CESifo *Working Paper Series*

CAPITAL STRUCTURE, WAGE BARGAINING AND EMPLOYMENT

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Working Paper No. 275

March 2000

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* The authors acknowledge financial support from the Academy of Finland.

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Abstract

We offer a unified framework to analyze the determination of employment, employee effort, wages, profit-sharing and capital structure when firms face stochastic revenue shocks. We apply a generalized Nash bargaining solution, which extends the wage bargaining literature by incorporating efficiency wage considerations, profit-sharing and capital structure. The profit-sharing instrument is demonstrated to have positive effort-augmenting and wage-moderating effects, which exactly offset the negative dilution effect in equilibrium. Leverage is shown to decrease employment and to have a strategic commitment value as a wage-moderating effect for firms facing unions in bilateral wage negotiations. Finally, some implications for equilibrium unemployment are characterized.

Keywords: Wage bargaining, profit sharing, capital structure, employment

JEL Classification: J51, J41, G32

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I. Introduction

In Europe the unemployment rate has shown a rising trend during the last twenty five years. This has raised the question of how to explain this development. Without going explicitly into that issue, which is still partly unresolved, one should notice that at the moment there are at least three important theoretical approaches to study the determination of unemployment, namely efficiency wage theories, search and matching theories and theories of union bargaining. Here we take the view that these different types of theories are complementary. In Europe various versions of the union bargaining theory have been quite popular. This is natural as in most European countries over three quarters of the workforce have earned wages that are covered by collective bargaining.

The most popular approach within the class of union bargaining theories has been to use a ‘right-to-manage’ model (see e.g. Layard, Nickell and Jackman (1991)). According to the ‘right-to-manage’ model trade unions and employer organizations bargain over wages and subsequently firms unilaterally choose the employment level in order to maximize their profits (see Oswald (1985) and Creedy and McDonald (1991) for complementary surveys of various union bargaining approaches). This kind of approach has recently been used to study the employment effects of various kinds of revenue-neutral tax reforms like a switch between labour taxation and taxation of “dirty” consumption, between labour taxation and taxation of “dirty” factors of production and between wage and payroll taxation (see e.g. Koskela and Schöb (1999a), Koskela, Schöb and Sinn (1998), Koskela and Schöb (1999b).

In the basic versions of union bargaining theories it is assumed that the supply of working hours and that the effort of the members of the trade union are exogenously given. On the other hand, the main idea behind theories of efficiency wages is that for various reasons the wage is not only a cost factor to the firm, but it also serves as an incentive device with effort-enhancing effects (Akerlof and Yellen (1986) provide a selection of some seminal articles on efficiency wages). Usually, union bargaining theories and efficiency wage theories have been analyzed separately in the literature. But to the extent that it is not possible to monitor the effort by workers, the outcome generated through wage bargaining may be affected by incentive-compatible effort provision by workers and vice versa. The interactions between wage bargaining and efficiency wage considerations have been analyzed by Lindbeck and Snower (1991), by Sanfey (1993), by Bulkley and Myles (1996) and by Altenburg and Straub (1999).

Profit sharing mechanisms represent an incentive device, which has been proposed and studied recently. Profit sharing refers to renumeration mechanisms where the traditional fixed-wage remuneration is replaced by a scheme with a fixed base wage plus a share of profits or revenues of firms. Why should profit sharing be an attractive renumeration mechanism? One answer is given by Weitzman (1985). He argues that the profit sharing system leads to better business cycle performance when compared to a fixed wage system. In a subsequent study (Weitzman (1987)) he has conjectured that profit sharing systems will reduce equilibrium unemployment. This intuition has been formally developed by Jerger and Michaelis (1999) in a model with the property that a switch from a fixed wage economy to a share economy results in lower aggregate unemployment. Weitzman's approach has also been re-examined by Holmlund (1991). He asked whether the profit sharing system actually leads to wage moderation and thereby to higher employment. Holmlund emphasizes that profit sharing provides an incentive for lower base wages and higher employment. However, the outside opportunities of workers will also increase if profit sharing becomes a general phenomenon. This, in turn, will strengthen the union's bargaining position by increasing its threat point, which tends to deteriorate employment, ceteris paribus. As Holmlund shows, as a general equilibrium phenomenon the consequences for employment of introducing profit sharing depend on the precise properties of the production function. A different argument for profit sharing have been presented by Pohjola (1987) and by Anderson and Devereux (1989). They argue that profit-sharing may be a necessary part of an efficient contract when the union-firm bargaining is constrained by the assumption that total employment is unilaterally determined by the firm so that wage and employment determination is inefficient in the absence of profit sharing.

The theories of unemployment mentioned thus far have abstracted from financial considerations by exploring the role of wages as factor costs and by focusing on the incentive effects associated with wages. There is currently, however, a fair amount of empirical evidence from several countries suggesting that the real interest rate and the firm's leverage (or share of debt financing) will have a negative effect on employment, ceteris paribus (see e.g. Sharpe (1994), Hanka (1999), Nickell and Nicolitsas (1999) and Funke, Maurer and Strulik (1999)). Theoretical models of employment determination should be able to also explain the mechanisms behind these findings.

