



**UNION-FIRM BARGAINING AND THE
INFLUENCE OF OUTPUT MARKET POWER
AND PRODUCTION TECHNOLOGY
ON THE FIRM SYSTEMATIC RISK**

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Discussion Paper n° 9201

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D/1992/3082/01

**Union-Firm Bargaining
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The relationship between the CAPM firm β and the firm's microeconomic decisions is studied by a model under uncertainty, which combines the feature of an ex ante 'inputs substituable' production technology and the existence of a specific union which may bargain over different economic dimensions of the firm. It is shown that the earlier findings of a relationship between the firm β and such variables like the labor-capital ratio may be reinforced through the indirect channel of labor market bargaining, although the relationship heavily depends on the timing and scope of the union-firm bargaining process.

* This paper is part of the IRES 'Price and Wage Formation' programme. The research has been made possible under a F.D.S. grant at U.C.L., Louvain-la-Neuve. I have already benefited from discussions with J.B. Châtelain and D. de la Croix, and from participants at seminars at IRES and at Facultés Saint-Louis, Brussels. I also want to thank Prof. R. Anderson and L. Booth for their comments.

1. INTRODUCTION

There have been some recent attempts in the finance literature to relate firm systematic risk to the microeconomic decisions of the firm (see e.g. SUBRAHMANYAM and THOMADAKIS [1980] or BOOTH [1981]). But nearly all papers have restricted themselves to assuming pure competition in input markets, omitting the analysis of more complex input competition conducts on the relationship between firm risk and its market decisions.

This paper aims at filling this gap by highlighting *how the introduction of labor market imperfection under the form of (decentralized) firm-union bargaining* may impact the relationship between the firm risk, its labor-capital intensity, and its output market power.

The paper objective - we believe - seems worthwhile because it accounts for the common criticism of asymetry in models which postulate *imperfect* output market competition, *together with pure competitive input markets*. In this respect, the empirical fact of many *unionized* firms requires to model the labor market in terms of the recent advances in the theory of firm-union bargaining, which precisely develops interesting links between output *and* labor market power (refer e.g. to DOWRICK [1989;1990] or BUGHIN [1991]).

By concentrating on a simple model where risk is measured in a 'mean-variance-capital-asset-pricing model' framework (- henceforth, *CAPM* -) , we show, among others, that in a world where capital and labor are to some degree substituable, the relationship between one firm β and its capital-labor ratio is *indeed reinforced by the conjunction of the firm monopoly position and its union power in the labor market*.

That is to say, as *endogenous* variables, the firm β and its capital-labor ratio are both determined by the same exogenous variables, - such the price-elasticity of product demand - ,*but* - and this is also a crucial by-product of this analytical study - the complete set of common exogenous variables and their respective influence on the firm β and capital-labor ratio are actually shown to depend on the bargaining *scope* prevailing between the union and the firm.

To anticipate this, assume in the first place that the bargaining scope is restricted to the wage, so that, as in the ANDREWS and NICKELL [1983] '*right-to-manage*' model, the firm retains its own management right over the determination of labor ; when a greater output market power by the firm reduces unambiguously the risk of the firm - as shown e.g. by SUBRAHMANYAM and THOMADAKIS [1980] ; BOOTH [1981] or CHEN *et alii*

[1986] -, this paper also makes clear that greater output market power also incites a powerful union to require a higher bargained wage. In turn, this effect, and because of the traditional downward-sloped labor demand curve, increases the capital-labor ratio through a relative price effect.

But, while the introduction of a '*right-to-manage*' union-firm bargaining process allows the firm β and its capital-labor ratio to be *negatively* linked through the effect of firm monopoly power, this link is no longer so obvious when the bargaining scope is enlarged to the negotiation over, say, labor as is the case with the MAC DONALD and SOLOW [1981] '*efficient*' bargaining model. Generally, depending on whether the union is wage- or employment-oriented, and depending on the union power when negotiating respectively over wage and labor, the wage-labor locus may become *positively* sloped so that bargaining power over labor becomes also crucial for assessing the link between the firm β and its capital-labor ratio.

It happens that the introduction of union-firm bargaining becomes relevant not only from a theoretical point of view in revealing new channels between financial decisions and real market decisions (refer also to BRANDER and LEWIS [1986]); the introduction of labor market bargaining is also crucial from an empirical point of view by showing that union power when negotiating over wage, *as well as* over labor must be used as supplement control variables in studies between β and operating leverage. This stratification of the data according to output and labor market power is in contrary to early works by LEV [1974] or MANDELKER and RHEE [1984], and may explain their (quite) decevant results.

The paper is organized as follows.

Section 2 develops a model of the firm under uncertainty and derives some relationships between the firm systematic risk and some of the microeconomic variables of the firm. In the section, union-firm wage bargaining is introduced, under the assumption of a simple union seniority model *à la* OSWALD [1987], and the basic propositions are derived. Section 3 discusses some extensions to the precedent model: assuming an union utility function which gives some weight to labor, the model is refined to analyse the impact of different bargaining scopes. Section 4 summarizes the main findings, and provides the concluding remarks.

2. THE BASIC MODEL¹

2.A. The assumptions

The model presented in this section is made the simplest possible, in order to concentrate preliminary on the problem on hand, that is, the introduction of (decentralized) firm-union bargaining in models of firm uncertainty. Generalization is possible, and extensions are discussed in Sections 3 and 4 of the paper.

The analysis focuses on a representative firm which operates in a single horizon period and the following assumptions are taken:

1. The firm is a 'one-product' firm and faces a downward-sloping demand curve, where ϵ stands for the constant price-elasticity of demand.
2. The firm produces with a technology, f , which depends on two homogenous inputs, labor, L , and capital, K , and is of the Cobb-Douglas form with non increasing returns-to-scale.
3. Demand to the firm is uncertain and demand shock, ξ , is assumed normally distributed with mean zero².
4. Inputs decisions are made simultaneously, before the demand shock is known [Hence, the only source of risk is a price-uncertainty].
5. Capital, K , is only obtained through the purchases of securities, and by agents other than the firm workers.

