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

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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 wage bargaining scheme, where a fraction of the wage is negotiated at firm level, raises the amount of investment per worker in the economy compared to a one-tier bargaining scheme, in which the 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.
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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. 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 more 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' and firms' unions 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" (see Boeri (2014)) applies. 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.

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, Conti, and Sulis (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 large capital firms will enter the market, raising the average level of investment per worker in the economy.

We support our theoretical findings providing some motivating evidence. In particular, we use RIL (Rilevazione Longitudinale su Imprese e Lavoro) firm level data provided by INAPP for a representative sample of Italian firms in the private (non-agricultural) sector for the year 2010 in order to provide supporting evidence on the mechanisms discussed above. In particular, we estimate a set of investment equations using Poisson quasi-maximum likelihood techniques, controlling for industry and region fixed effects, for a standard set of firm level demographics as well as for the existence of a work council within the firm. 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 a lack of a convincing quasi natural experiment.[2] Interestingly, we also find 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, Hirsch (2004), points out towards 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, Devicienti, and Maida (2014), using Italian data, finds a very small role for the hold-up mechanism.[3] Conversely, Cardullo, Conti, and Sulis (2015) study the hold-up problem

[2]Nevertheless, we also implement a control function approach as a first attempt to deal with endogeneity concerns.

[3]A recent paper by Devicienti, Manello, and Vannoni (2017) studies the role of unions and decentralized

and find, using cross-country cross-sector data, that powerful unions reduce investment per worker particularly in sunk capital intensive industries.

Second, the paper is related to theoretical studies that analyze the effects of different bargaining mechanism (centralized and decentralized) on labour market outcomes. Using a search and matching framework, Krusell and Rudanko (2016) 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). Using the same theoretical framework, Jimeno and Thomas (2013) construct a model with firm level productivity shocks and find that unemployment is lower under decentralized equilibrium than under sector level bargaining. Using a different theoretical framework, de Pinto (2017) analyzes the effect of different unionization structures on wages, employment and output. The model features firm heterogeneity with rent sharing and free entry. Under sector level bargaining, low productivity firms pay higher wages than under firm level bargaining, viceversa, high productivity firms pay lower wages. However, total profits increase as the gains of the high productivity firms are larger. With free entry, new firms enter the market with more competition thus making less productive firms to exit. Average productivity thus increases (firm selection effect) offsetting the markup effect (under sector level bargaining, higher markup is possible because there is less competition).[4]

Finally, the paper is related to a series of studies that explicitly analyze the role of two-tier bargaining. A recent study by Boeri (2014) analyzes the effects of two-tier bargaining structures on different outcomes (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 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

labour contracts on technical efficiency in Italy.

[4]Related papers also include Braun (2011) and Haucap and Wey (2004).

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 only improve the utility of the unions, but not of the firm. The paper also provides some descriptive evidence in this respect. A recent study by Garnero, Rycx, and Terraz (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 degree of competition in the sector. Their bottom line is that two-tier systems, by increasing both wages and productivity, benefit both workers and firms.

We contribute to the literature in three 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 contract 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. Third, we investigate alternative empirical modelling strategies with respect to the previous literature in the field and we also try to investigate the role of endogeneity for the variables of interest.

The remainder of the study is organized as follows. In Section 2 we provide motivating evidence, in Section 3 we present the theoretical model with different wage setting structures, in Section 4 we provide conclusions. We gather information on the institutional background and the data in the Appendix, where we also include additional proofs of the theoretical model and some additional results.

2 Motivating evidence

2.1 Estimation and Identification

In order to evaluate the impact of unions and two-tier bargaining on 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.[5] $Union$ is a measure of union power, which is proxied by a dummy variable equal to one for firms with an established worker council, TTB is a dummy variable equal to 1 in the case of firms where a two-tier bargaining agreement was in place and X_i is a set of controls at the firm level.[6] 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.[7]

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 to estimate equation (1) might lead to biased and inconsistent parameter estimates.[8]

Most empirical researchers have estimated the above equation by Tobit. However, in

[5] 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, Conti, and Sulis (2015)) unions are expected to affect investment per worker (see also Cingano et al. (2010)). Main results are however robust to using investment rate as dependent variable.

[6] In the vector X_i we consider various firms characteristics that could be important to control for in a reduced-form investment equation because they could explain both investment decisions as well as the strength of unions and/or the presence of decentralized bargaining, such as dummies for exporting firms or for firms that had already offshored some of their activities; dummies for workers human capital, etc.

[7] We consider three size categories, namely 16-49; 50-249 and more than 250 employees, with 16-49 being the omitted category. We prefer controlling for size effects using broader size categories instead of number of employees because the latter is more likely to be endogenous in an investment equation, as firms might react to an unobserved shock to, say, productivity, by raising both investment and employment. By way of contrast, the (quite wide) size categories we consider are more likely to be exogenous in an investment equation.

[8] See section A.2 in the Appendix for a description of the data and main variables.

order to apply Tobit to a corner solution outcome one needs to assume that the conditional distribution of the error term is normally distributed with constant variance, which are usually considered quite strong assumptions and that are not verified in our model[9]. Recently, a number of authors (see, for instance, Santos Silva and Tenreyro (2006) or Wooldridge (2010)) have proposed to deal with corner solution outcomes when the Tobit assumptions fail by assuming an exponential distribution for the conditional mean and then estimating the model by Poisson quasi-maximum likelihood techniques. It is important to note that, if one applies Poisson quasi maximum likelihood techniques, 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): indeed, investment per worker cannot follow a Poisson distribution by definition. 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.[10] Therefore, in this study we use Poisson quasi maximum likelihood techniques to estimate equation (1) above, although results are broadly robust to using Tobit.

