Abstract

We lay out a model of wage bargaining with two leading features: bargaining is ex post to relevant investments and there is individual bargaining in firms without a Union. We compare individual ex post bargaining to coordinated ex post bargaining and we analyze the effects on wage formation. As opposed to ex ante bargaining models, the costs of *destroying* the employment relationship play a crucial role in determining wages. High firing costs in particular yield a rent for employees. Our theory points to a employer size-wage effect that is independent of the production function and market power. We derive a simple least squares specification from the theoretical model that allows us to estimate components of the wage premium from coordination. We reject the hypothesis that labor coordination does not alter the extensive form of the bargaining game. labor coordination substantially increases bargaining power but decreases labor's ability to pose costly threats to the firm.

JEL Clasiification: J51, J41, J52.

Ex post bargaining, Labor Coordination and Wage Formation at the Firm Level

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1 Introduction

Most of the literature that has looked into the economic implications of trade unions and labor coordination at bargaining has focused mainly on the theory and measurement of the union wage premium as well as on the effects of unionization on decisions within the firm, like those on hiring and investing. The leading models to frame union effects are the efficient bargaining (EB) model and the right to manage (RTM) model[1]. They have in common two characteristics: the assumption of Nash bargaining to determine surplus division and the abstraction of possible distortionary effect of ex post bargaining on ex ante investments. RTM differs with EB in that contracting is incomplete, it does not include employment decisions. The implicit assumption behind the EB model is that bargaining between the union and the owner is ex ante to relevant decisions for running the firm. In the RTM model bargaining is ex ante to all those decisions except for the hiring decision, that is a control right allocated to management.

Some limitations of this theoretical framework, in particular, its lack of robustness, have been recently pointed out. Manning (94) shows that if a firm's decision on the nature of the technology chosen is introduced, the standard predictions of the EB and RTM models can be reversed.

More generally, a number of issues remain unsolved within the EB/RTM paradigm. Although many instances of bargaining in firms can be thought of as ex ante bargaining, there are also cases where bargaining takes place ex post with respect of decisions relevant for running the firm. In Spain, for instance bargaining games previous to closing collective agreements in large firms take place periodically[2] (often yearly or every two years). These agreements (the so called "Convenios Colectivos") are reached between representatives of ownership (managers) and elected representatives of previously hired employees. This implies in particular that the terms of trade between owners and employees are decided in a sequence of negotiated short-term (one year) contracts independent of each other. It also implies that long-term investments (those that have effects on firm's payoffs at least one year after they are sunk) are subject to a standard *hold-up* problem[3], as described

[1] see Manning (94) for a critical review of these two models.

[2] See Bentolila and Dolado (94), Jimeno and Toharia (93), Jimenez (95) and Metcalf and Milner (94) for a description of the Spanish labor market institutional setting.

[3] The recent objections to the lack of committment assumption underlying the hold-up problem in Maskin and Tirole (98) do not apply to labor wage bargaining when the law

in Grout (84) and Hart and Moore (90).

More to the point, an important consequence of ex post bargaining (*ex post* being defined as posterior to the investment decision but previous to the production stage) is that the relevant outside options to parties are indeed very different to those under ex ante bargaining. In particular, under ex post bargaining, the outside option to the owner is plausibly related to her payoff when firing a subset of the employees. Firing a subset of employees has two consequences: one is that the set of fired employees is not part of the production team, what reduces surplus. The second is that, if labor regulations impose it, the owner is forced to pay a severance payment to the set of fired employees.

In summary, a theory of wage formation under ex ante (respectively, ex post) bargaining cannot (can) explain generally the dependence of wages on variables related to the costs of destruction of the employment relationship. This is because ex ante (respectively, ex post) bargaining is previous (posterior) to sunk cost related to the creation of the employment relationship.

A second issue that is not solved in the EB/RTM paradigm is that it is mute on the type of bargaining that takes place in firms without coordinated labor. If instead we allow for the existence of bargaining of some type in firms without a Union (as it seems plausible: why cannot individuals bargain with the owner?) the EB/RTM approach does not give an answer on what is the effect of labor coordination on, say, the level of wages.

This paper attempts to tackle precisely these two points. We consider the effects of firing costs and inefficiencies arising from separations (quits and layoffs) on ex post bargaining. We also introduce the possibility of the existence of individual bargaining in firms without coordinated bargaining. In our setting, the comparison of a coordinated bargaining setting and an uncoordinated setting does not imply comparing a bargaining regime with an wage-taking regime, but rather it implies comparing two extensive forms of the bargaining game.

We lay out a model of a firm with a continuous number of employees. We describe wage bargaining without a union as individual bargaining. This means that without a union each of the employees bargains simultaneously and non-cooperatively with the firm over her own wage. We model a simple extensive form game for individual bargaining that yields simple solutions even if the number of employees is a continuous variable. Coordinated (or

assures the labor's right to strike by firm-level Unions or Works Councils.

Union) bargaining means that employees delegate the right to make or accept offers to a unique agent (a union leader), that coordinates the negotiation with the firm. We allow for increases in bargaining power when a union leader intervenes.