¹ From now, and in order to provide some substance to our analysis, we will assume, if not otherwise stated, the existence of output market power and union power over wage and labor.

² As specified, and following the supplement assumptions 4 and 7, the random variable allows the possibility that the quantity-setter firm may receive a negative price, or that ex post profit may be negative. Hence, strictly, the constraint that the firm does not receive a negative price should be included in the optimizing problem, as well as the constraint that the bargained wage may not imply negative profit. Henceforth, we assume that the support of noise is small enough that these constraints never affect the equilibrium, and the constraints are no longer made explicit in the main text (for the same assumption, see e.g. KLEMPERER and MEYER [1986]).

6. The firm is a price-taker in the financial market and price uncertainty is valued by a complete set of contingent security prices, while securityholders value firms by maximizing an utility function which is quadratic in income.

7. Wage, w , which is paid with certainty at the end of the period, is negotiated through bargaining between a representative union and the firm, simultaneously with the input decisions.

8. Union utility, that we denote by U , depends only - and positively- on the wage.

9. The risk-free rate r is normalized to zero and capital is fully depreciated at the end of the period.

Before elaborating on the model, a few words about those assumptions are in order:

Assumption 1 is mainly taken to parallel earlier analyses of the impact on firm risk on output market power, which focused on the monopoly power effect through the value of the price-elasticity of the demand the firm faces for its product (see e. g. BOOTH [1981]). The case of monopolistic competition easily follows (refer to CAHUC and LAURENT [1989]), while the case of oligopoly is somewhat more complicated as conjectured from the work by DOWRICK [1989]³.

Assumption 2 is made for analytical tractability, and results found here also apply to more general technological forms. We also postulate non-increasing returns-to-scale to concentrate directly on first-order conditions, and assure the concavity of the NASH bargaining solution. Finally, introducing substitutability in the production function (as implied by the COBB-DOUGLAS) is required to allow the capital-labor ratio to adjust to relative input price effects.

³ In DOWRICK [1989], it is namely shown that, provided union cares about employment, an increase in collusion in a right-to-manage model may lead to the special case that wage decreases with output market power.. Incorporating this result in our framework, this would mean that a positive relationship could occur between firm β and its capital-labor ratio. However, we do not believe this case to be interesting empirically, due to: - its theoretical specificity; - the empirical evidence that the right-to-manage model is rejected in favor of more general bargaining models which allow for some union power during labor negotiation; - and the problem of measuring collusion among firms adequately.

Assumptions 3 and 4, which imply that the firm output is decided before uncertainty is resolved, are of course necessary to allow -if any- for risk premium ⁴. Notice already that a crucial aspect of the model is the putty-clay nature of the firm technology, that is, both inputs (capital and labor) are chosen *ex ante* by the firm to maximize its market value. By those assumptions the valuation of uncertainty will of course matter, but since price uncertainty will impact on both inputs equally, the optimal capital-labor ratio [*but not* the levels of capital and labor] will be *independent* of risk premium. The motivation behind this model, with a fixed capital-labor ratio *ex post*, is to match closely the early model by SUBRAHMANYAM and THOMADAKIS [1980] ⁵.

The *Assumption 5* of 'all securities' firm is undertaken in all of the studies dealing with the linkage between firm risk and its capital-labor ratio. The assumption is taken to abstract for the effect of debt in the firm valuation and so, to abstract for the possible impact of the debt-equity mix strategy on optimal investment (JENSEN and MECHLING [1976]), and output strategies (BRANDER and LEWIS [1986]) ⁶.

Assumption 6 allows to value firm risk within the Sharpe-Lintner CAPM. Generalization to other cost of capital measures is straightforward and is e.g. discussed in BOOTH [1991].

⁴ The question whether firms should be concerned themselves with the shareholders' risk remains an open question but as argued, say, in OSLER [1991], the MODIGLIANI-MILLER [1958] is based on unrealistic assumptions, and " ..while it would be ordinarily impossible for widely held firms to concern themselves with shareholder utility *per se*, they have certainly been known to smooth earnings for the benefit of their shareholders " (p. 1316; footnote 11).

⁵ To be more precise, and as it will be apparent later on in the formulation of the optimal capital-labor ratio, the " *ex ante* capital-labor choice model involves the choice of labor and capital prior to the resolution of the uncertainty. As a result, the equity owners do indeed provide the money capital at a competitive rate taking into account the equilibrium level of uncertainty " (correspondance with L. Booth, November 1991). Extension to flexible production models, in which, say, labor adjusts *ex post* to price uncertainty, is possible, but is not considered in this study, mainly because bargaining involves strategic underinvestment (see e.g. PENCARVEL [1991]) which is difficult to deal with in a model of uncertainty.. A model with *ex post* flexibility represents however a fruitful avenue, because it will capture more adequately the finance notion that capital is riskier than labor because its costs are fixed.

⁶ Incorporation of those aspects in the model below are beyond the scope of this paper, but allowing for those aspects is by no doubt worth to be investigated in further research.

Assumption 7 introduces the bargaining situation in the model. The fact that we consider wage being paid with certainty at the end of the period implies that the firm engages itself with long-term contracts. Wage contract that deals with uncertainty by specifying state-contingent wages is an alternative, which is e.g. somewhat discussed in BOOTH [1981], but that we omit here for simplicity [recall here the footnote 2].