The potential role of financial factors in employment determination raises questions regarding the implications of financial factors more generally. Do financial factors affect the wage determination and, if so, how will these effects influence the optimal capital structure of the firms? In their comprehensive survey of capital structure theories Harris and Raviv (1991) argue that "capital structure models based on product/input market interactions are in their infancy" (p.319). Since then an emerging literature has focused on the interaction between corporate finance, wage and employment policies. Bronars and Deere (1991) as well as Perotti and Spier (1993) have shown how firms can use debt as a strategic instrument to reduce the costs that unionized workers can impose on shareholders through their collective bargaining power. Bronars and Deere (1991) also present empirical evidence from U.S. industries of financial leverage being an increasing function of the probability of union formation. They argue that this is consistent with the view that debt offers strategic advantages to shareholders in the context of bilateral bargaining with workers.

In a different vein Garvey and Gaston (1998) have introduced a strategic role of debt into a simple version of an efficiency wage model. In the framework of a theoretical model equipped with some econometric evidence they show that employers for whom firm-specific human capital investments are important to profits will choose low debt-equity ratios, thereby committing themselves to a relatively "soft" bargaining position in order to encourage efficiency-enhancing activities by workers. Also Dasgupta and Sengupta (1993) have investigated the role of capital structure as a strategic instrument designed to affect the outcome of bilateral bargaining with workers or other input suppliers. In their model debt is chosen so as to balance the bargaining advantage of debt against its agency costs (due to moral hazard) and debt is an optimal financial instrument only when it can provide a bargaining advantage for the firm. Moreover, the firm switches to lower debt if its relative bargaining power becomes high enough.

Finally, Sarig (1998) has recently studied the effect of leverage on shareholder-union bargaining. He has shown that leverage may affect shareholders' bargaining position vis-à-vis their employees by affecting the shareholders' threat point within the framework of Nash bargaining. Sarig, however, takes the existence and extent of debt financing as given and demonstrates that the union's expected wage increases with the leverage of the firm - a result different from those outlined above. This is due to Sarig's assumption that with higher leverage a disagreement increases shareholders' risk of bankruptcy and makes the shareholders 'softer' in wage negotiations.

We can conclude our literature review by observing that several papers have focused on the impact of financial factors on wage bargaining, but with mixed results. At the moment there is no unified framework to simultaneously deal with the determination of wages, employment, employee effort, profit-sharing and the choice of capital structure by firms. The purpose of this paper is to carry out precisely such an analysis by starting from the notion that decisions take place in an environment where firms face uncertainty, and thereby risks of bankruptcy. Prior to the stage of wage negotiations, and in anticipation of the outcome of this bargaining process, firms strategically commit themselves to profit-sharing schemes and capital structure. Subsequently firms unilaterally make the employment decisions.

Our analysis shows that employment depends negatively on the effective labour cost as well as on the hazard rate capturing the uncertainty associated with the survival and continuation of the firm's production. The effective labour cost consists not only of the wage rate, but it also incorporates the interest rate and, importantly, the firm's leverage rate. Further, the effort provision by employees is shown to depend positively not only on the usual efficiency wage considerations, but also on the effort-enhancing effects of profit-sharing. We offer a generalized Nash bargaining solution, which both unifies and generalizes the wage bargaining literature by incorporating not only the efficiency wage considerations extended to capture uncertainty, but also profit sharing and capital structure. The generalized bargaining solution exhibits how performance-based evaluation in the form of profit-sharing and capital structure will to have a strategic wage-moderating commitment value for a firm facing a union in wage negotiations. Finally, we derive the optimal profit-sharing system and the optimal capital structure from the firm's point of view. The profit-sharing instrument is demonstrated to have positive effort-augmenting and wage-moderating effects, which exactly offset the negative dilution effect at the optimal profit share. We also establish the mechanism whereby a higher leverage rate will not only increase the effective labour cost, but also moderate the wage rate. This latter mechanism represents a crucial effect determining the firm's optimal capital structure.

We proceed as follows. In section II we present the basic structure of the model as well as the time sequence of decisions under circumstances where a firm operates in an environment characterized by uncertainty and thereby the risk of bankrutpcy. The determination of effort by employees and the employment decisions by firms are studied in section III. In section IV we investigate the wage determination in the presence of efficiency wage considerations and under the assumption that firms unilaterally determine employment. Conditional on the firm's commitments to a profit-sharing system and a capital structure we derive a generalized Nash bargaining solution. In section V we characterize the optimal combination of profit-sharing and capital structure from the firm's point of view. In section VI we ask: What difference does it make that the firm commits itself to a profit-sharing system relative to a situation where the profit share would be determined at the bargaining stage simultaneously with the wage rate? Section VII outlines the implications of profit sharing, union bargaining power, leverage and the benefit-replacement ratio on equilibrium unemployment. Finally, concluding comments as well as suggestions for further research are presented in section VIII.

II. The Basic Structure of the Model

We consider a firm operating in an environment characterized by uncertainty. Production requires the firm to employ workers within the framework of a unionized labor market. In conformity with the efficiency wage hypothesis we assume that the output of the firm depends not only on the number of workers employed, but also on the efficiency-enhancing effort offered by each worker.[1] For simplicity we neglect other production factors. By employing L units of labor, each providing effort denoted by a, the stochastic revenues accruing to the firm are given by

(1) $$q\ R(a,L) \quad ,$$

where q denotes a random revenue shock with a cumulative distribution function $F(q)$, and an associated density function $f(q)$. The support of this probability distribution is assumed to be $\left[0,\bar{q}\right]$ with $\bar{q} \leq \infty$. Further we assume that the production function R(a,L) satisfies the following conventional conditions: $R_a > 0,\ R_{aa} < 0,\ R_L > 0,\ R_{LL} < 0$ and $R_{aL} > 0$. Thus, the production function is an increasing and concave function of both the production factors, and the two production factors exhibit complementarity.