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: indeed, unions are probably more likely to sign a decentralized agreement if the firm is expected to have higher profits (in order to share these profits through pecuniary and non-pecuniary benefits), introducing a possibly spurious positive correlation between TTB and investment per worker; moreover, 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, Manello, and Vannoni (2017) who argue that, in the Italian institutional context, it is unlikely that unions target the most profitable firms, especially when firm heterogeneity

[9]We have used the user-written STATA command `bctobit` which leads us to strongly reject the null hypothesis of homosckedasticity and normality underlying the Tobit model

[10]As noted by Wooldridge (2010), "the consistency of Poisson quasi-maximum likelihood does not require any additional assumptions concerning the distribution of y given X."

has already being controlled for. 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.[11] 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. Nevertheless, one might not be entirely convinced by this line of reasoning, because of unobserved heterogeneity (e.g. associated to firms with relatively higher growth opportunities, even within narrowly defined sectors, or endowed with better management) that could both lead to more investment per worker and to a higher likelihood of setting up a work council.

Unfortunately, we do not have clear cut exclusion restrictions for TTB and $Union$ following from a quasi natural experiment deriving from the institutional rules: however, following Devicienti, Naticchioni, and Ricci (2018) and Jirjahn and Mohrenweiser (2016), we have experimented using, as instruments, the average probability of RSU-RSA 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 work council) in a given industry-region cell positively predicts current presence of a two-tier decentralized agreement (work council) within the firm.[12]

In particular, we follow Wooldridge (2010) who shows that, under certain quite general assumptions, a control function approach can be used to deliver consistent parameter estimates when estimating a regression model with endogenous variables in a Poisson quasi maximum likelihood estimation framework. Indeed, Wooldridge (2010) shows that a two step-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

[11] We refer to section A.1 in the Appendix for an overview of the institutional background.

[12] For instance, setting up union representation requires the help of trade unions local branches: therefore, in sectors and regions with a strong union presence it is more likely that an RSU is set up in a given firm. Similarly, the presence of a decentralized labour contract in a given region-sector cell can spur imitations in local firms within the same sector.

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, a test for endogeneity is easily performed by testing whether residuals are equal to zero: if one cannot reject the null hypothesis, then one can conclude that there is no major indication that the regressors are endogenous.

2.2 Main Results

In all regression specifications we include a full set of 69 industry dummies, 20 region dummies as well as a set of firm size dummies. 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 in Italy.

In column 1 of Table 1 we only include the unionization variable, omitting the decentralized agreement dummy. The empirical estimates suggest the existence of a negative correlation between unionization and investment per worker, although the union coefficient is poorly estimated. However, as we noted in the Introduction, unionization is strongly correlated with the existence of a decentralized bargaining agreement and, if the latter tends to generate a more favorable environment for investment, its omission might lead to a bias toward zero in the coefficient of the union variable.

In column 2 we include a dummy equal to 1 for those firms where a two-tier bargaining was in place. Interestingly, we note that the coefficient of unionization goes up in absolute value and it is now statistically significant at 10%. In particular, the existence of a work council 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 worker.

In the next regressions we probe the robustness of these results along various dimensions. First, in columns 3 we include a full set of collective agreements fixed effects. Indeed, there is

Table 1: Baseline regressions for investment per worker. Poisson model with dummy works council

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
works council (RSA-RSU)	-0.155	-0.237*	-0.349***	-0.315**	-0.271**	-0.272**	-0.229*	-0.327**	-0.578*
	(0.127)	(0.136)	(0.112)	(0.161)	(0.131)	(0.128)	(0.139)	(0.160)	(0.325)
two-tier bargaining		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)
works council × 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 works council									0.230
									(0.367)
residual two-tier bargaining									-0.403
									(0.694)
Size dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Collective contract dummies	No	No	Yes	No	No	No	No	No	No
Sector x Region dummies	No	No	No	No	No	No	No	No	No
Constant	9.462***	9.390***	9.642***	9.370***	9.247***	9.584***	9.615***	9.585***	
	(0.287)	(0.293)	(0.435)	(0.292)	(0.547)	(0.806)	(0.787)	(0.781)	
Observations	6,009	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. We use weights. Number of sectors in column 9 is equal to 69. See Section A.2 in the Appendix for more details.

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 4 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 5-8 we show that these results are robust to including additional control variables that could explain investment per worker. First, in column 5 we include controls related to the firm workforce composition, such as the share of workers by age group (younger than 25, between 26 and 34 and between 35 and 49), education level (high skilled and medium skilled, low skilled is the omitted category), gender, training provisions and presence of fixed-term contracts. Then, in column 6 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 dummy variables that are meant to capture other firm characteristics that could be important determinants of the levels of investment per worker, 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, 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.[13] As long as these variable are both

[13] 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 with a workforce above 15 and 50 employees respectively. Depending on the nature of the redundancy problem the firm is facing, there are different CIG categories. See Boeri and Bruecker (2011) for the effects of the STW during the economic crisis and further discussion.

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.[14] Regression results in column 7 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.[15]

Finally, in columns 9 we address possible endogeneity concerns using the control function approach described in Section 2.1 above. We consider a regression without the possibly endogenous covariates, in order to avoid a bad control problem.[16] The first stage results (which are not reported but are available from the authors upon request) show that the share of firms with a work council (the share of firms with a two-tier level agreement) in the industry-region cell in 2007 is positively correlated with the probability that a given firm in 2010 has an work council (a two-tier bargaining agreement in place). Regression results confirm that unionization has a negative and statistically significant impact on investment per worker, while the coefficient of the two-tier bargaining agreement dummy is positive but imprecisely estimated.[17] However, the two residual terms are individually and jointly statistically insignificant. If one believes on the validity of the exclusion restrictions and the first stages, this is an indication that the union and two-tier dummies are exogenous in our model: in this case, the Poisson quasi-maximum likelihood estimator in column 2 should be more efficient than the corresponding control function estimator, and therefore it is not surprising that the estimates in the latter have larger standard errors.

[14]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

[15]In column 8 we report results for regressions in which we include all controls and the interaction term between works councils and two-tier bargaining, our results are broadly confirmed.

[16]See Deuchert and Huber (2017) for an analysis of possible pitfalls associated to the use of improper controls in IV regressions.