Assumption 8 refers to the union seniority model in which the union is dominated by some sub-coalitions who know themselves to be insulated from job loss. Yet a priori restrictive in its own right ⁷, the assumption has the advantage of neglecting the difference between the NICKELL-ANDREWS [1983] right-to-manage model and more general forms such the McDONALD-SOLOW [1981] efficient bargaining model. Section 3 generalizes to an utility form with weight given to labor in order to discuss how the propositions expressed in section 2 are contingent to the bargaining *scope*, ranging from wage alone to both wage and labor.

Finally, *assumption 9* is made for simplicity. The model is easily extended, namely when allowing capital not to fully depreciate at the end of the period ⁸. As noted e.g. by BOOTH [1991], however, it is easy to show that *both the risk-free and the depreciation rates affect the firm capital-labor and β in opposite directions*, so that those effects on the negative relation between the firm risk measure and its capital-labor are implicitly present in this model.

⁷ Refer e.g. to KEMP et alii [1987, p.1095] : ' It may be wondered how a seniority-based union can survive if it secures employment for only half of its members'.

⁸ Note that full depreciation is consistent with a one-period model.

2.B. The model

2.B.1. The firm respective cash-flows and profits:

Following assumptions, one notes the firm market values, at the beginning and at the end of the period, respectively by ⁹:

$$Vb = [p \cdot (1-\lambda) \text{cov}(\xi, Rm) \cdot Q - wL] / (1+r) \quad [1]$$

$$Vf = p^* Q - wL \quad [2]$$

where:

- Vb is the expected utility value of the firm cash-flow by equity holders; - Vf is the ex-post cash-flow, that is, the observed cash-flow when the shock is known to the demand;
- $p^* = (1+\epsilon) \cdot p$ is the *ex post* price, while p is the *expected* output price;
- λ is the market price of risk; - Rm is the return of the market portfolio;
- r is the one-period risk-free rate, which under *assumption 9* above is normalized to zero;
- Q is the firm output and is such that $Q = K^a L^b$.

The goal of the firm amounts to maximizing the wealth of its equityholders, that is, identifying $(1-\lambda) \text{cov}(\xi, Rm)$ by χ :

$$\text{Max } V = Vb - kK = p \cdot \chi Q - wL - kK \quad [3]$$

where k is the original cost of capital, which -without involving loss of generality, is set to $k = 1$ for notational ease.

⁹ See BOOTH [1991]: note $\Pi(s)$ the cash-flow value depending on state of nature s , then:

$$V = \sum pr(s) \psi \cdot \Pi(s) = E(\psi \Pi)$$

where $P(s)$ is the probability of state s occurring and ψ is the ratio of the equityholders' marginal utility of income in state s on the marginal utility of current income. Expanding the expectation term E and noting from our previous assumptions that the utility is quadratic, V is again rewritten as:

$$V = (1/(1+\epsilon)) [E(\Pi) - A \cdot \text{cov}(Rm, Vm, P)]$$

where Vm is the total market value and A is the Arrow-Pratt measure of constant absolute risk-aversion, which is easily related to λ following our assumption of the one-period CAPM.

2.B.2. The firm optimal capital-labor ratio:**- The optimal level of capital and labor**

Because the utility form of the union only depends on the wage, K and L are always set at their efficiency levels, i.e., [3] is maximized over K and L , yielding the following first-order conditions:

$$R_N = p \chi^b K^a L^{b-1} (1-m) = w \quad [4]$$

$$R_K = p \chi^a K^{a-1} L^b (1-m) = 1 \quad [5]$$

where R_N (resp., R_K) is the marginal revenue product of labor (resp., capital) and $m = 1/|\epsilon|$ is the reciprocal of the absolute price elasticity of product demand.

Combining [4] and [5], it follows that the optimal labor-capital ratio writes:

$$K/L = (a/b) \cdot w \quad [6]$$

which is function of the state of the technology (as measured, say, by a) and of the relative prices (as measured by w).

Of course, as conjectured previously in the discussions of the model assumptions, the optimal capital-labor ratio expressed by equation [6] does not depend on uncertainty as both inputs *are chosen symmetrically ex ante with no possible ex post flexibility in either inputs*. But equally important also, equation [6] is *not a closed form* because the wage is the result of a bargaining process between the firm and the union.

- The optimal wage

Applying a generalized Nash solution, S , as the outcome of the bargained wage, w writes ¹⁰ :

¹⁰ The use of the generalized Nash product as the possible outcome of bargaining is common place in labor economics and has been rationalized in a strategic context by BINMORE et alii [1986].

$$w = \operatorname{argmax} S = \operatorname{argmax} [(U - U^0)^\tau \cdot (V - V^0)] \quad [7]$$

where:

- U, V are the respective utility of the union and the firm, with $U = w$ as discussed above, and V is provided by [3];
- U^0, V^0 are the fall-back utility levels which are assumed respectively equaling the outside option for simplicity ¹¹;
- $\tau (\geq 0)$ reflects the union power relative to the (normalized) power of the firm.

The condition [7], under the constraints [4] and [5], writes again:

$$\delta \ln S / \delta \ln w = \tau / [w - w_a] + V'(w) / V(w) = 0 \quad [8]$$

where the symbol w_a stands for the measure of the alternative wage - that we assume exogenous ¹² -, and V^0 is set to zero ¹³;

so that the wage in equation [6] is the solution to:

$$w - w_a = \tau \cdot (V/L) \quad [9]$$

because the partial derivative of V with respect to w , $V_w = -L$.

Substituting the expression for V , the optimal wage, w^* , writes also:

¹¹ Strictly speaking, the fall-back is defined as the level of utility available to the parties when facing *temporary* disagreement. Outside options, on their hand, represent the utilities available when negotiation fails and actors close the negotiation. In the general case, thus, outside options appear as *constraints* to the Nash solution expressed with fall-back utility levels, and those constraints implicitly bind in our approach by postulating strict equality between the fall-back and the outside points.