In the long run, the firm commits itself to a capital structure determining how its production will be financed as well as to the form of the wage contract determining to what extent profit-sharing will be utilized. The profit share, t, determines what fraction of the firm's profits is transferred to employed workers as part of the contract. Conditional on the capital structure as well as the structure of compensation to organized labor the firm and the trade union engage in wage bargaining. At the stage of firm-union negotiations the firm and the union engage in traditional Nash bargaining regarding the base wage, w, to be paid to all the workers employed by the firm. We pay particular

[1] Akerlof and Yellen (1986) contains a number of seminal papers about the various versions of the efficiency wage hypothesis and Romer ((1996) offers some applications.

attention to characterizations of how the firm's leverage and profit sharing will impact on the negotiated wage.

Conditional on the negotiated wage contract the firm and the trade union both make optimizing decisions. The firm unilaterally determines the employment level once the conditions of the wage negotiations have been settled. In line with the tradition of efficiency-wage models, the wage contracts cannot be made contingent on the effort provision of workers, because effort is unobservable and cannot be verified by a third party. Thus, the representative union member decides on effort so as to maximize his objective function, which takes into account that effort provision causes disutility. At the stage of the wage negotiations the employer holds rational expectations regarding how the outcome of the bargaining will impact on the effort incentives of the individual union member. These incentives depend on the base wage as well as on the profit share.

It is important to emphasize, however, that the effort incentives of individual union members are affected not only by the wage negotiations, but also by the firm's capital structure. If a debt-financed firm is bankrupt the employment relationship will not survive. In such a case the unemployed worker will receive the unemployment benefit, b, which is assumed to be exogenously given and financed by the government.

We summarize the timing of the decisions made by the firm, the union and the representative union member in Figure 1. In the subsequent sections we turn to a more

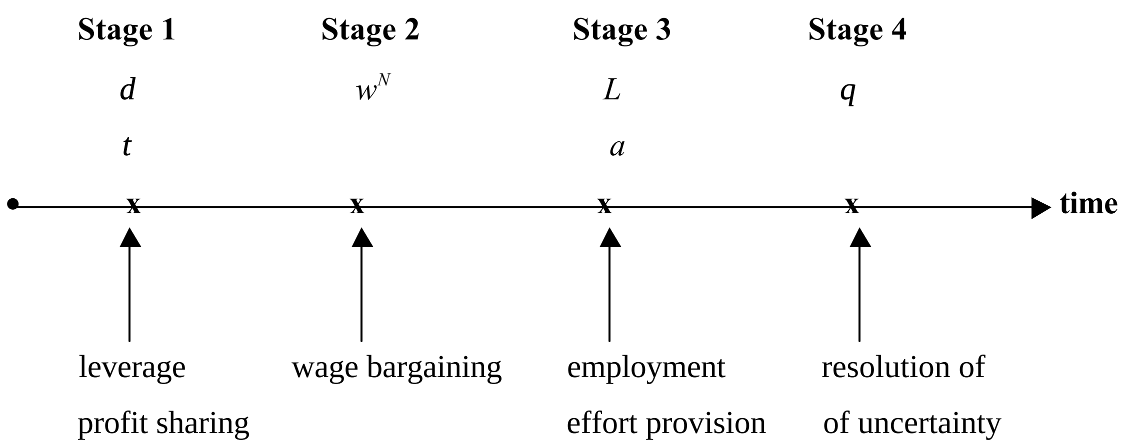

Figure 1: Time sequence of decisions

detailed analysis of the decisions taking place at the different stages of the firm-union interaction. We use backward induction and solve the game in reverse order by starting to investigate the determination of employment and effort in the next section. In section IV we analyze the bargaining between the firm and the union and in section V we explore the optimal capital structure and the optimal profit-sharing arrangement of the firm. In section VI we ask: Does it matter whether the firm commits itself to a profit-sharing system relative to a situation where the profit-share would be determined at the bargaining stage simultaneously with the wage rate? Section VII provides a characterization of the implications of profit sharing, bargaining power, benefit-replacement ratio and firm's leverage on equilibrium unemployment from a general equilibrium perspective.

III. The Determination of Employment and Effort

At this stage we assume that the firm has irreversibly committed itself to a capital structure whereby the fraction d $(0 \leq d \leq 1)$ of the firm's production expenses are covered by debt. We consider a standard debt contract exhibiting limited liability and characterized by an interest rate, r. Further, we assume that the wage negotiations have generated a wage contract with a wage w and that the firm has decided to apply the profit share t .

Under these circumstances the firm decides on employment L so as to maximize the expected profits

$$(2) \qquad Ep(a,L) = \int_{\hat{q}}^{\bar{q}} \left(q \; R(a,L) - w(1+rd)L\right) f(q)\, dq \quad ,$$

where

$$(3) \qquad \hat{q} = \frac{w(1+rd)L}{R(a,L)}$$

denotes the "break-even" state of nature such that the firm remains solvent for $q \geq \hat{q}$, while there is bankruptcy when $q < \hat{q}$. We can infer that the firm's employment decision as well as the employee's effort provision will impact on $\hat{q}$, and thereby on the probability of bankruptcy, F($\hat{q}$). Differentiating (3) with respect to a and L, respectively, we can conclude that

$$\hat{q}_a = -\frac{R_a(a,L)\hat{q}}{R(a,L)} < 0$$

and

$$\hat{q}_L = \frac{\hat{q}}{R(a,L)}\left[\frac{R(a,L)}{L} - R_L(a,L)\right] > 0 .$$

Consequently, an increase in effort (employment) will shift the break-even state of nature towards lower (higher) levels meaning that increased effort (employment) will decrease (increase) the probability of bankruptcy, ceteris paribus.