[17]In order to deal with the generated regressor problem, we have computed standard errors by bootstrapping (and clustering by industry).

In the remainder of this section, we describe some additional robustness checks that we have performed on our baseline regression in column 2.[18] First, we have checked that our results are robust to excluding firms that do not apply a national collective contract or that have a labour productivity below or above the 1 and 99 percentile, respectively. Second, we have run our regression without using the sample weights. Third, we have excluded the firms with the highest increase an decrease in employment between 2009 and 2010.[19] In each case our main results are confirmed. Finally, we have run our main regressions in columns 1-8 with Tobit and OLS and we broadly find similar evidence to that reported in this Section.

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:

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

[18] Results are not reported but are available upon request.

[19] In practice, we have computed the rate of growth of employment between end of 2009 and the time of the interview in 2010. We have then computed the 1 percentile and the 99 percentile and kept only the firms within these percentiles. We do this in order to focus only on firms with a relatively stable employment.

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

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

$$p_b = \left[1 + \left(\frac{\phi}{1-\phi}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}}. \tag{6}$$

3.2 Investment decision and free-entry condition

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

$$r\Pi_i^E = (1+\ell)p_i - w_i + \delta\left[\Pi_i^V - \Pi_i^E\right] \tag{7}$$

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

$$r\Pi_i^V = q(\theta_i)\left[\Pi_i^E - \Pi_i^V\right] \tag{8}$$

for $i \in \{a, b\}$. As in Acemoglu (2001), we assume for simplicity that there are no flow vacancy costs[20]. 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

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

are nonnegative. Since they have to buy k_i in advance, this implies $\Pi_i^V = k_i$ for $i \in \{a, b\}$. So, rearranging eqs. (7) and (8) yields:

$$\frac{(1+\ell)\,p_i - w_i}{r + \delta + q(\theta_i)} = \frac{r k_i}{q(\theta_i)} \tag{9}$$

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 rk_i multiplied by the expected duration of a vacancy, $1/q(\theta_i)$.

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:

$$r J_i^U = z + f(\theta_i)\left[J_i^E - J_i^U \right]. \tag{10}$$

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 $z < 1+\ell$. This ensures that 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:

$$r J_i^E = w_i + \delta\left[J_i^U - J_i^E \right] \tag{11}$$

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 (10) and (11) we have:

$$\frac{f(\theta_a)}{r + \delta + f(\theta_a)}\,(w_a - z) = \frac{f(\theta_b)}{r + \delta + f(\theta_b)}\,(w_b - z) \tag{12}$$

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

$$w_i \equiv \omega + d_i \cdot \ell, \tag{13}$$

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[21]. 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 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.

[21]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.

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:

$$rU^W = e_a\,(\omega + d\cdot\ell\,) + e_b\,(\omega + d\cdot\ell\,) \tag{14}$$

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

$$\begin{aligned} rU^F &= e_a\,[\,(1+\ell)p_a - \omega - d\cdot\ell\,] + \\ &+ e_b\,[\,(1+\ell)p_b - \omega - d\cdot\ell\,] \end{aligned} \tag{15}$$

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:

$$w \,=\, \omega\,(1+\ell) \tag{16}$$

with $i \in \{a, b\}$. Using equations (14), (15), and the expressions for $\bar{U}^W$ and $\bar{U}^F$ yields:

$$w \cdot e \,=\, \beta\,(1+\ell)\,[\,e_a\,p_a \,+\, e_b\,p_b\,] \,+\, (1-\beta)\,z \cdot e \tag{17}$$

Unions at sectoral level choose a value for w such that the total wage bill (the LHS of 17) is a weighted average between the total revenues raised in the intermediate industries and the aggregate amount of home production (the RHS of 17). The weight is given by workers' union bargaining power β. Dividing both sides of (17) by e, we have:

$$w \,=\, \beta\,(1+\ell)\,[\,\phi\,p_a \,+\, (1-\phi)\,p_b\,] \,+\, (1-\beta)\,z \tag{18}$$

Thanks to the wage equation (18), we are able to close the model under one-tier bargaining. Indeed, after inserting (18) into the zero profit conditions (9) and the no arbitrage condition (12), 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* $\beta \,<\, \min\left[\,\frac{1}{2},\, \frac{1}{\sigma}\,\right]$, *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 (12), an identical pay ($w_a \,=\, w_b \,=\, w$) 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 (9) are satisfied only if firms in a earn higher revenues, that is the price of the intermediate good a is higher than the price of the intermediate good b: $p_a > p_b$. For the demand equations (5) and (6), 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 low 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 $\beta < \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$ for the uniqueness of the equilibrium depends on the wage equation (18) 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.[22] So, a larger share of high-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.[23] 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 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

[22] See Appendix B.

[23] 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.

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. The former is equal to:

$$r\bar{J}_i^E \;=\; \omega \,+\, \delta \left[\, J_i^U \,-\, J_i^E \,\right] \tag{19}$$

for $i \in \{a, b\}$. The latter is given by.

$$r\bar{\Pi}_i^E \;=\; p_i \,-\, \omega \,+\, \delta \left[\, \Pi_i^V \,-\, \bar{\Pi}_i^E \,\right] \tag{20}$$

for $i \in \{a, b\}$. 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, we think it would be too extreme to consider the values of unemployment and of an unfilled vacancy as fall-back positions in a negotiation over just a fraction of the wage. 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:

$$\epsilon \cdot \left(\, \Pi_i^E \,-\, \bar{\Pi}_i^E \,\right) \;=\; (1 \,-\, \epsilon) \cdot \left(\, J_i^E \,-\, \bar{J}_i^E \,\right) \tag{21}$$

for $i \in \{a, b\}$. Using eqs. (7), (11), (19), and (20), we get:

$$d_i \;=\; \epsilon \, p_i \tag{22}$$

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 (14), (15), and the expressions for $\bar{U}^W$ and $\bar{U}^F$, we get:

$$e_a \, w_a \,+\, e_b \, w_b \,=\, \beta \, (1+\ell) \, [\, e_a \, p_a \,+\, e_b \, p_b \,] \,+\, (1-\beta) \, z \cdot e \tag{23}$$