¹² This is only a statement about partial equilibrium. For example, in a general equilibrium framework, with similar firms, the outside wage is the same for each firm, so that w_a becomes dependent on w^* . We omit this possibility here for simplicity, but the analysis can be easily extended in that way, without modifying the qualitative results expressed in this paper.

¹³ By setting $V^0 = 0$, we are consistent with the capital budgeting problem where the firm is restricted by a *non negative* marginal net present value.

$$w^* - w_a = \tau \cdot w^* [(p \chi Q / w^* L) - 1 - (K/w^* L)] \quad [10]$$

or, expressing L and K as functions of output quantity, Q :

$$K = a p \chi Q (1-m) \quad [11]$$

$$L = b p \chi Q (1-m) (1/w) \quad [12];$$

w^* is the solution to :

$$[w^* - w_a]/w^* = \tau [(1/(1-m) b) - 1 - (a/b)] \quad [13]$$

that we may simplify for expository purpose to:

$$w^* = w_a / (1 - \tau \cdot [m / (1-m) b]) \quad [14]$$

when making the supplement assumption that $a+b=1$ (i.e., constant returns to scale) .

Omitting 'degenerate' cases ¹⁴, the following proposition emerges:

PROPOSITION 1: *Given assumptions 1-9, the negotiated wage is an increasing function of the union power and of the utility fall-back, and decreases with the (absolute) level of the firm price-elasticity of product demand and the labor intensity of the production technology.*

The rationale behind this proposition is quite straightforward as one will find self-evident that wage increases with the outside wage, and union power over wage. Also, the assertion that wage increases with the monopoly power of the firm comes from the fact that firm profit is increased and union faces the situation of a higher 'cake' to be shared. Finally, the finding that wage decreases with the labor-intensity of the firm technology is understood by the fact that the higher the labor-intensity of the firm technology, the more reluctant the firm to any increase in the wage, which in fact translates into a higher wage bill.

¹⁴ That is, [14] only holds true for $1 \geq (1 - \tau \cdot [m / (1-m) b]) \geq 0$, which implies an upper bound on τ . In the following, we assume away this constraint on τ , by assuming that the values of the exogenous are such that the constraint is never binding. Furthermore, we assume $m > 0$ for proposition 1 to hold true. [This restriction is however necessary only under the case of constant returns-to-scale].

Given *proposition 1* and the fact that $\delta (K/L) / \delta w > 0$, [following the inputs-substitutable technology], the same comparative statics as for the negotiated wage are true for the capital-labor ratio.

- The structural capital-labor ratio

Indeed, substituting the expression [14] into equation [6], one gets:

$$K/L = (1-b/b) \cdot (w_a / (1-\tau \cdot [m/(1-m)b])) \quad [15]$$

where partial derivatives are easily found and of the following sign:

$$\delta (K/L) / \delta b < 0; \delta (K/L) / \delta \tau > 0;$$

$$\delta (K/L) / \delta w_a > 0; \delta (K/L) / \delta m > 0$$

so that proposition 2 appears:

PROPOSITION 2: *Given assumptions 1-9 above, the capital-labor of a technology with ex ante substitutable inputs, is an increasing function of the union power and of the utility fall-back, and decreases with the (absolute) level of the firm elasticity of product demand and the labor intensity of the production technology.*

This proposition seems not too heroic as e.g. it is in accordance with the empirical findings that capital-intensity is higher in concentrated industries. However, we wish to anticipate on section 3 by already asserting here that proposition 2 depends on the bargaining *scope* it is postulated in the firm labor market.

2.B.3. The firm beta:

Holding *proposition 2* aside for the moment and its robustness with regard to other bargaining schemes, the firm cost of capital following the CAPM theory is defined by 15:

¹⁵ In what follows, we concentrate on the typical case where the *beta* measure is positive, that is, when $\text{cov}(\xi, R_m) > 0$. Naturally, the results are reversed in the (very uncommon) case of a negative firm *beta*.

$$\beta_{\text{eta}} = \text{cov} (R, R_m) / \text{var } R_m \quad [16]$$

where R is the firm return is defined as: $[V_b - V_f]/V_f$, so that [16] is equivalently written as:

$$\beta_{\text{eta}} = \text{cov} ([V_b - V_f]/V_f, R_m) / \text{var } R_m \quad [17]$$

or:

$$\beta_{\text{eta}} = \text{cov} (V_f, R_m) / V_b \cdot \text{var } R_m \quad [18]$$

or:

$$\beta_{\text{eta}} = \text{cov} (V_f, R_m) / \text{var } R_m \quad (p \cdot \chi \cdot Q - w L) \quad [19]$$

Again, replacing V_f by its expression [2], and expressing L as a function of Q , one has:

$$\beta_{\text{eta}} = \text{cov} (\xi, R_m) / \text{var } R_m \quad (\chi [1 - (1-m) \cdot b]) \quad [20]$$

so that *proposition 3* is found:

PROPOSITION 3: *When a firm has positive capital cost (i.e. , $\beta_{\text{eta}} \Rightarrow 0$; see footnote 15), and determines its inputs on their respective input demand curves, the firm cost of capital, as measured by the one-period CAPM, is positively related to the labor intensity of the underlying production technology, and negatively related to its output monopoly power.*

This proposition is not new: it is in essence what is found in SUBRAHMANYAM and THOMADAKIS [1980], but adapted here within the context of an ex ante 'inputs substitutable' technology function. The rationale behind the proposition is also quite straightforward: ceteris paribus, a higher labor intensity increases the wage bill so that the risk is spread over less value, and risk premium increases accordingly; furthermore, a higher monopoly power lowers marginal revenue, which ceteris paribus reduces the variance of observed revenue, and risk premium is also reduced accordingly.