We compare in the first place wage formation under Union or coordinated bargaining and without Union or individual bargaining. We find that under individual bargaining wages are less dependent of firm characteristics than under collective bargaining. In particular under individual bargaining wages are independent of the size of the firm, what is not true under coordinated bargaining. Under coordinated bargaining there is in general a firm size-wage effect. The sign of the firm size-wage effect depends on whether the owner benefits from scale economies at firing (for instance, if liquidation costs are low). In both bargaining regimes wages depend crucially on agents payoffs when the employment relation is destroyed. We find in particular that firing costs yield a rent for labor that is independent of the productive activities of the firm.

We test the empirical implications of our model with a data base of Spanish firms. We show that if labor coordination modifies the extensive form of the bargaining game inside the firm, then the conditional expectation of wages in firm with and without labor coordination should follow a different functional form, in a particular direction. We derive a nested specification of firm wages as a function of firm characteristics and an indicator of the bargaining regime in the firm. The theory implies that a set of coefficients in this nested specification are different to zero if coordination alters the extensive form of the bargaining game. This is found to be the case in our data base. We find that coordinated bargaining substantially increases bargaining power, but reduces labor's ability to pose threats to management.

Regarding the sources of our data, it should be noticed that we will not be strictly observing unions' behavior. We will be studying the effect of firm-level collective agreements (FLCA) on the bargaining game inside the firm. A discussion of the similarities and differences between unions and FLCA can be found in Freeman (94), Jiménez (95) and Palenzuela and Jimeno (96). In what follows and for simplicity we will identify FLCB with a Union at the firm level.

The paper is organized as follows. Section 2 presents the theoretical model of coordinated and individual bargaining. Section 3 finds implications of coordinated bargaining on the Union wage premium and derives an econo-

metric specification used to identify the effect of labor coordination on the bargaining game. Section 4 closes the paper with concluding remarks. The description of the data base used is contained in an Appendix.

2 The Model

We consider an *ex post* bargaining game within a firm. The firm is composed by two types of agents: the owner (F) and a number N of employees. Shortly before the production stage, the N employees have the option of bargaining with the owner in order to split the gross surplus from production of given size S. Bargaining can follow two regimes. It can either be *individual* (without Union: each employee bargains individually with the firm) or *collective* (with Union).

Under collective bargaining the employees delegate decision-making to a unique agent (a Union leader) that coordinates the wage bargaining game, that follows an ultimatum game. The unique bargaining game takes place between the Union leader and the owner. Nature gives all the bargaining power to the Union leader with probability α_c. With probability α_c (respectively, $1-\alpha_c$) the labor representative (the owner) gets the right to make a wage offer common for all employees. Finally, the agent that receives the wage offer decides whether to accept or reject it.

Under individual bargaining the N employees bargain for wages with the owner. Each employee bargains simultaneously and non-cooperatively with respect to the other employees. Individual bargaining follows an ultimatum game for each of the employees. In particular the N ultimatum games are modeled as follows: there is a continuum of independent, binomial random variables p_i, where i is an index of employees: $i \in [0, N]$. Each random variable p_i satisfies $p_i \in \{F, i\}$ and $\Pr(p_i = i) = 1 - \Pr(p_i = F) = \alpha_d = \alpha_c - \Delta\alpha$, with $\Delta\alpha \equiv \alpha_c - \alpha_d$. If $p_i = i$ (respectively, F) then in the game between employee i and the firm, i (respectively, the firm) makes a take it or leave it wage-offer to the firm (employee i). Initially the N random variables are realized. By construction, there is a total of $\alpha_d N$ employees that make offers to the firm and $(1-\alpha_d)N$ employees that receive offers from the firm. All these offers are made simultaneously and non-cooperatively. At the next stage, each of the $(1-\alpha_d)N$ employees that receive an offer independently decide whether to accept or reject the offers they got from the firm. Simultaneously, the owner decides whether to accept or reject each of

the $\alpha_d N$ offers she got from the fraction of employees that had the chance of making take it or leave it offers.

The outside opportunity for the owner ,$U_F(z)$, when bargaining with a coalition of z employees is to unilaterally destroy the employment relationship. That is, to fire all employees in $\{z\}$ or possibly (if $z = N$) to liquidate the firm. F's outside utility $U_F(z)$ depends on the number $z \in [0, N]$ of employees that are *outside* of the producing coalition, $\{N - z\} \cup F$. In order to exclude $\{z\}$ employees from the producing coalition $\{N - z\}$, F is forced to fire them at a direct cost $G(z)$, with $G(0) = 0$ and $G' > 0$. The remaining producing coalition $\{N - z\} \cup F$ is able to obtain only a fraction $\tau(z) \in [0, 1]$ of the efficient outcome, S. The efficient outcome S is the ex post surplus[4] when no employees are fired. The outside opportunity of the firm as a function of the number of fired employees, $U_F(z)$, is:

$$U_F(z) = \tau(z) S - G(z) \qquad \text{where: } \tau(0) = 1 \text{ and } \tau'(z) \leq 0 \qquad (1)$$

The function $\tau(z)$ captures the nature of agents' specific investments sunk in the firm. In particular, it measures the degree to which employees' effort increases the productivity of the physical assets or the productivity of their own human capital. If agents invest in the productivity of physical assets then employees' separation does not decrease the size of the surplus ($\tau(z) \simeq 1 \ \forall z$). If agents invest in their own human capital, then firing z employees decreases surplus sharply ($\tau(z) \simeq 0 \ \forall z$).