Conditional on the negotiated wage contract the representative union member makes the effort decision in order to maximize the expected rent

$$(4) \quad Eu(a) = F(\hat{q})b + \left[1 - F(\hat{q})\right]\left[w + \frac{t}{L}\int_{\hat{q}}^{\bar{q}}\left(q\,R(a,L) - w(1+rd)L\right) f(q)\,dq\right] - g(a),$$

where the increasing and convex function g(a) is a monetary representation of the disutility of effort and where b denotes the unemployment benefit financed by the government. The operation of the firm faces uncertainty and by the employment contract the union members commit themselves to incentive compatible effort provision prior to the realization of the random shock. Thus, from the perspective of the worker the disutility of effort represents a sunk cost. One interpretation for this is that in order to qualify for the unemployment benefit b the union member must be prepared for employment, which in the context of our model means incentive compatible effort provision. With probability F($\hat{q}$) the firm goes bankrupt and in that case the worker is unemployed receiving the unemployment benefit b. With the complementary probability, 1 - F($\hat{q}$), the firm remains solvent and in that case the employed union member is remunerated according to the compensation contract, i.e. the sum of the base wage, w, negotiated with the employer, and the share, t/L, of the profit realization, fixed by the employer.

The formulations (3) and (4) incorporate an important qualitative, and empirically relevant, difference between the base wage w on the one hand and the performance-based profit share t on the other hand. The fact that w is part of the definition of $\hat{q}$ captures the commonly observed feature that wages represent senior claims relative to those of debtholders, while the performance-related profit share represents a contractual claim, which is junior relative to that of debtholders.

The optimal combination of employment and effort provision is determined by the system of first-order conditions

(5) $$\int_{\hat{q}}^{\bar{q}} (qR_L(a,L) - w(1+rd))\ f(q)\,dq \quad = \quad 0$$

and

$$\frac{f(\hat{q})}{1-F(\hat{q})}\ \frac{R_a(a,L)\hat{q}}{R(a,L)}\left[\ (w-b)\ \ +\ \ \frac{t}{L}\int_{\hat{q}}^{\bar{q}}(q\ R(a,L)-w(1+rd))\ f(q)\,dq\right]$$

(6)

$$+\ \ \frac{t}{L}R_a(a,L)\int_{\hat{q}}^{\bar{q}}q\ f(q)\,dq\qquad=\qquad g'(a)\quad .$$

According to condition (5) the firm chooses the employment level so as to equalize the expected marginal return from labour (the term $qR_L(a,L)$) to the effective wage cost (the term $w(1+rd)$), which is adjusted to take account of limited liability whereby the firm will bear the production costs only in the solvent states of nature.

Equation (6) characterizes the determination of effort by a representative employee so as to equalize the marginal benefit from effort (the LHS terms) to the marginal disutility of effort (the RHS term). We can make these interpretations more precisely. The first term on the LHS describes the effect of effort on the break-even state of nature, above which the firm remains solvent**.** Since higher effort decreases $\hat{q}$ and thereby decreases the probability that the employee becomes unemployed, it will represent a positive marginal benefit by increasing the probability that an employee gets the rent w-b from the base wage as well as the share, t/L, of the profit realization. The second term on the LHS in (6) captures the higher marginal product of increased effort provision given the probability of bankruptcy. The higher the marginal product, ceteris paribus, the more the employee benefits from profit sharing.

In order to simplify our analysis so as to make it possible to highlight the economic mechanisms involved as transparently as possible we make the following three assumptions regarding the functional forms of the production technology, the probability distribution of the random revenue shocks and the disutility of employee effort.

For the production technology we make

Assumption R: *The technology is assumed to satisfy*

$$\text{(R1)} \qquad R(a, L) \;=\; \frac{(a\,L)^{a}}{a} \quad .$$

The parameter a is restricted to satisfy $0 < a < 1$ so that specification (R1) can be thought of as a well-defined concave production function exhibiting decreasing returns to scale with effort and employment separated as production factors, between which complementarity prevails. We assume, following Solow (1978), that labour and effort enter the production function multiplicatively so that the parameter a captures the productivity of each of the two production factors. For our purposes the assumption of equalizing the productivity of the two production factors incorporates no loss of generality as it can be achieved through an appropriate selection of measurement units with respect to these production factors.

For the distribution function of the random revenue shocks we make

Assumption F: *The random shock* q*,* $q \geq 0$*, follows a Poisson process so that the density function is given by* $f(q) = l\, e^{-lq}$ *, with* $l > 0$*.*

We can offer several interpretations of the random shock q. It could, depending on the context, capture a technology, an output or a price shock. In our context the Poisson distribution is particularly appealing, because it implies a constant hazard ratio defined by $\lambda = f(\hat{\theta})/(1 - F(\hat{\theta}))$.

For the disutility of employee effort we make

Assumption G: *The disutility of effort belongs to the class of functions* $g(a) = g\, a^{1/g}$ *with* $0 < g < 1$.