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 (23) by e and using equations (13) and (22) we get:

$$w_a \;=\; \beta \, (1+\ell) \, [\, \phi \, p_a \,+\, (1-\phi) \, p_b \,] + (1-\beta) \, z \,+\, \epsilon (1-\phi) \, \ell \, (\, p_a - \, p_b \,) \tag{24}$$

$$w_b \;=\; \beta \, (1+\ell) \, [\, \phi \, p_a \,+\, (1-\phi) \, p_b \,] + (1-\beta) \, z \,+\, \epsilon \, \phi \, \ell \, (\, p_b - \, p_a \,) \tag{25}$$

The first two terms at the RHS in (24) and (25) are identical and coincide with the wage equation (18) 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. Indeed, it is easy to see that the first two terms in (24) and (25) are equal to the average wage in the economy:

$$\phi \, w_a \,+\, (1-\phi) \, w_b \,=\, \beta \, (1+\ell) \, [\, \phi \, p_a \,+\, (1-\phi) \, p_b \,] \,+\, (1-\beta) \, z \tag{26}$$

Wage differences depend on the third terms at the RHS of (24) and (25). 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 (24) and (25) allow us to close the system and find the equilibrium of the model.

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

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 (9) and the no arbitrage condition (12):

$$\begin{aligned} (1+\ell)\, p_a - w_a &= rk_a \frac{r + \delta + q(\theta_a)}{q(\theta_a)} \\ (1+\ell)\, p_b - w_b &= rk_b \frac{r + \delta + q(\theta_b)}{q(\theta_b)} \\ \frac{f(\theta_a)}{r + \delta + f(\theta_a)}\,(w_a - z) &= \frac{f(\theta_b)}{r + \delta + f(\theta_b)}\,(w_b - z) \end{aligned} \tag{27}$$

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 (24) and (25) 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 27). Hence at the equilibrium the RHS in the first equation of (27) cannot be lower than the RHS in the second equation of (27).

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 (24) and (25) 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 (5) and (6), $p_a > p_b$ 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. The condition for the uniqueness of the equilibrium is the same we imposed in the one-tier bargainng scenario. The rationale for that is the same expressed at the end of the previous section.

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 both scenarios admit a unique equilibrium and*

$$\eta \geq \beta + z \cdot \frac{1-\beta}{1+\ell} + \frac{1}{2}\left(\frac{k_a}{k_b} - 1\right),$$

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 condition 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 (18), (24), and (25) 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 a one-tier scenario all jobs are paid the same, 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 inequality in Proposition 3 is 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. Moreover, if the bargaining power of workers' unions β is weak or the value of home production relative to market production $z/(1+\ell)$ is low, 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.

Finally, condition in Proposition 3 also requires that the capital ratio k_a/k_b must not be high. To understand why, recall that large differences in capital equipment translate in two a big productivity gap. So, if k_a were much larger than k_b, the wage firms of type b need to pay (that is a function of the average productivity in the economy) would be so high that just a few vacancies v_b out of total job openings would be posted. In this limit case, when

ϕ is already close to 1, it is possible there would not be room for any additional increase in the share of high-capital firms.

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, the present 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 inducing more large capital high productive firms to enter the market.

In our model, the investment in capital equipment is made before a job vacancy is posted and the wage negotiation occurs, so that the model features an hold-up mechanism. In such a setting we consider two different wage scenarios. In the one-tier wage bargaining, earnings are uniquely determined by workers' and firms' unions at sectoral level; while in the second one, a fraction of the wage is negotiated at firm level after the sectoral negotiation has taken place. 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 results of the theoretical part are also corroborated by our empirical analysis, 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 legislation, has relevant effect on the (mis)allocation of labour inputs with implications in terms of 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.[24] The first level of bargaining is the national collective one, with contractual labour agreements that extend virtually *erga omnes*; the second level is the decentralized one, with firm (or establishment) level agreements that supplement the national collective contracts.[25] Since very recently, and for our period of analysis, decentralized agreements could not 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.

The introduction of the two-tier bargaining system in Italy is very related to the persistent stagnation in productivity growth that has been taking place in the country during the last two decades. While national collective contracts deal with main issues related to wage and working conditions, 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 particular relevant role. The Italian law does not impose particular rules on the formation of unions and their general 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.[26]

Union representation at the firm level takes place through the set up of RSA (Rap-

[24] Important legislative changes have occurred in the immediate period after the last available year of our survey. See D'Amuri and Giorgiantonio (2014) for a discussion.

[25] Second level bargaining may take place either at firm, occupational or territorial level. However, more than 87% percent of decentralized labor contract takes place at the firm level in our sample (see more below). For the remainder of the paper we consider interchangeably firm level agreements and decentralized labor contracts.

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

presentanze Sindacali Aziendali) or, more recently, RSU (Rappresentanze Sindacali Unitarie). Although the latter partially resemble traditional works councils, 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 not already covered by national collective agreements.[27]

A.2 Data

We use data from the ISFOL-RIL (Rilevazione Longitudinale su Imprese e Lavoro) Survey.[28] The sample comprises about 22 thousands firms on the national territory, extracted from the universe of Italian firms ASIA (Archivio Statistico Imprese Attive), which is made available by the ISTAT (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.

The dataset allows us to study the relations of interest as comprises valuable information on the industrial relation system, as for example, the presence of unions, the number of union members in the workplace, and various variables concerning the level of bargaining and additional information on contractual labour agreements. The survey contains also information on the composition of the workforce in terms of skills and types of contracts for workers. On the firm side, although the dataset is quite rich in terms of variables related to firms activity, as for example, their export, innovation or offshoring, only limited information is available concerning balance sheets data. In particular, among the others, we have information on the expenditures in physical capital investment and sales.[29]

[27]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.