The outside opportunity of z employees that leave the firm, U_z, is what they can achieve by themselves by voluntarily quitting the production coalition. We call that reservation wage w_T. Then: $U_z = z w_T$.

We assume that the efficient outcome is that the N employees remain in the production coalition

$$\left(\frac{1 - \tau(z)}{z}\right) S > w_T \Rightarrow S > \tau(z) S - G(z) + z w_T$$

since $G(z) \geq 0$. The functions $\tau(z)$ and $G(z)$ play the only role of determining the terms of trade between $\{z\}$ and F at the bargaining stage. These functions determine the *distribution technology* of the firm. In particular, we can think of $\tau(z)$ as the "threat" of the fired coalition to the owner in terms of the proportion of surplus lost. The term $1 - \tau(z)$ is the proportion of surplus at stake in the bargaining game. For concreteness, we introduce:

[4] S is the surplus gross of the costs of relevant non-monetary investments.

Definition 1 *we will refer to* $\beta(z) = \frac{1-\tau(z)}{z}$ *as the* average stake *when* z *employees bargain jointly with the owner.*

Identically, $G(z)$ is a threat of the fired coalition $\{z\}$ to F in terms of direct owner's costs of firing $\{z\}$. For concreteness we will characterize the nature of investments in the following way.

Definition 2 *We call* $\tau(z)$ *the* production threat-technology *of coalition* $\{z\}$, *and we call* $G(z)$ *the* firing costs threat-technology *of coalition* $\{z\}$.

We allow for economies and diseconomies of scale in the threat technologies. The production threat technology $\tau(z)$ shows increasing marginal returns for labor if $\tau'' < 0$ [5]. Similarly, the firing costs threat-technology shows increasing marginal returns to N for labor if $G'' > 0$. This arises for instance if liquidation procedures are very costly for the owner of the firm, so that firing many employees is proportionally more expensive than firing fewer employees. Decreasing marginal returns (for labor) in the firing costs threat technology are on the other hand the result of employment regulation regimes that facilitate payroll reduction or liquidation (so that the average direct cost of firing employees decreases with the number of employees).

3 Implications

3.1 Individual vs collective bargaining

Under coordinated bargaining the Union leader has a probability (α_c) of making a take-it-or-leave-it offer to the owner (and a probability $(1-\alpha_c)$ of receiving it). Offers under coordinated bargaining are for the joint wage bill of employees, $w^c N$. If the Union leader (respectively, firm's owner) has all the bargaining power to make an offer, the owner (Union leader) decides subsequently to accept or reject the offer received. The outside opportunity of the owner is to collect the surplus remaining after firing all employees, $\tau(z=N)S$ and honoring the firing costs, $G(z=N)$. This yields, for the expected wage bill of the employees:

[5] Since the game is a zero-sum game, $\tau'' < 0$ implies decreasing marginal returns to N for owners in the distribution technology.

Remark 1 *Under labor coordination, wages capture a fraction* α_c *of average firing costs* $\left(\frac{G(N)}{N}\right)$ *and average stake* $(\beta(N))$.

$$w^c N = \alpha_c \{S - [\tau(N) S - G(N)]\} + (1 - \alpha_c) w_T N \qquad \Rightarrow$$

$$w^c = (1 - \alpha_c) w_T + \alpha_c \beta(N) S + \alpha_c \frac{G(N)}{N} \tag{2}$$

Moreover, the wage w^c *increases (respectively, decreases) with the size of the firm* (N) *if firing costs are convex (respectively, concave) and if the stake function* $1 - \tau(N)$ *is convex (respectively, concave).*

Interestingly, employees internalize firing costs in wages even if firing does not occur in equilibrium. It is important to remark that this type of result is not possible in the standard "Efficient bargaining" and "Right to Manage" paradigms. In those settings wages are determined previously to the start of the employment relationship, and they are invariant to agents' payoffs under inefficient allocations. Under ex post bargaining on the other hand, the regulation on firm liquidation affect directly the division of gross surplus. In particular, expensive liquidation procedures imply that employees extract a rent of expected value $\alpha_c G(N)/N$ that is independent of productive factors in S.

Under individual bargaining the ultimatum game described above takes place simultaneously N times, between the owner and each of the employees. This means that each of the N employees bargains individually, simultaneously and independently of the other employees. Under this specification agents anticipate (since bargaining is efficient) that in equilibrium all offers in the other $\{N - i\}$ subgames are accepted and no employees are fired at those $\{N - i\}$ subgames. Moreover, each employee i will anticipate the wage bill paid to the other employees in equilibrium, H_{-i}. For symmetry, each of the N bargaining games are characterized by a surplus to be divided between F and i, π_{iF}, and outside opportunities for F and i (respectively, $U_F(\varepsilon)$ and $U_i(\varepsilon)$) given respectively by:

$$\begin{aligned} \pi_{iF} &= S - H_{-i} \\ U_F(\varepsilon) &= \tau(\varepsilon)\ S - G(\varepsilon) - H_{-i} \\ U_i(\varepsilon) &= w_T \varepsilon \end{aligned}$$

where we have divided the segment $[0, N]$ in $\frac{N}{\varepsilon}$ equal intervals so that each employee i is of "size" $\varepsilon > 0$.