2.C. The relation between firm β and its capital-labor ratio

The analytics above are sufficient to analyse hereafter the relationship between the firm risk and its capital-labor ratio.

Merging *proposition 3* with *proposition 2*, one finds that the firm β and its optimal capital-labor ratio vary together with some identical exogenous variables, and specifically, - omitting the risk-free and the depreciation rates; recall assumption 9 -, the firm output market power and the labor intensity of the production technology.

It follows that as BOOTH [1991, p. 114] says : ' (..) *It is not meaningful to talk about a causal relationship between the cost of capital and the capital-labor ratio (..)* ', but rather that the cost of capital and the capital-labor ratio, as *endogenous* variables, are both determined by the same *exogenous* variables.

Comparing with the case where purely competitive labor market is assumed, we find the main result *that the output market affects both variables*, so that we are able to assert the following proposition:

PROPOSITION 4: *Under assumptions 1-9 [and focusing on positive β 's] , the negative correlation between firm capital-labor ratio and its cost of capital is caused by either the firm labor intensity of the production technology and/or the firm output monopoly power.*

What this proposition adds to earlier works in the field, is the emphasize that *input market imperfection may interfere with this relationship* : specifically, within an unionized firm, the firm knows that the existence of some bargaining power by the union makes the negotiated wage depending on the firm monopoly rents, *and so*, the firm increases its capital/labor ratio; on the other hand, monopoly power reduces marginal revenue so that the contribution of revenue to the variance of firm cash-flow is reduced (*and so* , the risk premium as measured by the CAPM β). .

Proposition 4 remains however dependent on critical assumptions. The next section analyses the robustness of the various propositions set out in this present section by enlarging the bargaining scope to labor.

To anticipate, it will be seen in this larger context that the firm β and the firm capital-labor ratio are both influenced by the union power over employment. This already creates

a new channel by which the firm β and its capital-labor ratio are linked, although that link will be seen to depend on the relative union strength when negotiating over labor and wage respectively.

3. GENERALIZING THE BARGAINING SCOPE

One natural *-and critical-* extension to the model presented so far concerns the generalization of the union utility function to more complex forms.

In what follows, we consider a simple utility function where some weight is attributed to labor, L . By this extended utility form, one can analyse the aspects of different bargaining scopes without providing the trivial case that even when union bargains over variables in addition to the wage, optimal labor always lies *on* the firm labor demand curve.

In order to focus on a union utility function which differs non-trivially from the seniority model proposed in Section 2, we adopt in the following the special rent-maximizer case:

$$U^* = (w - w_a) \cdot L \quad [21]$$

More general cases are possible ¹⁶, but the specific union model, as given by [21] is sufficient for our purpose.

¹⁶ PEMBERTON [1988] paper is interesting in this respect; the author derives a 'managerial' model of trade union in which union policy is influenced both by leadership and membership preferences. On their hand, CARRUTH and OSWALD [1987] deal with the case with insider-outsider members and the relationship between insiding and the employment - membership ratio.

Note that, by assuming pure-rent maximizing behavior, we assume away either risk-loving or risk-aversion by union members, which seems like an asymmetry in a model where shareholders are postulated risk-averse. However, recall first that the arguments in the workers' utility function are not subject to any shock, on the contrary to the argument in the utility function of the shareholders (recall [2]), and second that an amendment of [21] is always possible such as, say, the following STONE-GEARY type utility function: $U^* = (w - w_a)^p \cdot L$ where p can also be interpreted as a risk-attitude parameter in the ARROW-PRATT sense. The case of an employment-oriented union ($p < 1$) corresponds to the case in the main text where the union power over labor is greater than over wage.

With U^* instead of U , we now proceed to show that the relationship between firm risk and its capital-labor ratio depends on the bargaining scope it is postulated in the firm-union negotiation.

To elaborate on this, denote τ , as in section 2, the (normalized) union power over *wage* while μ , *which is not necessarily equivalent to τ* , is the union power during *labor* negotiation.

As discussed by MANNING [1987], the 'right-to-manage' -which imposes $\tau = 0$ - and the 'efficient' - which imposes $\tau = \mu$ - bargaining models are both special cases of a more general model where union power over wage is different from than over labor : $\tau \neq \mu$.

In the following, we concentrate directly on this general case, as this will allow us to discriminate directly the actual effects of union power over wage and labor, respectively, on the various economic dimensions of the firm. The general model is in another respect that which seems the more relevant empirically (see AGOLOSKOUFIS and MANNING [1991]).

3.A. Optimal capital-labor ratio under 'general bargaining'

Because the union utility, U^* , depends positively on labor, it is conjectured that in a general bargaining model, optimal labor as given by [4] does not hold true, as well as the expression for the optimal capital-labor ratio (equation [15]).

Although the expression for the optimal optimal capital is still provided by expression [5] because the firm retains its management right over K , it is well-known from the 'efficient bargaining' literature (see e.g. ABOWD [1989], CLARK [1986]) that optimal labor will generally lie *to the right* of the traditional labor demand curve. This comes evidently from the fact that the union will make use of its power during labor negotiation to elude the more constraining trade-off between wage and employment as given by the firm labor demand curve.

Considering our general case, optimal level of labor becomes the solution to the problem:

$$L = \operatorname{argmax} [(U^* - U^0)^\mu \cdot (V - V^0)] \quad [22]$$

under the constraint that wage verifies (see [7])¹⁷ :

$$w = \operatorname{argmax} [(U^* - U^0)^\tau \cdot (V - V^0)] \quad [23]$$

with, as earlier said, τ stands for union power over wage, while μ , *which is not necessarily equivalent to τ* , is the union power during labor negotiation.