Assumption G means that we consider a class of functions with the property that the distility of effort can be captured through an increasing and convex relationship with constant elasticity.

From now on and throughout our subsequent analyses we assume these functional form assumptions, R, F and G, to hold. Under such circumstances the equilibrium condition (5) with respect to the employment decision can be simplified to yield the first-order condition

$$(7) \qquad \hat{q} \quad = \quad \frac{a}{(1-a)\ l} \ .$$

Thus, according to equation (7) the optimal employment decision will imply a constant probability of bankruptcy $F(\hat{q}) = 1 - e^{-l\hat{q}}$, which depends positively on the degree of concavity of the production function. By combination of (R1), (3) and (7) we can conclude that the optimal employment has to satisfy

$$(8) \qquad L^{*} \quad = \quad \left[w(1+rd)\right]^{-h} \ l^{-h} \ a^{h-1} \left(\frac{h-1}{h}\right)\left(\frac{1}{h}\right)^{1-h} \quad ,$$

where $h = (1-a)^{-1}$ is the elasticity of labour demand with respect to the effective labour cost $\tilde{w} = w(1+rd)$. As $0 < a < 1$, we know that $h > 1$. In particular, from (8) we can conclude that the labor demand will exhibit constant elasticity with respect to effective wage costs - a feature which turns out to be analytically convenient at subsequent stages of our analysis. Moreover, the effort by employees will have a direct positive effect on labour demand.

Substituting the production function (R1) as well as Assumptions F and G into equation (6) we obtain

$$\frac{(h-1)^2}{h}\ (w-b)\ +\ t\, a^{a}\, L^{a-1}\, k\, \frac{2h-1}{l}\ =\ \frac{a^{1/g}}{k}\ ,$$

where $k = e^{-l\,\hat{q}}$, which is a constant by (7). Substituting the RHS of (8) for L into this equation shows that the optimal effort provision can be explicitly expressed as

$$(9) \qquad a^{*}\ =\ \left[C_{w}(w-b)\ +\ C_{t}\ t\ w(1+rd)\right]^{g}\ ,$$

where $C_{w} = \frac{k\,(h-1)^2}{h}$ and $C_{t} = k^{2}\,(h-1)^{-1/h}\,h^{(2-h)/h}\,(2h-1)$. We can directly see that C_{w} and C_{t} are both positive.

We can summarize our characterization of the optimal combination of employment and effort provision according to the following proposition.

Proposition 1: ***The equilibrium configuration of employment and effort provision is*** **given by (8) and (9).**

According to equation (8) employment depends negatively on the effective labour cost as well as on the hazard rate capturing the uncertainty associated with the continuation of the firm's production. The effective labour cost consists not only of the wage rate, but also of the interest rate and the fraction, d , of the firm's production expenses covered by debt (the leverage rate**).** Equation (8) thereby suggests that the higher is the firm's leverage rate, the lower is employment, ceteris paribus. In fact, empirical evidence from USA (see e.g. Sharpe (1994) and Hanka (1998)), from UK (see e.g. Nickell and Wadhwani (1991) and Nickell and Nicolitsas (1999)) as well as from Germany (see e.g. Funke, Maurer and Strulik (1999)) lies in conformity with the prediction that the firm's leverage will have a negative effect on employment. Further, we can conclude that employment depends positively on the effort chosen by the employees – a most natural feature.

According to equation (9) the effort by a representative employee depends positively both on the difference between the basic wage rate and the unemployment benefit and on the magnitude of profit-sharing. The former characteristic is a typical feature of the effort function used in the context of the efficiency wage hypothesis (see e.g. Romer (1996)). The latter characteristic reminds of a positive relationship between the effort provision and the intensity of incentives in the sense of the principal-agent literature. However, in the context of wage bargaining between firms and unions possessing market power this feature has not previously been analyzed in the literature.[2] Finally, from (9) we can infer an appealing feature. Namely, for a given combination of the base wage and the profit share a rise in the firm's survival probability enhances effort provision.

IV. Nash Bargaining and Wage Structure

We now turn to analyze the wage negotiations between a union and a firm both posessing market power with respect to the wage determination. For this purpose we apply the Nash bargaining solution and make use of the 'right-to-manage' approach according to which employment is unilaterally determined by the firm. Effort provision takes place at the discretion of the employees. Finally, and importantly, the wage negotiations are assumed to take place conditional on the firm having committed itself both to a capital structure incorporating some degree of debt finance as well as to a system of profit sharing as an incentive scheme offered to the unionized employees.

[2] There is a relatively recent literature, which studies the relationship between profit sharing, wage bargaining and unemployment under various bargaining structures (see Pohjola (1987), Anderson and Devereux (1989), Holmlund (1990), and Jerger and Michaelis (1999)). This literature, on which we will comment in a more detailed way later on in section VI, has been restricted to deterministic models where profit shares are determined as a result of bargaining simultaneously with the wage determination. Moreover, this literature has not considered the natural case where effort by an employee may be affected by a commitment to profit sharing.