Since in equilibrium there are no quits or layoffs, the threat of firing is credibly realized by the firm to each employee as if he was the only one possibly fired. The wage for each employee i is:

$$\varepsilon w^d = \alpha_d \left(S - H_{-i} - \left(\tau \left(\varepsilon \right) \ S - G \left(\varepsilon \right) - H_{-i} \right) \right) + \left(1 - \alpha_d \right) \varepsilon w_T$$

Taking the limit as $\varepsilon \to 0$, we have:

Remark 2 *Under individual bargaining wages capture a fraction α_d of the cost of firing "one" employee ($G'(0)$) and the "average surplus at stake" when only "one" employee bargains, $\lim_{z \to 0} \beta(z) = -\tau'(0)$* [6].

$$\begin{aligned} w^d &= \left(1 - \alpha_d \right) w_T + \alpha_d G'(0) - \alpha_d \tau'(0) S \\ &= \left(1 - \alpha_d \right) w_T + \alpha_d G'(0) + \alpha_d \beta(0) S \end{aligned} \tag{3}$$

Moreover, wages in firms with individual bargaining are independent of the size[7] *of the firm, N.*

As opposed to the coordinated labor case, there is not a firm size-wage effect in firms with individual bargaining (this is in spite of the fact that employees are not price takers). In this case employees compete with each other for offers, and are able to internalize only a fraction of the marginal threat when all employees remain in the firm. This is the surplus at stake plus the firing costs when only one employee is fired. Moreover, equation (3) is compatible with w^d capturing a larger fraction of the firm's surplus S, than w^c, if N is large enough and the average stake $\beta(z)$ decreases with z.

In order to compare the effects on wages of collective bargaining in a firm with N employees and surplus S, we can use (2) and (3) to find the wage premium, $\Delta w \equiv w^c - w^d$:

$$\begin{aligned} \Delta w &= -\Delta \alpha w_T + \alpha_c \frac{G(N)}{N} - \alpha_d G'(0) + \alpha_c \frac{1 - \tau(N)}{N} S + \alpha_d \tau'(0) S \\ &= -\Delta \alpha w_T + \alpha_c \frac{G(N)}{N} - \alpha_d G'(0) + \left(\alpha_c \beta(N) - \alpha_d \beta(0) \right) S \end{aligned} \tag{4}$$

[6] This follows since $-\tau'(0) = \lim_{N \to 0} -\frac{\tau(N) - \tau(0)}{N} = \lim_{N \to 0} \frac{1 - \tau(N)}{N} = \lim_{N \to 0} \beta(N) = \beta(0)$

[7] It is important to notice that the terms $G'(0)$ and $\tau'(0)$ in (3) are not the result of a Taylor expansion. Expression (3) is the *exact wage* under individual bargaining when ε is arbitrarily small.

It is clear from (4) that the relation between the wage premium from coordination Δw and the size of the firm depends on the concavity or convexity of average firing costs and average stake, $\beta(N)$. We have:

Remark 3 *The wage premium Δw from labor coordination increases with the degree of convexity of the stake function $(1-\tau(z))$ and with the degree of convexity of firing costs $G(z)$.*

In particular, if labor benefits from scale economies at firing (that is, if liquidation procedures increase more than proportionally with the size of the firm: $G''(0) > 0$), the wage coordination premium increases with firm size. This is irrespective of the effect of coordination on bargaining power as long as $\alpha_c > 0$.

3.2 Empirical implications

In this section we exploit the differences in the functional form of expected wages as a function of firm size N and surplus S, under individual and collective bargaining, for testing the implications of ex post bargaining. An implication of our model is that expected wages in firms with collective bargaining $(w^c(\alpha^c, N))$ depend nonlinearly on the total number of employees, but wages in firms with individual bargaining $\left(w^d\left(\alpha^d\right)\right)$ are independent firm size.

We derive a simple test based on the fact that $w^c(\alpha, N)$ tends to equalize $w^d(\alpha)$ for sufficiently small firms. More precisely: $\lim_{N\to 0} w^c(\alpha, N) = w^d(\alpha)$. Since the type of bargaining regime is observed ($c_i = 1$ if in firm i labor coordinates bargaining and $c_i = 0$ otherwise), we approximate wages in firm i by $w_i \simeq w_i^d + c_i N_i \Delta w_i$ [8]. This will allow us to map structural and estimated parameters straightforwardly. The following definition will be useful for this purpose

$$w(k, \overline{z}) \equiv \frac{1}{\overline{z}} \alpha_k \left[U_F(z=0) - U_F(z=\overline{z})\right] + (1-\alpha_k) w_T \qquad \text{with } k = c, d$$

A second-order Taylor expansion of the term $U_F(z=\overline{z})$ yields:

[8] We will have to take into account that possibly $\alpha_c \neq \alpha_d$ and that we only observe *average* firm wages. Firms' employees are actually composed of long-term employees eligible for severance payments (N in our model) and fixed-term models, not eligible for severance payments. This latter fact makes the derivation of the test less straightforward.