From [22] -[23], it follows that optimal labor verifies:

$$R_N = \underline{w} = \phi \cdot w + (1-\phi) w_a \quad [24]$$

where $\phi = [1 - (\mu / \tau)]$;

that is, in general, optimal labor is set at a level such that marginal revenue product of labor is a combined set of the firm own wage and the outside opportunity wage, with the particularity that, if $\phi < 0$ (respect., if $\phi > 0$) the shadow wage, $\underline{w}$, is *decreasing* (resp., *increasing*) in the negotiated wage, w ; and optimal capital-labor writes now:

$$K/L = (a/b) \cdot (\underline{w}) \quad [25]$$

Two important points stand out here:

- *first*, since any union power over labor makes the wage-labor curve lie *off*, *but to the right*, of the labor demand curve, overemployment of labor results;

- *second*, the effect of the bargained wage, w , on the firm capital-labor ratio depends on the union power over wage as compared to that over labor. With union power over labor greater than that over wage, the wage-labor outcomes locus becomes *positively* sloped, and an increase in the negotiated wage becomes associated with increase in labor employment, and thus a lower capital-labor ratio.

Those two points are crucial here as the first point already highlights some possible effects of union power over labor on the firm β , through the effect of union power

¹⁷ The program also is subject to the constraint that capital is set at the point where return to capital is equal to the marginal value of capital. The constraint is omitted here as not binding because the union utility function does not depend on the level of capital (refer to BUGHIN [1991] for a formal proof).

over labor on the total wage bill of the firm. The second point, on its hand, shows the crucial aspect of labor bargaining, which may create a positive link between firm β and its capital-labor ratio.

However, to determine a final expression for the 'general bargaining' firm capital-labor ratio, we still have to determine the bargained w in relation with the exogenous variables.

In this respect, the bargained wage, which stands for the outcome of [23] must appear as a generalization of equation [14] and, following the derivation shown in Section 2, the optimal wage, that we denote by $w^\wedge$, writes :

$$w^\wedge - w_a = \tau \cdot w^\wedge \left[(P \chi Q / w^\wedge L^\wedge) - 1 - (K/w^\wedge L^\wedge) \right] \quad [26]$$

with $L^\wedge$ is the level of labor employment as given by [22].

Given [25], [26] writes again:

$$w^\wedge - w_a = \tau \cdot w^\wedge \cdot \left[(P \chi Q / w^\wedge L^\wedge) - 1 - (1-b/b) ([\phi \cdot w^\wedge + (1-\phi) w_a] / w^\wedge) \right] \quad [27].$$

Since in the general case, the bargaining outcome $(w^\wedge, L^\wedge)$ lies *to the right* of the labor demand curve, the expression $[1/(1-m) b]$ does not match any longer the inverse of the *observed* labor share $(P \chi Q / w^\wedge L^\wedge)$. Rather, it equals the expression $(P \chi Q / \underline{w} L^\wedge)$ because $\underline{w}$ is the shadow wage that corresponds to a cost-minimizing firm.

Following works by BUGHIN [1991], the labor share becomes greater than within the case of the firm retaining its right over labor because union power in bargaining over employment reduces the margin of the firm, by imposing 'excess- labor' at each earning level. Specifically, and following BUGHIN [1991], one has:

$$(P \chi Q / w^\wedge L^\wedge) = [1/(1-m) b + \sigma m] \quad [28]$$

where:

$$\sigma = [\mu / 1 + \mu]. \quad [29]$$

so that the ex post margin $m^{\wedge} = [1/(1+\mu)] m$ is lower than m because of the union imposing a solution *to the right* of the labor demand curve and hence, imposing an extra wage bill to the firm ¹⁸.

Following [28], the wage equation is finally derived:

$$w^{\wedge} - w_a = \tau \cdot w^{\wedge} [(1/(1-m)) b + \sigma m^{-1} - [(1-b)(1-m)] / (1-m)b + \sigma m] \quad [30]$$

that is :

$$w^{\wedge} = w_a / 1 - \tau \cdot [1 - (1-m)b - \sigma m - [(1-b)(1-m)] / (1-m)b + \sigma m] \quad [31]$$

which writes also:

$$w^{\wedge} = w_a / 1 - \tau \cdot [(1-\sigma)m / (1-m)b + \sigma m] \quad [32]$$

and correctly degenerates when $\sigma=1$ to the specific case given by equation [14], that is, when one imposes optimal labor to lie *on* the conventional labor demand curve.

Incorporating [32] into [25], one finds the optimal capital-labor ratio as:

$$K/L = ([1-b]/b) \cdot w_a \frac{[(\phi + (1-\phi)) [1 - 1/(1-\tau) [(1-\sigma)m / (1-m)b + \sigma m]]}{1 - \tau \cdot [(1-\sigma)m / (1-m)b + \sigma m]} \quad [33]$$

so that in the case of the 'efficient bargaining' case ($\tau = \mu$), one will check easily that the capital-labor ratio is independent of the firm wage, and only depends positively on the

¹⁸ The mathematical formula may be easily understood by taking some special cases:

- *first*, assume that the union has no power in negotiating over labor. In this case, $\mu = 0$ and one finds again that $m^{\wedge} = m$ because the union has no power to constrain the bargained outcome *to the right* of the labor demand curve;
- *second*, assume identical power for the union and the firm in the negotiation over labor. In this case, $\mu = 1$, so that we find the common Nash solution, while $m^{\wedge} = 1/2 \cdot m$ which correctly amounts to saying that the union and the firm shares equally the extra cake given by the monopoly rent, m ;
- *third*, in the case where the union has all the power in fixing the level of employment ($\mu = \infty$), then the union will choose employment at a level where the associated marginal costs equal the average revenue of the firm, so that $m^{\wedge} = 0$.

outside option, w_a (CLARK [1984]), while if one imposes the constraint that the firm is on its conventional labor demand curve, the equation degenerates correctly to [15].