[28]ISFOL is the acronym for the Istituto per lo sviluppo della formazione professionale dei lavoratori. The Institute has been recently named INAPP, Istituto Nazionale per l'Analisi delle Politiche Pubbliche. Its main activities are oriented towards research, monitoring and public policy evaluation. It constitutes a building block in supporting activity of policy making by the Ministry of Labor and Social Affairs.

[29]Both Devicienti, Manello, and Vannoni (2017) and Devicienti, Naticchioni, and Ricci (2018) use

Although the survey has been conducted for three years (2005, 2007 and 2010), and a panel version of the dataset is in principle available for a limited number of firms, we decide to use only the 2010 wave (with limited use of some reliable information available for the year 2007). The reasons for this choice are of different kind. First, in 2005 and 2007 different sectoral classifications are adopted, comprising an important loss of details with respect to the sectoral classification used in 2010.[30] Second, some control variables are only available for the year 2010, as for example the skill and age distributions of workers or information concerning the control and management of firms. Third, the panel version of the dataset comprises only a very limited number of firms that are followed for the three years (less than 20% of the total) comprising a too severe loss in terms of observations and related problems in terms of representativeness of our sample.

In what follows we describe our sample selection procedure. We begin with 24,459 observations for the year 2010, then we append the year 2007, which comprises 24,230 observations (hence we have 48,689 observations for two years). The number of firms observed is the following: 13,212 firms observed for 2 years, 11,247 observed only in 2010 and 11,018 observed only in 2007. However, for the reasons state above, we decide to work only on the year 2010, using only some information for the firms present in 2007. We first drop firms that have negative sales (no observations), those that have zero (or below zero) employees in 2010 (4,114 observations), and those that in 2009 have below zero employees (148 observations). After dropping the above observations we end up with 44,427 observations (remind that 24,230 obs are for the year 2007). Hence we have 20,197 observations for the year 2010. Note that 13,509 are 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 missing union density. The above restriction criteria correspond to 6,005 observations, which is the sample size of our baseline regression. Other regressions run on a sample of 5,981 observations (or less) depending on missing data. Note also that when we include some lagged controls for the year 2007, the sample size drops to 4,057 observations.

In our sample, about 66% of the firms invest positive amounts in physical capital, while the remaining 34% do not. The average investment per worker is equal to about 8000 euros. Union density is around 21%, while RSA-RSU (Union dummy) are present in about half of the firms in our sample.

this data as a primary source of information to study the relationship between unions and productivity and unions and temporary contracts, respectively. Using social security codes, the authors are able to match other source of data with additional information on balance sheets. Unfortunately, for confidentiality reasons, the current version of the databases does not contain social security codes and does not allow us to match other sources of data.

[30]Unfortunately, the number of sectors in previous waves is much smaller than in the 2010 wave, hence we are not even able to map sectors across waves. In the robustness section of the paper we use some variables for the year 2007 for the firms that are observed for both years. Of course this entails a large loss of observations.

Table A1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Investment per worker	6,005	8051.515	17947.6	0	182942.8
Union density	6,005	.2083252	.2449899	0	1
Works council (RSA-RSU)	5,821	.494245	.5000098	0	1
National contract	5,997	.97999	.140046	0	1
Two-Tier bargaining	5,981	.2678482	.4428751	0	1
Employers' association	5,987	.7576416	.4285458	0	1
Family firm	5,854	.6897848	.4626211	0	1
Management	5,959	.2726968	.4453836	0	1
Offshoring	6,005	.0261449	.1595793	0	1
Export	6,005	.3733555	.4837356	0	1
Share of workers in cassaintegrazione	5,997	.2786393	.448367	0	1
Share of high skilled	4,388	.1346004	.1965104	0	1
Share of medium skilled	4,378	.4037524	.2471725	0	1
Share of low skilled	4,377	.4616163	.3123821	0	1
Share of female workers	6,005	.3472523	.2686969	0	1
Share of trained workers	5,748	.2867284	.3533708	0	1
Share of fixed term contracts	6,005	.1122784	.169943	0	1
Size between 16 and 49	6,005	.5706911	.4950188	0	1
Size between 50 and 249	6,005	.319234	.4662187	0	1
Size between 250 and above	6,005	.1100749	.3130092	0	1

Notes: Descriptive statistics have been calculated on the sample used in baseline regressions (Table A2 col. 1). See Section A.2 for more details.

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

We have already seen that, under one-tier bargaining, $\theta_a = \theta_b = \theta$. This equality allows us to put together the two zero profit conditions in (9) and obtain the following expression:

$$\Phi^O(\phi) \equiv \frac{(1+\ell)\,p_b - w}{k_b} - \frac{(1+\ell)\,p_a - w}{k_a} = 0 \tag{A1}$$

The expression for the wage w is in (18) and it depends on just one endogenous variable, ϕ. So $\Phi^O(\phi) = 0$ is an implicit function in ϕ. If a solution for (A1) 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 5 and 6 respectively), it is easy to see that, as $\phi \to 0$, we have $\Phi^O \to -\infty$. Moreover, when $\phi \to 1$, we have $\Phi^O \to +\infty$.[31] For a simple continuity argument, the RHS of (A1) 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 (A1) with respect to ϕ. If such a derivative is always positive, there exists a unique value for ϕ satisfying equation (A1).
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 (5) and (6) we have:

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

It can be shown that $-\phi\,p_a' = (1-\phi)p_b'$. So, from equation (18), we get:

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

The derivative is positive as we know that all the possible equilibria must have $p_a > p_b$.

[31] 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 (5) and (6), we have $\lim_{\phi\to 0} \phi\,p_a = 0$ and $\lim_{\phi\to 1}(1-\phi)\,p_b = 0$. From equation (18), 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.