$$U_F(z=\overline{z}) \simeq U_F(z=0) + \frac{\partial U_F(z=0)}{\partial z}\overline{z} + \frac{1}{2}\frac{\partial^2 U_F(z=0)}{\partial z^2}\overline{z}^2 \qquad (5)$$

We can show in particular that:.

$$\begin{aligned} w^d &= \lim_{z\to \mathbf{0}} w(k=d,z) = -\alpha_d \frac{\partial U_F(z=0)}{\partial z} + (1-\alpha_d)\, w_T \qquad (6) \\ w^c &= w(c,N) \simeq -\alpha_c \left[\frac{\partial U_F(z=0)}{\partial z} + \frac{N}{2}\frac{\partial^2 U_F(z=0)}{\partial z^2}\right] + (1-\alpha_c)\, w_T \end{aligned}$$

Expression (6)[9] gives a simple description of wages under both regimes. Abstracting for a moment from changes in bargaining power due to coordination ($\Delta\alpha = 0$), wages under collective bargaining can be approximated as the wages under individual bargaining plus an additional term (originating from the second-order term for $U_F(z)$ [10]). More generally (with $\alpha_c \neq \alpha_d$) we can write the wage premium from labor coordination Δw simply as:

$$\Delta w = \Delta\alpha \left(-\frac{\partial U_F(z=0)}{\partial z}\right) + \alpha_c \left(-\frac{N}{2}\frac{\partial^2 U_F(z=0)}{\partial z^2}\right) \equiv \Delta\alpha\ m_o + \alpha_c \sigma \quad (7)$$

where:

$$\sigma \equiv G''(0)\ N_I - \tau''(0)\ S\ N_I \qquad (8)$$

The term m_o in (7) does not depend on the number of employees, N. Equation (4) decomposes the effect of collective bargaining on wages in two effects, a *power effect* ($\Delta\alpha\ m_o$) due to changes in bargaining power, and a *scale effect*, $\alpha_c\sigma$. From (7) σ in (4) should be interpreted as a scale effect arising from the fact that employees bargain as a block and therefore have an effect of an additional order on the firm's utility change due to firing costs. Whether the scale effect hurts or benefits employees will depend on whether the firm has economies of scale of firing and the nature and specificities of employees investment (whether they increase human or physical capital productivity).

[9] Notice that we are not simply writting w^d as a first order approximation and w^c as a second order approximation. Instead, wages under decentralization exactly coincide with the first term of the approximation to wages under centralization.

[10] Wages under decentralization are not susceptible of a Taylor approximation arround $N = 0$, since they are independent of N (w^d is exactly (3)).

We expect m_o in (7) to be positive[11]. The wage premium arises from increments in bargaining power ($\Delta\alpha$), or from a positive scale effect (σ), or both.

3.2.1 Average Wage Equations

The two bargaining games described above have different implications on the functional form of expected wages, conditioned on observables like the ex post surplus to be divided, the number of long term employees and their cross products. As a first step, we need to adapt the model to the structure of our sample. The sample is a panel of Spanish firms observed yearly from 1988 to 1992 [12]. We observe for each firm i, the total wage bill of the firm and the total number of employees, M. We can decompose the latter number in long-term employees, N (those such that firing them requires a cost) and fixed-term employees, $N_T = M - N$ (those such that not keeping them in the firm after the employment term is over has no cost) [13].

We model average wages, in firms with and without collective bargaining, and we nest the conditional expectation for both types of firms in one equation. Since we observe the exact total surplus S_i that is divided each year between employees and owners in the firm, we do not need to make assumptions about the production function of the firm. For $k = \{c, d\}$, the average wage in the firm, ω^k is: $\omega^k \equiv \frac{1}{M}\left(w_T N_T + w^k N\right) = w_T\left(1-f\right) + w^k f$, where $f \equiv \frac{N}{M}$ and N and w^k are as defined in previous sections.

Through a second order expansion around $N = 0$ of $G(N) \simeq G'_o N + \frac{1}{2}G''_o N^2$ and $\tau(N) \simeq 1 + \tau'_o N + \frac{1}{2}\tau''_o N^2$ and from (2), average wages in firms with collective bargaining are:

$$\begin{aligned} \omega^c &= w_T(1-f) + \left[\left(1-\alpha_c\right) w_T + \alpha_c G'_o\right]\ f + \frac{1}{2}\alpha_c G''_o\ Nf \\ &\quad -\alpha_c \tau'_o\ N\widetilde{S} - \frac{1}{2}\alpha_c \tau''_o\ N^2\widetilde{S} \end{aligned} \tag{9}$$

where we use the subscript "$_o$" for the function evaluated at zero and where $\widetilde{S}$ is the surplus per employee: $\widetilde{S} \equiv S/M$. From (3), average wages in firms

[11] See section 3.2.2 for estimates.

[12] See the Appendix for the description of the data base.