Hence, since equations [32] and [33] are clearly generalizations of the results expressed with the specific assumption of union-management negotiations being on the conventional labor demand curve, we should be able at this stage to generalize the propositions expressed in section 2.

As to proposition 1 that refers to the exogenous influences on the bargained wage, the comparative statics hold true for the more general equation [32], that is, the wage remains an increasing function of the union power over wage, of the firm output market power [i.e., of the inverse of the absolute price-elasticity of demand, $1/\epsilon$], the capital-intensity of the technology, and the utility fall-back. However, what becomes apparent from [32] is that the bargained wage is also decreasing in the union power over labor, μ . This result is not surprising as it simply shows that the overemployment of labor reduces the surplus available for higher wage claims to the union [recall, say, from [9], that negotiated wages depend positively on profit *per unit of labor employment*] :

PROPOSITION 5: *Under general bargaining with ex ante substitutable inputs, proposition 1 holds true, but we also find that the bargained wage decreases ceteris paribus with the union power over labor.*

Interesting also is the generalization of proposition 2, because it has been shown in [24] that the shadow wage which determines the relative price effect in the optimal capital-labor ratio is *either increasing or decreasing in the observed wage*, depending on the relative union power over wage and labor employment. From [33], one should be willing to anticipate that:

- i) - as long as union power over wage is greater than union power when negotiating over labor (i.e., the wage-labor locus remains negatively-sloped) any variable which impacts positively (resp., negatively) the bargained wage impacts also positively (resp., negatively) the optimal capital-labor ratio;
- ii) -the reasoning going symmetrically, but in the opposite way, if the union power over wage is lower than union power when negotiating over labor.

As shown hereafter, however, the part "ii)" of this conjecture is only valid under certain restrictions; this may be verified by applying partial differentiations to equation [33], but, in order to isolate the various effects, this is done henceforth by merging [24] and [25] so that one has:

$$K/L = (1-b/b) \cdot ([1 - (\mu/\tau)] w^{\wedge} + [\mu/\tau] w_a) \quad [34]$$

and the derivatives with respect to m , b , w_a , μ , τ are:

$$- \delta[K/L] / \delta m = (1-b/b) \cdot [1 - (\mu/\tau)] \cdot \delta w^{\wedge} / \delta m \quad [35];$$

$$- \delta[K/L] / \delta b = (1-b/b) \cdot [1 - (\mu/\tau)] \cdot \delta w^{\wedge} / \delta b \\ + (-1/b^2) ([1 - (\mu/\tau)] w^{\wedge} + (\mu/\tau) w_a) \quad [36];$$

$$- \delta[K/L] / \delta w_a = (1-b/b) \cdot ([1 - (\mu/\tau)] \cdot \delta w^{\wedge} / \delta w_a + [\mu/\tau]) \quad [37];$$

$$- \delta[K/L] / \delta \mu = (1-b/b) \cdot [1/\tau] ([w^{\wedge} - w_a] + [1 - (\mu/\tau)] \cdot \delta w^{\wedge} / \delta \mu) \quad [38];$$

$$- \delta[K/L] / \delta \tau = (1-b/b) \cdot ([\mu/\tau^2] ([w_a - w^{\wedge}] + [1 - (\mu/\tau)] \cdot \delta w^{\wedge} / \delta \tau)) \quad [39];$$

so that from [35] to [39], and considering the case where union power over wage is greater than over labor (i.e., $\mu < \tau$), one will check that *unambiguously*, the capital-labor ratio remains increasing in the firm output market power, the capital-intensity of the technology, the union alternative wage and the union power over wage (part "i)" of the conjecture).

Those results are of course not terribly surprising because the locus of wage-labor outcomes remains negatively-sloped in the wage-labor space, as it is the case when the firm lies on its conventional demand curve. Hence, proposition 2 generalizes to:

PROPOSITION 6: *Under general bargaining with ex ante flexible inputs, and as long as union power in wage is higher than in employment, proposition 2 holds true, with the supplement finding that the capital-labor ratio is decreasing in union power over employment.*

[Note that the final of this proposition, which follows directly from equation [39], reflects the idea that union constrains the firm to overutilize labor more than capital, even with constant returns-to-scale. This follows from the additional substitution effect between capital and labor which arises from the fact that union reduces its wage claims when increasing its power over labor (see proposition 5)].

All of those results, one reminds, depend critically on the respective union power over wage and labor. Hence, again from [35] -[39] (or from [33]), it is straightforward to see that:

PROPOSITION 7: *In case of union power over wage being lower than that over labor, the capital-labor of the firm is decreasing in the firm output market power. Further, under 'reasonable circumstances' the capital-labor remains positively linked to union power over wage and the capital-intensity of the technology while it remains negatively related to union power over labor employment. The effect of the union alternative wage on the capital-labor ratio is also not defined a priori.*

Proposition 7 is thus not the symmetric case of proposition 6, because the influence of the capital intensity of the firm technology, the union power over wage and employment, and the alternative wage on the capital-labor ratio is not defined *a priori*. This is because, when the wage-locus is *positively-sloped*, the exogenous variables play *opposite* effects on the wage and on the other components of the optimal capital-labor ratio, so that the sign of the net effect remains undefined.

In principle, however, 'reasonable circumstances' make sure that *independently of the slope of the wage-labor locus*, the capital-labor ratio remains (logically) positively linked to the capital intensity of the firm technology and to the union (resp., the firm) power over wage (over labor) ¹⁹. On its hand, the effect of the alternative wage on the capital-labor ratio depends critically on whether the firm has chosen a capital-intensive technology *and* on the relative union power over wage and labor.