Then a sufficient condition for $\frac{d\,\Phi^O}{d\,\phi} \, > \, 0$ is

$$(1+\ell)\, p_b' \, - \, w' \, = \, (1+\ell) \left[\frac{1}{\sigma} \frac{1}{\phi} \frac{1}{1-\phi} \, p_b \, p_a^{1-\sigma} \; - \; \beta \, (p_a \, - \, p_b) \right] \, > \, 0. \qquad \text{(A2)}$$

The inequality above can be rewritten as follows:

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

Using (5) and (6) to rearrange the expression for $p_a^{1-\sigma}$, we have:

$$\beta \, \sigma \, \phi \, (1-\phi) \left[\frac{p_a}{p_b} \, - 1 \right] \left[1 \, + \, \frac{1-\phi}{\phi} \frac{p_b}{p_a} \right] < \, 1 \qquad \Longleftrightarrow$$

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

When $\sigma \, > \, 2$, the expression inside the square brackets is always lower than 1 (details are available on request). So a sufficient condition for (A2) is $\beta \, < \, \frac{1}{\sigma}$.
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 (A2) is $\beta \, < \, \frac{1}{2}$.
Putting together the two conditions, we have that (A2) is verified (so that $\frac{d\,\Phi^O}{d\,\phi} \, > \, 0$ and the equilibrium is unique) if $\beta \, < \, \min \left[\frac{1}{2}, \, \frac{1}{\sigma} \right]$.

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

Consider the system (27). The first two equations can be expressed in terms of θ_i ($i \in \{a, \, b\}$):

$$\theta_i \;\; = \;\; \left[\frac{(1+\ell)\, p_i - \, w_i \, - \, r k_i}{r k_i \, (r+\delta)} \right]^{\frac{1}{\eta}} \qquad \text{(A1)}$$

in which the formulas for w_a and w_b are in equations (24) and (25) respectively. Inserting equations (A1) into the third equation in (27) yields:

$$\Phi^T(\phi) \equiv \left[\frac{(1+\ell)\,p_a - w_a - rk_a}{rk_a\,(r+\delta)}\right]^{-\frac{1-\eta}{\eta}} + \\ - \left[\frac{(1+\ell)\,p_b - w_b - rk_b}{rk_b\,(r+\delta)}\right]^{-\frac{1-\eta}{\eta}} \cdot \frac{w_a - z}{w_b - z} - \frac{w_a - w_b}{(r+\delta)(w_b - z)} = 0 \tag{A2}$$

$\Phi^T(\phi) = 0$ is an implicit function of ϕ. If a solution for equation (A2) 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[32]. For a simple continuity argument, the RHS of (A2) must cross the horizontal axis at least once. So at least one equilibrium exists.
For the uniqueness of the equilibrium, a sufficient condition is $\frac{d\,\Phi^T}{d\,\phi} > 0$. Such derivative is equal to:

$$\frac{d\,\Phi^T}{d\,\phi} = -\frac{1-\eta}{\eta}\,\frac{\theta_a^{\eta-1}}{(1+\ell)p_a - w_a - rk_a}\,[\,(1+\ell)p'_a - w'_a\,] + \\ + \frac{1-\eta}{\eta}\,\frac{\theta_b^{\eta-1}}{(1+\ell)p_b - w_b - rk_b}\,\frac{w_a - z}{w_b - z}\,[\,(1+\ell)p'_b - w'_b\,] + \\ + \frac{p_a - p_b}{r+\delta}\,\frac{\beta(1+\ell) - \epsilon\ell}{(w_b - z)^2}\,(w_a - w_b) + \\ + \frac{\epsilon\,\ell\,p'_a}{w_b - z}\left[z\,\frac{\theta_b^{\eta-1}}{w_b - z} - \frac{1}{r+\delta}\right] + \\ - \frac{\epsilon\,\ell\,p'_b}{w_b - z}\left[z\,\frac{\theta_b^{\eta-1}}{w_b - z} - \frac{1}{r+\delta}\left(1 + \frac{w_a - w_b}{w_b - z}\right)\right] \tag{A3}$$

Now we show that all the five addends at the RHS of equation (A3) are positive. First notice that the third one is positive as we know that all the possible equilibria must feature $p_a > p_b$ and $w_a > w_b$.
As concerns the first two addends, using the wage equations (24) and (25), we get that

$$(1+\ell)p_i - w'_i = (1+\ell-\epsilon\ell)\,p'_i - [\beta(1+\ell) - \epsilon\ell]\,(p_a - p_b) \tag{A4}$$

with $i \in \{a, b\}$.
When $i = a$, equation (A4) is negative for $p'_a < 0$ and $p_a > p_b$. So the first term at

[32]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 (24) and (25) 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.

the RHS of equation (A3) is positive.
Moreover, in the previous Appendix B we have shown that $p_b' - \beta\,(p_a - p_b) > 0$ if $\beta < \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$. So, *a fortiori*, this condition also ensures that in the case $i = b$, equation (A4) is positive. Thus, the term in the second line of (A3) is also positive.

It can also be shown that the fourth term at the RHS of equation (A3) is positive under mild conditions on z or $r + \delta$. Then, it is easy to see that the last term will be positive *a fortiori*.

We conclude that, if $\beta < \min\left[\frac{1}{2}, \frac{1}{\sigma}\right]$, $\frac{d\,\Phi^T}{d\,\phi} > 0$ and the equilibrium is unique.

D Proof of Proposition 3

In this Appendix we show that a two-tier equilibrium exhibits a higher share of type a firms, ϕ, compared to a one-tier equilibrium. This implies a higher level of investment per worker in the economy.

To prove this, notice first that the equation determining ϕ in the two-tier setting, (A2), is identical to the equation determining ϕ in the one-tier equilibrium, (A1), when $\epsilon = 0$ and consequently $w_a = w_b$. The one-tier scenario is just a special case of the two-tier setting with $\epsilon = 0$.

Therefore, we can evaluate the differences between the two scenarios by computing the derivative $\frac{d\,\Phi^T}{d\,\epsilon}$. Indeed, applying the implicit function theorem we get:

$$\frac{d\,\phi}{d\,\epsilon} = -\frac{d\,\Phi^T}{d\,\epsilon}\Big/\frac{d\,\Phi^T}{d\,\phi}$$

In the previous Appendix C we have shown that a unique equilibrium implies $\frac{d\,\Phi^T}{d\,\phi} > 0$. Therefore, if $\frac{d\,\Phi^T}{d\,\epsilon} < 0$ for each value of $\epsilon \in [0,\,1)$, we can conclude that, when the conditions for a unique equilibrium are satisfied, passing fro a one-tier wage setting to two-tier one (i.e. from $\epsilon = 0$ to a strictly positive ϵ) raises the share of high-capital firms, ϕ.