[13] It is straightforward to show that the results of the model do not change when we introduce fixed-term employees that are not susceptible to cause a firing cost to the firm and whose wage is a committed firm expenditure. See Rodriguez Palenzuela (97) for a full description of the model with fixed-term employees.

with individual bargaining are given exactly by:

$$\omega^d = w_T\ (1-f) + \left[(1-\alpha_d)\, w_T + \alpha_d G'_o\right]\ f - \alpha_d \tau'_o\ N\widetilde{S} \tag{10}$$

Average wages should have a different functional form with respect to observables (f, N, $\widetilde{S}$) in firms with collective and individual bargaining. This implication will let us test the existence of different bargaining games in firms with individual and collective bargaining.

Comparison of equations (9) and (10) point to an econometric specification for observed wages and to a number of tests about the effects of Union on the bargaining game. Let c_{it} be an indicator variable that is equal to 1 if firm i in year t has a collective agreement and is equal to 0 otherwise. Then average firm wages, w_{it}, can be written as the following nested expression:

$$\begin{aligned}
\omega_{it} \;=\; & (w_T)\left[1-f_{it}\right] + \left(\alpha_d G'_o + (1-\alpha_d)\, w_T\right)\ \left[f_{it}\left(1-c_{it}\right)\right] \\
& + \left(\alpha_c G'_o + (1-\alpha_c)\, w_T\right)\ \left[f_{it} c_{it}\right] + \left(\frac{1}{2}\alpha_c G''_o\right)\ \left[N_{it} f_{it} c_{it}\right] \\
& + \left(-\alpha_c \tau'_o\right)\ \left[N_{it}\widetilde{S}_{it} c_{it}\right] + \left(-\alpha_d \tau'_o\right)\ \left[N_{it}\widetilde{S}_{it}\left(1-c_{it}\right)\right] \\
& + \left(-\frac{1}{2}\alpha_c \tau''_o\right)\ \left[c_{it}\widetilde{S}_{it} N_{it}^2\right]
\end{aligned} \tag{11}$$

where we have written coefficients in brackets and observable variables in square brackets.

Our ex post bargaining model has implications on the signs of the coefficients when estimating equation (11). In particular we have the following restrictions:

Table 1:

Restrictions on correlations:

Variable:	Coefficient	Restriction
$[1-f_{it}]$	w_T	>0
$[f_{it}(1-c_{it})]$	$\alpha_d G'_o + (1-\alpha_d) w_T$	>0
$[f_{it}c_{it}]$	$\alpha_c G'_o + (1-\alpha_c) w_T$	>0
$\left[N_{it}\widetilde{S}_{it}c_{it}\right]$	$-\alpha_c \tau'_o$	>0
$\left[N_{it}\widetilde{S}_{it}(1-c_{it})\right]$	$-\alpha_d \tau'_o$	>0
$[N_{it}f_{it}c_{it}]$	$\frac{1}{2}\alpha_c G''_o$	$\neq 0$
$\left[c_{it}\widetilde{S}_{it}N_{it}^2\right]$	$-\frac{1}{2}\alpha_c \tau''_o$	$\neq 0$

Even if we do not intend to estimate the structural parameters of the model [14], we can learn some facts about them through the estimated coefficients.

The coefficient of $[N_{it}f_{it}c_{it}]$ captures the product of the bargaining power in Union firms and the derivative of firing costs per employee at the origin, $\left(\frac{1}{2}\alpha_c G''_o\right)$ and therefore the type of returns to scale of the firing cost distribution technology. Although we expect G'_o to be positive, we do not have a prior for G''_o.

The sign of τ''_o can be captured by the opposite sign of the coefficient on the variable $\left[c_{it}\widetilde{S}_{it}N_{it}^2\right]$, that measures $\left(-\frac{1}{2}\alpha_c \tau''_o\right)$. Clearly, $\tau''_o < 0$ favors employees, since it implies increasing returns to scale in the technology of threats.

The significance of labor's bargaining ability arising from "marginal threats" $(-\tau'_o > 0)$ implies that coefficients $-\alpha_c \tau'_o$ and $-\alpha_d \tau'_o$ should be positive. Moreover, from their ratio $\frac{-\alpha_d \tau'_o}{-\alpha_c \tau'_o} = \frac{\alpha_d}{\alpha_c}$ we recover the effect of coordination on aggregate bargaining power. Similarly, the relevance of marginal firing costs at the origin (G'_o) can be tested by the comparison of w_T and $\alpha_k G'_o + (1-\alpha_k) w_T$, for $k = c, d$.

Expected signs are compared to the signs of the estimated coefficient from a least squares estimation of equation (11). Although least squares is often as restrictive estimation procedure, it provides at the least an approximation to the coefficients. Moreover, if our model is correctly specified, *ols* provides consistent estimates if observed variables are measured without error (what

[14] The structural parameters are not identified. We focus on restrictions on the structural parameters that are sufficient conditions to restrict the structural parameters.

seems reasonable) and if the structural parameters ($\alpha_c, \alpha_d, \tau'_o, \tau''_o, G'_o$ and G''_o) are economy-wide parameters rather than specific firm effects. This is indeed the case of G'_o and G''_o (and possibly also of α_c and α_d) that depend on regulations at national level, common to all firms. The case of τ'_o and τ''_o requires some discussions. Although it is plausible that the stake function $1-\tau(z)$ is firm specific, there are also reasons to argue that there is one such function for the economy. The amount of gross surplus ($\tau(z)S$) that remains to the owner of a firm after z employees are fired is a relevant hypothesis that can rarely be tested or verified by owners and employees in actual bargaining games. If a firm j has its specific function $\tau_j(z)$, it will be in general prohibitively expensive to learn $\tau_j(z)$ (j will have to engage in inefficiently firing a large fractions of its employees to learn the stake function). It is plausible that instances of data relevant for estimating $\tau(z)$ are shared in the economy in order to save those learning costs, and that there is social learning of one $\tau(z)$ mapping for the economy.