In the following, we will assume that the values of the exogenous are such that the capital-labor ratio decreases with union power over labor and with the labor-intensity of the technology; following this assumption, and propositions 6 and 7, one may hence note that the existence of union power over labor may be crucial to assess the role of the firm output power on the capital-labor ratio. Since monopoly power also impacts the firm β (see proposition 3), it is time to analyse how 'general bargaining' impacts the firm β ,

¹⁹ For instance, the cut-off value of the labor-intensity of the technology, b^* , is such that :

$$(1 - b^*/b) \cdot [1 - (\mu/\tau)] \cdot \delta w^*/\delta b^* = (1/b^{*2}) \cdot ([1 - (\mu/\tau)] w^* + (\mu/\tau) w_a)$$

but we may be self-confident that b is sufficiently high that it exceeds the cut-off value, below which the capital-labor ratio should become *positively* linked to the labor-intensity of the technology.

so that one could analyse further in this general setting the relationship between the firm β and its capital-labor ratio:

3.B. The firm β

Recall that the firm β writes by definition:

$$\beta = \text{cov} ([V_b - V_f] / V_f, R_m) / \text{var } R_m \quad (\text{see [17]})$$

or, given our model assumption:

$$\beta = \text{cov} (V_f, R_m) / \text{var } R_m \quad (p \cdot \chi \cdot Q - w L) \quad (\text{see [19]}).$$

Dividing the numerator and denominator by $p \cdot Q$, one finds in our general context:

$$\beta = \text{cov} (\xi, R_m) / \text{var } R_m \quad (\chi [1 - \{ (1-m) \cdot b + \sigma m \}]) \quad [40]$$

where:

$$\sigma = [\mu / (1 + \mu)]. \quad (\text{see [29]})$$

so that *proposition 8* is found:

PROPOSITION 8: *For a positive firm β , and under general bargaining, the firm cost of capital, as measured by the one-period CAPM, is positively related to the labor intensity of the underlying production technology, and negatively related to its output monopoly power. Further, union power over labor increases the firm cost of capital.*

Compared to *proposition 3*, *proposition 8* reveals that the firm β becomes influenced positively by the union power over labor: because union power during labor bargaining increases ceteris paribus the wage bill, and reduces the value of the firm the risk is spread over less value and risk premium increases.

Merging *propositions 6, 7, 8*, one finally finds:

3.C. The relation between firm β and its capital-labor ratio

PROPOSITION 9: *Within a general bargaining framework, a negative correlation between firm capital-labor and firm β is caused by union power over labor. Under general circumstances, the negative correlation also plays through the firm labor-intensity of the production technology, while output market power also implies a positive (resp., negative) relationship when union power over labor is greater (lower) than union power over wage.*

Compared to proposition 4, this new proposition shows that union power over labor, as an additional exogenous variable, may impact *in opposite direction* the firm capital-labor and β , as endogenous variables. Proposition 3 is thus reinforced, but depending on the union power over labor relative to union power over wage, the output monopoly power may impact the two endogenous variables, in the *same* direction.

Hence, as far as a negative trade-off remains between wage and employment, union-firm bargaining reinforces the negative correlation between the firm capital-labor and β , through the channels of union power over labor, and the firm power in its output market. In the case when the bargaining locus is positive-sloped, however, output monopoly power plays in the sense of a positive (partial) correlation between the firm capital-labor and the firm β , so that the final (total) correlation depends on the relative magnitude of the impact the various exogenous variables play on the relation between the firm capital-labor and the firm β .

It then follows that one has first to control for union power before assessing the relation between the firm capital-labor and the firm β : this could explain the decevant results obtained e.g. by MANDELKER and RHEE [1984], where the relationship revealed insignificant or positive, instead, as conjectured by the authors, negative.

4. CONCLUSIONS.

This paper has incorporated union-firm bargaining in a model of firm uncertainty, and has analysed how the bargaining scope may impact the relationship between the firm own cost of capital and other key variables, such as the capital-labor ratio or the firm output market power.

Results expressed all along the paper have shown that the firm own risk -as measured by the one-period CAPM β - remains negatively related to output monopoly power, as in traditional models that postulate perfect competition in the firm labor market. However, the firm β has been also shown to depend on the scope of union-firm bargaining, because the union power over labor -if any- plays also a (positive) role on the firm own cost of capital.

More importantly, the optimal capital-labor ratio has been namely shown to depend on the output monopoly situation of the firm and the union power over both wage and labor negotiation. Hence, it has been shown that the relationship between the firm β and its capital-labor ratio will act through the supplement channels of monopoly power and the union power over labor, although the direction of the effect of monopoly power on the relationship between the firm β and its capital-labor ratio depends critically on whether the union is more wage-oriented than employment- oriented.

In a nutshell, those results also express a word of caution about empirical models that test for the determinants of the firm β , without taking care on the type of market imperfections that may occur in the firm *input* markets. Namely, controlling for union power over wage and labor seems crucial to assess the actual relationship between the firm β and its optimal capital-labor ratio, since union power plays a significant on those two endogenous variables. Empirically, however, the task remains difficult, because union power over wage and labor are rather latent variables than variables which can be observed quite directly.

Concerning finally the various extensions to this paper, the most interesting relates principally to the timing of decisions, that is, it should be crucial to analyse how results and propositions expressed in the paper are robust with respect to a model of the putty-putty nature, where capital is chosen *ex ante* to the union-firm bargaining situation. The possibility that wages are paid *ex post* to the resolution of uncertainty seems also a fruitful avenue. Some other refinements concern e.g. the generalizations to multi-period

β etas, or firms concerned with oligopolistic situation, but we expect those avenues to generate more tedious analytics than new insights as to the effect of union-firm bargaining in model of the firm under uncertainty.

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