phi) \equiv \frac{(1+\ell)\,p_b - w}{k_b} - \frac{(1+\ell)\,p_a - w}{k_a} = 0 \qquad (\text{B1})$$

The expression for the wage w is in (16) and it depends on just one endogenous variable, ϕ. So $\Phi^O(\phi) = 0$ is an implicit function in ϕ. If a solution for (B1) exists, all the other endogenous variables can be easily derived by the other equilibrium equations of the model. Knowing the expression for p_a and p_b (equations in 5), it is easy to see that, as $\phi \to 0$, we have $\Phi^O \to -\infty$. Moreover, when $\phi \to 1$, we have $\Phi^O \to +\infty$.[22] For a simple continuity argument, the RHS of (B1) must cross the horizontal axis at least once. So at least one equilibrium exists.

To find the conditions for the uniqueness of the equilibrium, we differentiate the RHS of (B1) with respect to ϕ. If such a derivative is always positive, there exists a unique value for ϕ satisfying equation (B1).

Denoting p'_i ($i \in \{a,\,b\}$) and w' the derivatives of prices and the wage with respect to ϕ, we have:

$$\frac{d\,\Phi^O}{d\,\phi} = \frac{(1+\ell)\,p'_b - w'}{k_b} - \frac{(1+\ell)\,p'_a - w'}{k_a}$$

From equations in (5) we have:

$$p'_a = -\frac{1}{\sigma}\frac{1}{\phi}\frac{1}{1-\phi}\,p_a\,p_b^{1-\sigma} < 0 \qquad \text{and} \qquad p'_b = \frac{1}{\sigma}\frac{1}{\phi}\frac{1}{1-\phi}\,p_b\,p_a^{1-\sigma} > 0$$

---

[22]Notice that $\lim_{\phi \to 0} p_a \to +\infty$, $\lim_{\phi \to 1} p_a = 1$, $\lim_{\phi \to 1} p_b \to +\infty$, and $\lim_{\phi \to 0} p_b = 1$. Moreover, using equations in (5), we have $\lim_{\phi \to 0} \phi\,p_a = 0$ and $\lim_{\phi \to 1}(1-\phi)\,p_b = 0$. From equation (16), this implies that $\lim_{\phi \to 0} w = \beta(1+\ell) + (1-\beta)z$ and that $\lim_{\phi \to 1} w = \beta(1+\ell) + (1-\beta)z$. The limit behaviour of function $\Phi^O(\phi)$ is then easily computed.

It can be shown that $-\phi\,p_a' = (1-\phi)p_b'$. So, from equation (16), we get:

$$w' = \beta(1+\ell)\left[p_a - p_b + \phi p_a' + (1-\phi)p_b'\right] = \beta(1+\ell)\left(p_a - p_b\right) > 0$$

The derivative is positive as we know that all the possible equilibria must have $p_a > p_b$. Then a sufficient condition for $\frac{d\Phi^O}{d\phi} > 0$ is

$$(1+\ell)\,p_b' - w' = (1+\ell)\left[\frac{1}{\sigma}\frac{1}{\phi}\frac{1}{1-\phi}\,p_b\,p_a^{1-\sigma} - \beta\,(p_a - p_b)\right] \geq 0. \tag{B2}$$

The inequality above can be rewritten as follows:

$$\frac{1}{\sigma}\,p_a^{1-\sigma} \geq \beta\,\phi\,(1-\phi)\left[\frac{p_a}{p_b} - 1\right]. \tag{B3}$$

From eq. (5), we have $p_a^{\sigma-1} = 1 + \frac{p_b}{p_a}\frac{1-\phi}{\phi}$. So inequality (B3) can be rearranged as follows:

$$\beta\,\sigma\left[\phi\,(1-\phi)\left(\frac{p_a}{p_b} - 1\right) + (1-\phi)^2\left(1 - \frac{p_b}{p_a}\right)\right] \leq 1$$

When $\sigma > 2$, the expression inside the square brackets is always lower than 1 (details are available on request). So a sufficient condition for (B2) is $\beta \leq \frac{1}{\sigma}$.

In the interval $1 \leq \sigma \leq 2$, the expression $\sigma\left[\phi\,(1-\phi)\left(\frac{p_a}{p_b} - 1\right) + (1-\phi)^2\left(1 - \frac{p_b}{p_a}\right)\right]$ reaches a maximum value of 2. Therefore a sufficient condition for (B2) is $\beta \leq \frac{1}{2}$.

Putting together the two conditions, we have that (B2) is verified (so that $\frac{d\Phi^O}{d\phi} > 0$ and the equilibrium is unique) if $\beta \leq \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$.