The description of the variables used can be found in the Appendix. Table 2 contains descriptive statistics of the data..

Table 2:
Descriptive statistics of variables and regressors

variable	**mean**	**std.dev.**
log wage $(w).10^{-1}$	0.2495	0.0957
Union (c)	0.2694	0.44375
Number of long term employees $(N_I).10^{-3}$	0.5323	1.5928
Surplus per employee $(\widetilde{S}).10^{-5}$	3.4855	2.9121
proportion of insider employees $[1-f]$	0.0718	0.1133
$f*c$	0.2510	0.4166
$[f*(1-c)]$	0.6770	0.4233
(N_I*f*c)	0.2510	1.0769
$\boxed{(1-c)*N_I*\widetilde{S}}$	1.8134	5.9299
$\boxed{c*N_I*\widetilde{S}}$	0.9058	4.3393
$\boxed{c*N_I^2*\widetilde{S}}$	4.3654	39.1351

3.2.2 Estimation

Equation (11) implies that the expectation of average wages, conditioned on observable variables like surplus per employees, number of long term employees and proportion of temporary employees over total number of employees in firms is a nonlinear function of theses variables and that this function is different in firms with and without Union. The results of the estimation are in table 3

Table 3.
OLS estimation of (11)

variable	coefficient	coef.	std.error	p-value
$[1-f]$	w_T	0.2383	0.0122**	0.0276**
fc	$\alpha_c G'_o + (1-\alpha_c)\, w_T$	0.2479	0.0039**	0.0066**
$[f\,(1-c)]$	$\alpha_d G'_o + (1-\alpha_d)\, w_T$	0.2413	0.0021**	0.0047**
Nfc	$\frac{1}{2}\alpha_c G''_o$	-0.0167	0.0027**	0.0044**
$\boxed{(1-c)\, N\widetilde{S}}$	$-\alpha_d \tau'_o$	0.0028	0.0003**	0.0012*
$\boxed{cN\widetilde{S}}$	$-\alpha_c \tau'_o$	0.0139	0.0011**	0.0032**
$\boxed{cN^2\widetilde{S}}$	$-\frac{1}{2}\alpha_c \tau''_o$	-0.0009	0.0001**	0.0037*

()** coefficient is statistically significant w.r.t. standard error at 1% level
()* coefficient is statistically significant w.r.t. standard error at 5% level

Notice in particular that the restrictions imposed by the model in table 1 are satisfied: all coefficients in table 1 are estimated as positive in table 3. Additionally, the null hypothesis that $-\widehat{\alpha_d \tau'_o} = -\widehat{\alpha_c \tau'_o}$ (equivalent to $\alpha_c \neq \alpha_d$) is rejected at the 1% level (not in the table). Finally, the firing cost function appears to be concave ($G''_o < 0$) and the stake function $1-\tau$ is also concave -there are decreasing marginal returns to N for labor in the distribution technology. This last finding is sufficient for our purposes: it is incompatible with the existence of a common bargaining game for firms with and without labor coordination. More precisely,

Remark 4 *The finding that $\tau''_o \neq 0$ and $G''_o \neq 0$ is incompatible with the hypothesis that the only effect of labor coordination is to increase labor's ex post bargaining power from $\alpha_d \geq 0$ to $\alpha_c > \alpha_d$.*

Our model of ex post bargaining where coordination alters the extensive form of the bargaining game in addition to increase power can accommodate the findings in Table 3.

It is on the other hand not possible to recover the value of the structural parameters, since the model is not identified. If we normalize the bargaining power of coordinated labor to a given value, say $\alpha_c = 0.2$, we can recover estimates of the structural parameters[15]. With this normalization, the structural parameters compatible with Table 3 are:

Table 4

Values of structural parameters under normalization: $\alpha_c = 0.2$:

w_T	0.2380
α_c	0.2000
α_d	0.0400
G_o'	$\in [0.286, 0.313]$ [16]
G_o''	-0.1670
τ_o'	-0.0695
τ_o''	0.0009

From table 4, bargaining power under labor coordination is five times higher than without coordination. The main implication of table 4 (that is independent of the normalization used for α_c) is that owners of larger firms face better conditions at bargaining with coordinated labor than those of smaller firms with coordinated labor[17]. As the size of the firm increases, total firing costs increase less than proportionally and the proportion of surplus destroyed by layoffs increases less than proportionally. Labor's threat-point increases less than proportionally to the number of employees, reducing wages per employee.

[15] We can recover as well the standard deviations of the estimated structural parameters (for instance, by the delta method). Notice nevertheless that table 3 is incompatible with the structural parameters not being statistically significant.

[16] Once we normalize α_c to 0.2, the model is overidentified and two values can be recovered for G_o'.