Differentiating equation (A2) we get:

$$\begin{aligned}
\frac{d\,\Phi^T}{d\,\epsilon} &= \frac{1-\eta}{\eta}\,\frac{\frac{d\,w_a}{d\,\epsilon}}{rk_a\,\theta_a\,(r+\delta)} - \frac{1-\eta}{\eta}\,\frac{\frac{d\,w_b}{d\,\epsilon}}{rk_b\,\theta_b\,(r+\delta)}\,\frac{w_a - z}{w_b - z} + \\
&- \theta_b^{\eta-1}\,\frac{\frac{d\,w_a}{d\,\epsilon}\,(w_b - z) - \frac{d\,w_b}{d\,\epsilon}\,(w_a - z)}{(w_b - z)^2} + \\
&- \frac{1}{r+\delta}\,\frac{\left(\frac{d\,w_a}{d\,\epsilon} - \frac{d\,w_b}{d\,\epsilon}\right)(w_b - z) - \frac{d\,w_b}{d\,\epsilon}\,(w_a - w_b)}{(w_b - z)^2}
\end{aligned}$$

Using equation (A1) and rearranging yields:

$$\frac{d\,\Phi^T}{d\,\epsilon} = -\frac{d\,w_a}{d\,\epsilon}\left[-\frac{1-\eta}{\eta}\,\frac{\theta_a^{\eta-1}}{(1+\ell)p_a - w_a - rk_a} + \frac{\theta_b^{\eta-1}}{w_b - z} + \frac{1}{(r+\delta)(w_b - z)}\right] +$$
$$+\frac{d\,w_b}{d\,\epsilon}\left[-\frac{1-\eta}{\eta}\,\frac{\theta_b^{\eta-1}}{(1+\ell)p_b - w_b - rk_b}\,\frac{w_a - z}{w_b - z} + \frac{\theta_b^{\eta-1}\,(w_a - z)}{(w_b - z)^2} + \frac{w_a - z}{(r+\delta)\,(w_b - z)^2}\right] \tag{A1}$$

Differentiating equations (24) and (25), we have $\frac{d\,w_a}{d\,\epsilon} = (1-\phi)\ell(p_a - p_b) > 0$ and $\frac{d\,w_b}{d\,\epsilon} = -\phi\,\ell(p_a - p_b) < 0$. So $\frac{d\,\Phi^T}{d\,\epsilon}$ is negative if the sum of the coefficients of $\frac{d\,w_b}{d\,\epsilon}$ and $-\frac{d\,w_a}{d\,\epsilon}$ are positive.
We consider first the coefficients of $\frac{d\,w_b}{d\,\epsilon}$. It is easy to see that a sufficient condition for their sum to be positive is:

$$\eta\,[\,(1+\ell)p_b - w_b - rk_b\,] \geq (1-\eta)(w_b - z)$$

Using the wage equation (25) and simplifying, this inequality becomes:

$$[\eta - \beta(1-\phi)]\,(1+\ell)\,p_b - \phi\,[(1+\ell)p_a - \epsilon\ell(p_a - p_b)] + (1-\beta)\phi\,(1+\ell)\,p_a - (1-\beta)\,z \geq 0$$

Dividing by $p_b(1+\ell)$, we get:

$$\eta - \beta(1-\phi) - \phi\frac{(1+\ell)p_a - \epsilon\ell(p_a - p_b)}{p_b(1+\ell)} + (1-\beta)\phi\,\frac{p_a}{p_b} - (1-\beta)\,\frac{z}{p_b(1+\ell)} \geq 0 \tag{A2}$$

It can be shown (details are available on request) that, in a two-tier equilibrium the following inequality holds:

$$\frac{(1+\ell)p_a - \epsilon\ell(p_a - p_b)}{p_b(1+\ell)} < \frac{k_a}{k_b}$$

Using this result, and the properties that $\frac{p_a}{p_b} > 1$ and $z < p_b$, a sufficient condition for the inequality (A2) to hold is:

$$\eta - \beta(1-\phi) - \phi\,\frac{k_a}{k_b} + (1-\beta)\phi - (1-\beta)\,\frac{z}{(1+\ell)} \geq 0$$

Recall that all the possible equilibria must feature $\phi < 1/2$. So the inequality above is respected *a fortiori* if:

$$\eta - \beta - \frac{1}{2}\frac{k_a}{k_b} + \frac{1}{2} - (1-\beta)\frac{z}{(1+\ell)} \geq 0$$

Rearranging, we have:

$$\eta \geq \beta + z \cdot \frac{1-\beta}{1+\ell} + \frac{1}{2}\left(\frac{k_a}{k_b} - 1\right). \tag{A3}$$

If this inequality holds, the sum of the coefficients of $\frac{d\,w_b}{d\,\epsilon}$ is positive. It can be shown that, applying the same procedure for the sum of the coefficients $\frac{d\,w_b}{d\,\epsilon}$ we get that their sum is positive under the same condition (A3).
We conclude that if inequality (A3) holds and the equilibria in both wage scenario are unique, $\frac{d\,\phi}{d\,\epsilon} > 0$. Passing to a two-tier wage mechanism raises the average level of investment per capita.

E Additional Results

In this Appendix we report results for further robustness checks. In Table A2 we report evidence using union density instead of the presence of works councils.