C   Existence of the Equilibrium in the Two-Tier Wage Bargaining Case

Consider the system (23). The first two equations can be expressed in terms of θ_i ($i \in \{a, b\}$):

$$\theta_i = \left[\frac{(1+\ell)\, p_i - w_i - rk_i}{rk_i\, (r+\delta)} \right]^{\frac{1}{\eta}} \tag{C1}$$

in which the formulas for w_a and w_b are in equations (21) and (22) respectively. Inserting equations (C1) into the third equation in (23) yields:

$$\begin{aligned}
\Phi^T(\phi) \equiv\ & \left[\frac{(1+\ell)\, p_a - w_a - rk_a}{rk_a\, (r+\delta)} \right]^{-\frac{1-\eta}{\eta}} + \\
& - \left[\frac{(1+\ell)\, p_b - w_b - rk_b}{rk_b\, (r+\delta)} \right]^{-\frac{1-\eta}{\eta}} \cdot \frac{w_a - z}{w_b - z} - \frac{w_a - w_b}{(r+\delta)(w_b - z)} = 0
\end{aligned} \tag{C2}$$

$\Phi^T(\phi) = 0$ is an implicit function of ϕ. If a solution for equation (C2) exists, then all the other endogenous variables can be easily determined.

Proceeding as in Appendix B we easily see as $\phi \to 0$, we have $\Phi^T \to -\infty$. Moreover, when $\phi \to 1$, we have that Φ^T tends to a positive finite number[23]. For a simple continuity argument, the RHS of (C2) must cross the horizontal axis at least once. So at least one equilibrium exists.

D   Proof of Proposition 3

Notice first that the equation determining ϕ in the two-tier setting, (C2), is identical to the equation determining ϕ in the one-tier equilibrium, (B1), when $\epsilon = 0$ so that $w_a = w_b = w$ and $\theta_a = \theta_b = \theta$.. The one-tier scenario is just a special case of the two-tier setting with

---

[23]With respect to what illustrated in footnote 5, the only difference is in the limit behaviour of wages w_a and w_b. Using equations (21) and (22) we get that $\lim_{\phi \to 0} w_a \to +\infty$, $\lim_{\phi \to 0} w_b = \beta(1+\ell) + (1-\beta)z$, $\lim_{\phi \to 1} w_b \to +\infty$, and that $\lim_{\phi \to 1} w_a = \beta(1+\ell) + (1-\beta)z$. Using these results, it is easy to find the limit behaviour of equation Φ^T.

$\epsilon = 0$. So, to evaluate the differences between the two scenarios, we perform a first-order Taylor expansion of equation (C2) when ϵ is close to 0:

$$\phi^T(\epsilon) = \phi(0) + \phi'(0) \cdot \epsilon,$$

in which ϕ^T denotes the equilibrium value of ϕ under the two-tier bargaining scenario. Since $\phi(0) = \phi^O$, that is the equilibrium value of ϕ under the one-tier bargaining scenario, we get that $\phi^T > \phi^O$ if $\phi'(0)$ is positive.

Applying the implicit function theorem, we have that $\phi'(0) = \frac{d\phi}{d\epsilon}\Big|_{\epsilon=0} = -\frac{d\Phi^T}{d\epsilon}\Big|_{\epsilon=0} / \frac{d\Phi^T}{d\phi}\Big|_{\epsilon=0}$.

The derivative at the denominator when $\epsilon = 0$ is:

$$
\begin{aligned}
\frac{d\Phi^T}{d\phi}\Big|_{\epsilon=0} &= -\frac{1-\eta}{\eta} \frac{\theta^{\eta-1}}{(1+\ell)p_a - w - rk_a} \left[(1+\ell)p'_a - w'\right] + \\
&+ \frac{1-\eta}{\eta} \frac{\theta_b^{\eta-1}}{(1+\ell)p_b - w - rk_b} \left[(1+\ell)p'_b - w'\right]
\end{aligned}
\tag{D1}
$$

Notice that, since we are evaluating such a derivative at $\epsilon = 0$, we have $\theta_a = \theta_b = \theta$ and $w_a = w_b = w$, as resulting at the equilibrium in the one-tier bargaining scenario. From Appendix B, a sufficient condition for the terms at the RHS to be positive is $\beta < \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$. Therefore, if $\frac{d\Phi^T}{d\epsilon}\Big|_{\epsilon=0} < 0$, we can conclude that passing fro a one-tier wage setting to two-tier one raises the share of large capital firms, ϕ.