We denote the relative bargaining power of the union by b, and, consequently, that of the firm by $(1-b)$. Further we assume that the threat points of the union and the firm can be described by $EU^o = N(b - g(a^*))$ and $Ep^o = 0$, respectively. Applying the traditional Nash bargaining solution the negotiating parties decide on w in order to maximize

$$\text{(10)} \qquad \Omega = [EU]^b \, [(1-t)\, Ep]^{1-b}$$

subject to the conditions described by the labour demand equation (8) and the effort determination (9).[3]

In the Nash bargaining product (10) $Ep = Ep(a^*, L^*)$ denotes the expected profit of the firm and it is adjusted with the factor $(1-t)$ in order to take the impact of profit sharing into account. The expected profits are evaluated at the equilibrium combination of effort and employment to capture that the wage negotiations take place in anticipation of optimal behavior with respect to these variables. The factor $EU = EU(a^*, L^*)$ denotes the expected rent of the union relative to the threat point constituted by the outside option of unemployment. Again, also on behalf of the union the negotiations are carried out in anticipation of optimal effort and employment decisions.

The expected rent of the union, which it tries to maximize in the wage negotiations, can be expressed as $EU = N\left(Eu(a^*) - (b - g(a^*)\right)$ subject to the constraint $N\left[1 - F(\hat{q})\right] = L$. This constraint formalizes the notion that that the expected employment is equal to the product of the number of union members and the probability that the firm remains solvent after the resolution of the random revenue shock θ. The calculation of the union's expected rent captures the idea that all the N workers have incentives to seek employment. Those union members who are left unemployed, either

[3] In general, the Nash bargaining approach can be justified either axiomatically (see Nash (1950)) or strategically (see Binmore, Rubinstein and Wolinsky (1986)).

due to the magnitude of the firm's production or due to bankruptcy, enjoy the unemployment benefit b. This formulation means that in order to qualify for the unemployment benefit all the union members must offer effort with the disutility of effort considered as a sunk cost. This assumption is consistent with the time sequence of decisions illustrated by Figure 1, from which we can see that effort provision takes place prior to the resolution of uncertainty.

Under these assumptions the expected rent of the union, EU, can be calculated to be

$$(11) \qquad EU \;=\; EU(a^*, L^*) \;=\; L^*\left(w - b\right) \;+\; \tau\, E\pi\,(a^*, L^*) \quad ,$$

where the term $L^*(w-b)$ represents the employment part and the term $\tau E\pi(a^*, L^*)$ the profit-sharing part.

Further, in anticipation of the equilibrium with respect to effort provision and employment the expected profit of the firm is given by

$$(12) \qquad E\pi = E\pi\,(a^*, L^*) \;=\; \kappa\left[\frac{1}{\alpha}\left(a^* L^*\right)^{\alpha} \;-\; w(1+r\delta)\,L^*\right]$$

or, alternatively, by[4]

$$(12') \qquad E\pi \;=\; \hat{\kappa}\, w(1+r\delta)\,L^* \quad ,$$

where $\hat{\kappa} = \kappa c$ with $\kappa = e^{-\lambda\hat{\theta}} > 0$ and with c defined by $c = \lambda\left(\eta - 1\right)^{-\frac{1+\eta}{\eta}} - 1$. In order to guarantee the expected profit of the firm to be positive we formally make

Assumption C: *The parameter c, defined above, is assumed to be strictly positive.*

[4] This can be obtained by substituting the optimal employment decision by the firm for L in the expected profit function (12).

To simplify the notation, from now on we will refer to the equilibrium values of effort and employment by (a,L) without superscripts.

The Nash bargaining solution has to satisfy the first-order condition

$$(13) \qquad \beta \frac{EU_w}{EU} \quad + \quad (1-\beta)\frac{E\pi_w}{E\pi} \quad = \quad 0 \quad ,$$

where the subscript w denotes differentiation with respect to the wage rate w.[5] In Appendix A we derive the expressions for the numerators exhibited in (13). According to equation (13) the Nash bargaining wage rate is affected by the relative bargaining power of the union, b, and the firm, $1-b$, respectively, as well as by the relative effect of the wage rate on the objective functions of the negotiating agents, i.e. the terms EU_w / EU and $E\pi_w / E\pi$.

For the first-order condition (13) to have an interior solution for $0 < b < 1$ it is necessary that the elasticity of effort with respect to wage, x_w, defined by $x_w = \frac{wa_w}{a}$, satisfies the inequality $x_w < 1$. As Appendix A makes clear, under this assumption the proportional marginal change in the expected profits of the firm from increasing the wage rate is negative, while the corresponding proportional marginal change in the expected rent of the union is positive. Both these properties are very natural and therefore the Nash bargaining solution has the intuitively appealing feature that the negotiated wage rate is an increasing function of the union's bargaining power, b. By substituting the ratios (A1) and (A4), derived in Appendix A, into (13) we find the Nash bargaining solution, w^N, to satisfy the following implicit form

[5] We assume that the sufficient second-order condition for the the Nash bargaining solution

$$\Omega_{ww} = \frac{b}{EU^2}\left[EU\,EU_{ww} - (EU_w)^2\right] \quad + \quad \frac{1-b}{Ep^2}\left[Ep\;Ep_{ww} - (Ep_w)^2\right] \quad < \quad 0$$

holds.