Table A2: Baseline regressions for investment per worker. Poisson model with union density

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
union density	-0.490***	-0.607***	-0.828***	-0.728***	-0.570***	-0.564***	-0.445***	-0.530**	-1.594*
	(0.176)	(0.173)	(0.197)	(0.235)	(0.156)	(0.155)	(0.163)	(0.216)	(0.893)
two-tier bargaining		0.230**	0.192**	0.127	0.200*	0.196*	0.210*	0.137	0.391
		(0.0924)	(0.0953)	(0.140)	(0.117)	(0.114)	(0.116)	(0.163)	(0.612)
union density $\times$ two-tier bargaining				0.387				0.274	
				(0.347)				(0.406)	
share of workers younger than 25					-0.140	-0.0731	-0.146	-0.143	
					(0.700)	(0.631)	(0.614)	(0.612)	
share of workers 26-34					0.0325	0.0579	0.0375	0.0275	
					(0.354)	(0.348)	(0.333)	(0.337)	
share of workers 35-49					-0.150	-0.117	-0.0571	-0.0642	
					(0.363)	(0.357)	(0.346)	(0.349)	
share of high skilled					0.496	0.527	0.484	0.501	
					(0.390)	(0.379)	(0.395)	(0.397)	
share of medium skilled					-0.00304	0.00862	-0.0236	-0.0259	
					(0.242)	(0.235)	(0.220)	(0.221)	
share of female workers					-0.406	-0.426	-0.405	-0.403	
					(0.415)	(0.412)	(0.402)	(0.401)	
share of trained workers					0.293*	0.282	0.286*	0.285*	
					(0.167)	(0.172)	(0.167)	(0.168)	
share of fixed term contracts					0.569*	0.553*	0.544*	0.537*	
					(0.316)	(0.290)	(0.286)	(0.284)	
national contract						-0.408	-0.393	-0.392	
						(0.354)	(0.356)	(0.356)	
employers' association						0.0327	0.0264	0.0290	
						(0.121)	(0.121)	(0.122)	
management							-0.136	-0.138	
							(0.127)	(0.127)	
offshoring							0.221	0.220	
							(0.275)	(0.274)	
export							0.116	0.115	
							(0.114)	(0.115)	
workers in "cassaintegrazione"							-0.317***	-0.315***	
							(0.122)	(0.120)	
residual union density									0.984
									(0.888)
residual two-tier bargaining									-0.0894
									(0.628)
Size dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Collective contract dummies	No	No	Yes	No	No	No	No	No	No
Sector x Region dummies	No	No	No	No	No	No	No	No	No
Constant	9.530***	9.431***	9.772***	9.444***	9.161***	9.493***	9.508***	9.524***	
	(0.253)	(0.268)	(0.416)	(0.270)	(0.559)	(0.771)	(0.752)	(0.745)	
Observations	6,005	5,981	5,517	5,981	3,979	3,972	3,938	3,938	3,013

Notes: Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Dependent variable is the level of investment per worker. We use weights. Number of sectors in column 9 is equal to 69. See Section A.2 for more details.

References

Acemoglu, Daron. 2001. “Good Jobs versus Bad Jobs.” *Journal of Labor Economics* 19:1–21.

Addison, John T, Thorsten Schank, Claus Schnabel, and Joachim Wagner. 2007. “Do Works Councils Inhibit Investment?” *Industrial and Labor Relations Review* 60 (2):187–203.

Addison, John T, Paulino Teixeira, Katalin Evers, and Lutz Bellmann. 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.

Boeri, Tito. 2014. “Two-tier bargaining.” *IZA Discussion Paper* No.8358.

Boeri, Tito and Herbert Bruecker. 2011. “Short-time work benefits revisited: some lessons from the Great Recession.” *Economic Policy* 26 (68):697–765.

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

Card, David, Francesco Devicienti, and Agata Maida. 2014. “Rent-sharing, holdup, and wages: Evidence from matched panel data.” *Review of Economic Studies* 81 (1):84–111.

Cardullo, Gabriele, Maurizio Conti, and Giovanni Sulis. 2015. “Sunk capital, unions and the hold-up problem: Theory and evidence from cross-country sectoral data.” *European Economic Review* 76:253–274.

Cingano, Federico, Marco Leonardi, Julian Messina, and Giovanni Pica. 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.

D’Amuri, Francesco and Cristina Giorgiantonio. 2014. “Diffusione e prospettive della contrattazione aziendale in Italia.” *Questioni di Economia e Finanza, Bank of Italy Occasional Papers* No. 221.

de Pinto, Marco. 2017. “The Impact of Unionization Structures with Heterogeneous Firms and Rent-Sharing Motives.” *Scandinavian Journal of Economics* .

Deuchert, Eva and Martin Huber. 2017. “A cautionary tale about control variables in IV estimation.” *Oxford Bulletin of Economics and Statistics* 79 (3):411–425.

Devicienti, Francesco, Alessandro Manello, and Davide Vannoni. 2017. “Technical efficiency, unions and decentralized labor contracts.” *European Journal of Operational Research* 260 (3):1129–1141.

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

Garnero, Andrea, François Rycx, and Isabelle Terraz. 2018. "Productivity and wage effects of firm-level collective agreements: Evidence from Belgian linked panel data." *Working Papers CEB* 18.

Grout, Paul A. 1984. "Investment and wages in the absence of binding contracts: A Nash bargaining approach." *Econometrica* :449–460.

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

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

Jimeno, Juan F and Carlos Thomas. 2013. "Collective bargaining, firm heterogeneity and unemployment." *European Economic Review* 59:63–79.

Jirjahn, Uwe and Jens Mohrenweiser. 2016. "Owner-Managers and the Failure of Newly Adopted Works Councils." *British Journal of Industrial Relations* 54 (4):815–845.

Krusell, Per and Leena Rudanko. 2016. "Unions in a frictional labor market." *Journal of Monetary Economics* 80:35–50.

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

Menezes-Filho, Naercio and John Van Reenen. 2003. *Unions and innovation: a survey of the theory and empirical evidence*, chap. 9. International Handbook of Trade Unions. Edward Elgar, XXX–XXX.

Petrongolo, Barbara and C.A. Pissarides. 2001. "Looking into the Black Box: A Survey of the Matching Function." *Journal of Economic Literature* 39:716–741.

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

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