Differentiating equation (C2) and using equation (C1), we get:

$$
\begin{aligned}
\frac{d\Phi^T}{d\epsilon}\Big|_{\epsilon=0} &= -\frac{dw_a}{d\epsilon}\left[-\frac{1-\eta}{\eta} \frac{\theta^{-1}}{(r+\delta)rk_a} + \frac{\theta^{\eta-1}}{w-z} + \frac{1}{(r+\delta)(w-z)}\right] + \\
&+ \frac{dw_b}{d\epsilon}\left[-\frac{1-\eta}{\eta} \frac{\theta^{-1}}{(r+\delta)rk_b} + \frac{\theta^{\eta-1}}{w_{-z}} + \frac{1}{(r+\delta)(w-z)}\right]
\end{aligned}
\tag{D2}
$$

From equations (21) and (22), we have $\frac{dw_a}{d\epsilon} = (1-\phi)\ell(p_a - p_b) > 0$ and $\frac{dw_b}{d\epsilon} = -\phi\,\ell(p_a - $

30

$p_b) < 0$. So, using equation (C1), equation (D2) can be written as:

$$\frac{d\,\Phi^T}{d\,\epsilon}\bigg|_{\epsilon=0} = -(1-\phi)\ell(p_a - p_b)\,\theta^{-1}\left[-\frac{1-\eta}{\eta}\frac{1}{(r+\delta)\,rk_a} + \frac{1}{w-z}\frac{r+\delta+f(\theta)}{r+\delta}\frac{(1+\ell)p_a - w - rk_a}{rk_a(r+\delta)}\right] +$$

$$- \phi\,\ell(p_a - p_b)\,\theta^{-1}\left[-\frac{1-\eta}{\eta}\frac{1}{(r+\delta)\,rk_b} + \frac{1}{w-z}\frac{r+\delta+f(\theta)}{r+\delta}\frac{(1+\ell)p_a - w - rk_a}{rk_a(r+\delta)}\right] =$$

$$= -(1-\phi)\ell(p_a - p_b)\frac{\theta^{-1}}{(r+\delta)\,rk_a}\left[-\frac{1-\eta}{\eta} + \frac{(1+\ell)p_a - w - rk_a}{w-z}\frac{r+\delta+f(\theta)}{r+\delta}\right] +$$

$$- \phi\,\ell(p_a - p_b)\frac{\theta^{-1}}{(r+\delta)\,rk_a}\left[-\frac{1-\eta}{\eta}\frac{k_a}{k_b} + \frac{(1+\ell)p_a - w - rk_a}{w-z}\frac{r+\delta+f(\theta)}{r+\delta}\right]$$

It is easy to see that both sums of the terms inside the square brackets are positive if

$$\frac{1-\eta}{\eta}\frac{k_a}{k_b} \leq 1 \;\Leftrightarrow\; \frac{\eta}{1-\eta} \geq \frac{k_a}{k_b} \tag{D3}$$

and

$$(1+\ell)p_a - w - rk_a \geq w - z \tag{D4}$$

Using the wage equation (16), and denoting average productivity $\bar{p} \equiv \phi p_a + (1-\phi)p_b$, inequality (D4) can be written as follows:

$$(1+\ell)p_a - 2\beta(1+\ell)\bar{p} + z\left[1 - 2(1-\beta)\right] - rk_a \geq 0 \;\Leftrightarrow$$

$$(1+\ell)(p_a - \bar{p}) + (1-2\beta)\left[(1+\ell)\bar{p} - z\right] - rk_a \geq 0$$

Recall that at the equilibrium $p_a > \bar{p} > p_b > 1$ and that we have imposed that $z < 1$ and $rk_a < \ell/2$. So inequality (D4) is satisfied if $\beta \leq \frac{1}{2}$. We have already imposed that $\beta \leq \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$ in order to have $\frac{d\,\Phi^T}{d\,\phi}\big|_{\epsilon=0} > 0$, so the condition $\beta \leq \frac{1}{2}$, that is less strict, is superfluous.

We conclude that if $\frac{\eta}{1-\eta} \geq \frac{k_a}{k_b}$ and $\beta \leq \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$ the derivative $\phi'(0) = \frac{d\,\phi}{d\,\epsilon}\big|_{\epsilon=0} > 0$ and passing to a two-tier wage mechanism raises ϕ and the average level of investment per capita.

References

Acemoglu, D. (2001). Good Jobs versus Bad Jobs. *Journal of Labor Economics*, 19:1–21.

Addison, J. T., Schank, T., Schnabel, C., and Wagner, J. (2007). Do works councils inhibit investment? *Industrial and Labor Relations Review*, 60(2):187–203.

Addison, J. T., Teixeira, P., Evers, K., and Bellmann, L. (2017). Collective bargaining and innovation in germany: a case of cooperative industrial relations? *Industrial Relations: A Journal of Economy and Society*, 56(1):73–121.