(14) $$w^N = \frac{c\,b\,h^* + (1-x_w)(1-b)}{c\,b\,(h^*-1) + (1-x_w)(1-b) + (1-x_w)\,t\,k\,c\,(1+rd)}\;b \quad ,$$

where $x_w = \dfrac{w a_w}{a}$ denotes the elasticity of effort with respect to wage and where $\eta^* = -\dfrac{w L_w}{L}$ denotes the total wage elasticity of labour demand incorporating both the direct effect and the indirect effect of the wage rate via effort provision on labour demand. The elasticity of effort with respect to wage can be explicitly calculated to be

(15) $$x_w = g\,\frac{w\,(C_w + t\,C_t\,(1+rd))}{w\,(C_w + t\,C_t\,(1+rd)) - b\,C_w} > g > 0\,.$$

Further it is straightforward from equation (8) to see that the total elasticity of labour demand h^* is associated with the conventional labour demand elasticity h according to the following relationship

(16) $$h^* = h + x_w\,(h-1)\,.$$

From (15) and (16) we can infer the following comparative static properties summarized in

Lemma 1:

a) ***The effort elasticity (*** x_w ***) is a decreasing function of the profit share (*** t ***), of the leverage rate (*** d ***) and of the interest rate (*** r ***) as well as an increasing function of the unemployment benefit*** (b).

b) ***The total elasticity of labour demand*** (h^*) ***is a decreasing function of the profit share, of the leverage rate and of the interest rate as well as an increasing function of the unemployment benefit.***

We can generally observe from the Nash bargaining solution (14) that most of the exogenous parameters affect the negotiated wage rate both directly and indirectly by changing the effort elasticity and thereby the total wage elasticity of labour demand. Here and in what follows we make the natural assumption that the direct effect of parameters dominate the indirect effects taking place via induced changes in the effort elasticity and thereby in the generalized elasticity of labour demand.

Using Lemma 1 we can identity three channels through which a change in the unemployment benefit will affect the wage rate. The direct effect is positive in reflection of the fact that w^N is proportional to b. Further, an increase in b raises the effort elasticity and, consequently, this indirect effect reinforces the direct one**.** Finally, the total elasticity of labour demand will increase which in turn has a negative effect on the wage rate**.**

Furthermore, the wage rate negotiated through the Nash bargaining process is affected by the interest rate, the profit share as well as the leverage rate again via three channels described in Lemma 1. Firstly, all these variables have negative direct effects on the wage rate in (14). Secondly, they all affect the negotiated wage rate indirectly by changing both the effort elasticity x_w and the total wage elasticity of labour demand h^*. The former effect reinforces the direct effect, while the latter effect runs counter to it. Assuming that the direct effect dominates the indirect ones we have $\frac{\partial w^N(r,\tau,\delta,b)}{\partial r} < 0$, $\frac{\partial w^N(r,\tau,\delta,b)}{\partial \tau} < 0$, $\frac{\partial w^N(r,\tau,\delta,b)}{\partial \delta} < 0$, and $\frac{\partial w^N(r,\tau,\delta,b)}{\partial b} > 0$ respectively.

We can summarize our analysis thus far according to

Proposition 2: ***The Nash bargaining wage is given implicitly by (14). This Nash bargaining solution exhibits that the interest rate, the profit share as well as the leverage rate will have wage-moderating effects, while the unemployment benefit has a wage-increasing effect.***

As Proposition 2 makes clear, the incentive schemes in the form of profit-sharing programs as well as capital structure both serve as strategic instruments whereby the firm can induce wage moderation to take place at a subsequent stage of wage bargaining.

The Nash bargaining solution (14) both unifies and generalizes the wage bargaining literature, which has analyzed the wage determination in a static framework with very limited attention attached to efficiency wage considerations, capital structure and profit sharing. Our analysis with the Nash bargaining solution (14) simultaneously includes efficiency wage considerations like in Altenburg and Straub (1999), Bulkley and Myles (1996), Lindbeck and Snower (1991) and Sanfey (1993), the price of capital like in Koskela, Schöb and Sinn (1998), the effect of profit sharing on the wage rate like in Holmlund (1991) and the effect of the firm's leverage like in Bronars and Deere (1991), Garvey and Gaston (1998), Perotti and Spier (1993) and Dasgupta and Sengupta (1993)).

The negotiated Nash wage (14) represents a generalization relative to the traditional Nash bargaining solution along several dimensions. (14) incorporates efficiency wage considerations into the framework of Nash bargaining. The magnitude of x_w captures how sensitive the effort provision is to changes in the wage. We can see that the negotiated Nash wage is higher the larger is x_w. Thus, the more important are the efficiency wage considerations, the higher is the negotiated Nash wage relative to the outside option covered by the unemployment benefit. Therefore the union-wage bargaining and efficiency wage motives reinforce each other. [6]

[6] Lindbeck and Snower (1991) as well as Sanfey (1993) have studied the question of whether the effieciency wage and insider-outsider theories of wage formation - which both aim to explain why wages may be set above their market-clearing levels - reinforce or weaken one another. While Lindbeck and Snower argues that that sensitivity of the negotiated wage in insider power decreases with higher efficiency wage incentives, Sanfey provides a model where the reverse happens. In a different vein, Bulkley and Myles (1996) have used a monopoly union model to study the effect of union power on the effort level under alternative assumptions concerning effort monitoring. They conclude that a union will set a wage which increases the level of effort relative to that which would be observed in a competitive labour market. Altenburg and Straub (1999) have integrated union-firm bargaining into an efficiency wage model with imperfect monitoring of worker performance. They examine the effects of an increase in the benefit replacement ratio on wages, employment and effort.

The generalized Nash bargaining solution (14) implies several interesting special cases against which it can be compared relative to existing knowledge from the literature. We now turn to consider these special cases.