[17] This is compatible with a positive firm-size effect in a regression that does not contrl for bargaining regime. Under fixed costs of coordination larger firms develop coordinated bargaining and extract more surplus.

4 Conclusion

We argue that it is realistic to introduce two leading assumptions in order to build a simple theory of the Union wage premium. The first one is that the relevant benchmark for comparing wages in firms with labor coordination is a firm where employees bargain with owners *without coordination,* rather than a firm where wages are exogenous. We assume that in firms where employees do not coordinate at bargaining, each employee individually bargains (possibly with very small bargaining power) with management. Under labor coordination employees delegate rights to make and accept offers to an elected labor representative. Coordination not only changes bargaining power, but it transforms the whole extensive form of the bargaining game. This has implications on the functional form of wages as a function of firm characteristics.

The second ingredient that we introduce is that we model wage formation in firms where there is ex post bargaining. As opposed to the Efficient Bargaining and Right to Manage paradigms, in our setting bargaining occurs after relevant investments have been sunk, but before production takes place. In this sense, we follow the seminal contribution of Grout (84), who focuses on the distortionary effects of ex post bargaining on non-verifiable investments. Instead, we analyze wage formation as a function of (in addition to *gross* surplus) agents payoffs when the employment relationship is *destroyed*. This leads to different implications of an ex ante bargaining theory, where wages depend (in addition to *net* surplus) on agents payoffs when the employment relationship is *not created*. Under ex post bargaining wages depend on two types of costs of destroying employment: direct firing costs (composed of severance payments and liquidation procedures) and the cost from lost surplus when a subset of productive employees are separated from the producing coalition. To the latter component we call the stake at bargaining. Stake at bargaining depends on the nature of agents investments in the firm: training (human capital) or investing in physical capital. We find that the costs of destroying employment crucially affects the distribution of rents inside the firm. In particular, under large firing costs labor enjoys a rent even if there are no quits or layoffs in equilibrium.

We find that the functional form of firing costs and the stake at bargaining as a function of the number of potentially fired employees determines the firm size-wage effect (the relationship between wages and firm size), but only in firms with labor coordination. In firms with individual bargaining wages

are independent of the size of the firm. This is because under individual bargaining employees compete for offers. The worst outcome for the firm when bargaining with an individual agent is to suffer the cost of destroying one employment relationship, independently of the owner's relationships with the other employees.

We derive a test the hypothesis that labor coordination (that is observable) transforms the extensive form of the bargaining game. The test is based simply on a least squares approximation to wages, with firm characteristics and cross-products as regressors. Our derivation of the wage equation maps the structural parameters to the estimable parameters. We reject the hypothesis that coordination does not change the extensive form of the game. We find in particular that coordination substantially increases labor's bargaining power , but damages its ability to pose costly threats to ownership. Our least squares specification is consistent as long as the structural parameters are economy-wide functions and not firm-specific functions. We argue for the plausibility of this assumption.

Our general contention is that the ex post bargaining approach (in the spirit of Grout (84) and Hart and Moore (90)) to labor relations is a fruitful avenue for research. Problems of dynamic inconsistency in contracting are a salient feature of labor relations, since Constitutions generally assure the right to strike and the right to (costly) terminate ventures at any point in time. Here we have built a simple theory of wage formation under ex post bargaining, but the number of potential extensions (like endogenizing the coordination, effort levels, firm size decisions, etc.) seems large.

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Appendix

Description of the data[18]

In order to provide empirical evidence on main predictions of the model, we collect data on the existence of formal firm-level bargaining in Spanish firms. In Spain, unlike other countries, there are no surveys on firms regarding industrial relations. Thus, a comprehensive statistical source on industrial relations and firms' characteristics is not available. The main statistical source on Spanish collective bargaining is the *Collective Agreement Statistics* (*Estadística de Convenios Colectivos*), developed from the register of collective agreements kept by the Spanish Ministry of Employment[19]. Data from this source provide information on the number of firms with formal bargaining and the number of workers affected by them, since 1981. However, they do not provide information on relevant economic variables (like wages, productivity, surplus, etc.) of firms with formal bargaining. Thus, data from the *Collective Agreement Statistics* has to be supplemented by a data set with firm-level economic characteristics, that contains firms under both regimes (with and without formal bargaining).

The supplementary data source that we use is the *Bank of Spain's Survey on Firm's Balance Sheets (Central de Balances del Banco de España).* This is a survey conducted by the Bank of Spain since 1982, that has information on relevant economic variables (like employment, production, labor costs, profits, etc.)[20]. Matching these two data sources we have a sample of firms under the two regimes, formal bargaining and no formal bargaining. We perform the matching using the information for 1990. Hence, in our sample, a firm with formal bargaining is a firm which has a collective agreement registered in 1990 and was covered by the *Bank of Spain's Survey on Firm's Balance Sheets*[21]

[18]The data used corresponds to the same data base than the one used in Palenzuela and Jimeno (96). We briefly describe the variables definition follwing the data section in that paper.

[19]Collective agreements must be registered in the Ministry of Employment in order to be legally enforceable.

[20]Bentolila and Dolado (1994) use this database to estimate a insider-outsider model of wage determination in Spanish firms.

[21]