Amaral, P. and Tasci, M. (2016). The cyclical behavior of equilibrium unemployment and vacancies across oecd counties. *Europena Economic Review*, 84:184–201.

Barth, E., Moene, K. O., and Willumsen, F. (2014). The scandinavian model–an interpretation. *Journal of Public Economics*, 117:60–72.

Boeri, T. (2014). Two-tier bargaining. *IZA Discussion Paper* No.8358.

Boeri, T. and Bruecker, H. (2011). Short-time work benefits revisited: some lessons from the great recession. *Economic Policy*, 26(68):697–765.

Braun, S. (2011). Unionisation structures, productivity and firm performance: New insights from a heterogeneous firm model. *Labour Economics*, 18(1):120–129.

Cahuc, P., Postel-Vinay, F., and Robin, J. M. (2006). Wage Bargaining with On-the-Job Search: Theory and Evidence. *Econometrica*, 74, No. 2:323–364.

Calmfors, L. and Driffil, J. (1988). Bargaining Structure, Corporatism, and Macroeconomic Performance. *Economic Policy*, 6:12 – 61.

Card, D., Devicienti, F., and Maida, A. (2014). Rent-sharing, holdup, and wages: Evidence from matched panel data. *Review of Economic Studies*, 81(1):84–111.

Cardullo, G., Conti, M., and Sulis, G. (2015). Sunk capital, unions and the hold-up problem: Theory and evidence from cross-country sectoral data. *European Economic Review*, 76:253–274.

Cingano, F., Leonardi, M., Messina, J., and Pica, G. (2010). The effects of employment protection legislation and financial market imperfections on investment: evidence from a firm-level panel of eu countries. *Economic Policy*, 25(61):117–163.

de Pinto, M. (2017). The impact of unionization structures with heterogeneous firms and rent-sharing motives. *Scandinavian Journal of Economics*.

Devicienti, F., Manello, A., and Vannoni, D. (2017). Technical efficiency, unions and decentralized labor contracts. *European Journal of Operational Research*, 260(3):1129–1141.

Devicienti, F., Naticchioni, P., and Ricci, A. (2018). Temporary employment, demand volatility and unions: Firm-level evidence. *Industrial and Labor Relations Review*, 71(1):174–207.

Garnero, A., Rycx, F., and Terraz, I. (2018). Productivity and wage effects of firm-level collective agreements: Evidence from belgian linked panel data. *Working Papers CEB*, 18.

Grout, P. A. (1984). Investment and wages in the absence of binding contracts: A nash bargaining approach. *Econometrica*, pages 449–460.

Hagedorn, M. and Manovskii, I. (2008). The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited. *The American Economic Review*, 98:1692 – 1706.

Haucap, J. and Wey, C. (2004). Unionisation structures and innovation incentives. *Economic Journal*, 114(494):149–165.

Hirsch, B. T. (2004). What do unions do for economic performance? *Journal of Labor Research*, 25(3):415–455.

Hosios, A. J. (1990). On the efficiency of matching and related models of search and unemployment. *Review of Economic Studies*, 57:279–298.

Jimeno, J. F. and Thomas, C. (2013). Collective bargaining, firm heterogeneity and unemployment. *European Economic Review*, 59:63–79.

Jirjahn, U. and Mohrenweiser, J. (2016). Owner-managers and the failure of newly adopted works councils. *British Journal of Industrial Relations*, 54(4):815–845.

Justiniano, A. and Michelacci, C. (2012). The cyclical behavior of equilibrium unemployment and vacancies in the united states and europe. In *NBER International Seminar on Macroeconomics*. University of Chicago Press, vol. 8(1), pages 169-235.

Krusell, P. and Rudanko, L. (2016). Unions in a frictional labor market. *Journal of Monetary Economics*, 80:35–50.

Malcomson, J. M. (1997). Contracts, hold-up, and labor markets. *Journal of economic literature*, 35(4):1916–1957.

Menezes-Filho, N. and Van Reenen, J. (2003). *Unions and innovation: a survey of the theory and empirical evidence*, chapter 9, pages XXX–XXX. International Handbook of Trade Unions. Edward Elgar.

Petrongolo, B. and Pissarides, C. (2001). Looking into the black box: A survey of the matching function. *Journal of Economic Literature*, 39:716–741.

Pissarides, C. A. (2000). *Equilibrium unemployment theory*. MIT press.

Santos Silva, J. M. C. and Tenreyro, S. (2006). The log of gravity. *The Review of Economics and statistics*, 88(4):641–658.

Shimer, R. (2005). The Cyclical Behavior of Equilibrium Unemployment and Vacancies. *The American Economic Review*, 95:25–49.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.