Firstly, in the absence of efficiency wage considerations we can reformulate (14) according to

$$(17) \qquad w^N \quad = \quad \frac{c\,b\,h \quad + \quad (1-b)}{c\,b\,(h-1) \quad + \quad (1-b) \quad + \quad t\;k\,c\,(1+rd)} \quad b \quad .$$

From (17) we can conclude that profit sharing, interest rate and firm's leverage will all have a wage-moderating effect. Such features are absent from the conventional Nash bargaining solution.

Secondly, if all the bargaining power lies with the union ($b = 1$), the Nash bargaining solution is simplified to the monopoly union solution

$$(18) \qquad w^M \quad = \quad \frac{h^*}{h^* - 1 + (1-x_w)\,t\;k\,(1+rd)} \quad b \quad .$$

In particular, (18) demonstrates explicitly how efficiency wage considerations and profit sharing impact on the optimal wage setting of a monopoly union. From (18) we can conclude that profit sharing will reduce the optimal wage rate of a monopoly union, while efficiency wage considerations would raise it. In the absence of efficiency wage considerations and profit sharing, (18) would imply the well-known monopoly wage

$$w^M \Big|_{x_w=0,\,t=0} \quad = \quad \frac{h}{h-1} \quad b \quad .$$

Thirdly, if all the bargaining power lies with the firm ($b = 0$), the wage would be determined so as to maximize the expected profits. As is shown in Appendix A, such a profit-maximizing wage w^C has to satisfy the condition x_w = 1. From (15) this condition is found to be equivalent to

$$(19) \qquad w^C = \frac{C_w}{(1-g)\left(C_w + t\ C_t\ (1+rd)\right)}\ b \quad .$$

where $C_w, C_t > 0$ are defined after (9). This captures the situation where the firm faces a competitive labour market. In the absence of profit sharing such a firm would adjust the wage to take incentive considerations into account in accordance with

$$w^C = \frac{b}{1-g} \quad .$$

Thus, in the absence of profit sharing a firm facing a competitive labour market would raise the wage above the unemployment benefit in order to provide incentives for effort provision. However, according to (19 introduction of profit sharing makes it possible to reduce the base wage of the workers. Consequently, profit sharing will have effects operating in an opposite direction relative to the conventional efficiency wage considerations. Furthermore, from (19) we can conclude that the magnitude of the effect introduced by profit sharing will be affected by the leverage rate of the firm. In particular, for combinations (g, t) such that g is sufficiently low and t is sufficiently high it might happen that the base wage of the workers is reduced below the unemployment benefit in such a way that the expected compensation including the profit share (adjusted to take account of the probability of bankruptcy) equalizes the unemployment benefit b.

V. Leverage, Profit Sharing and Bargaining

In the long run the firm can determine its capital structure as well as the nature of the incentive scheme, in particular the profit share, offered to the organized workers. These decisions serve as strategic commitments relative to the subsequent stage of wage negotiations with the union. In what follows we consider the firm's optimal determination of capital structure and profit sharing system conditional on the subsequent equilibrium with respect to employment and effort decisions and conditional on the Nash wage bargaining.[7]

At this stage the firm decides on the profit share, t, and on the capital structure, d, in order to solve the following optimization problem

$$\text{(20)} \qquad \max_{t,d} \quad Ep \; = \; k\left[\frac{1}{a}(aL)^{a} \; - \; w(1+rd)L\right](1-t) \; ,$$

in anticipation of the bargaining outcome whereby $w = w^N(\ldots, t, d)$ as implicitly given in the Nash bargaining solution (14). The optimal combination of profit share and leverage, (t^*, d^*), has to satisfy the system of equations[8]

$$\text{(21)} \qquad -ct \; + \; \frac{t\, a_t}{a} \; - \; \frac{t\, w_t^N}{w^N} \; = \; 0$$

and

[7] Harris and Raviv (1991) have provided a comprehensive survey of capital structure theories and available empirical evidence with the exception of tax-based theories. These theories of capital structure are based on agency costs, asymmetric information, product/input market interactions, and corporate control considerations. It is of particular relevance from the point of view of our analysis to observe, as we mentioned earlier, that Harris and Raviv say that "capital structure models based product/input market interactions are in their infancy" (Harris and Raviv 1991, p. 319). More recently, Hart (1995) has surveyed an alternative and complementary approach of the incomplete contracting to understand firms' financial decisions, and in particular the nature and implications of debt and equity as financial instruments.

[8] For the details of how to derive the first-order conditions (19) and (20) we refer to Appendix B.

(22) $$\frac{d\ r}{1 + d\ r} \quad + \quad \frac{d\ w_d^N}{w^N} \quad = \quad 0$$

for $t = t^*$ and $d = d^*$, respectively, where $a_\tau > 0$ and $w_\tau^N, w_\delta^N < 0$. The first-order condition (21) exhibits that the optimal profit share is implicitly determined so that the negative dilution effect is exactly counterbalanced by the positive effort-increasing incentive and wage-moderating effects**.** The optimal capital structure, in its turn, is implicitly determined by (22) so that the elasticity of the wage-moderating effect with respect to the leverage rate is equal to the ratio $-r\,d/(1 + r\,d)$.

We summarize our findings regarding the firm's optimal selection of profit share and capital structure by

Proposition 3: ***The optimal combination of profit sharing and capital structure,*** $\left(t^*, d^*\right)$ ***is determined by (21) and (22). The profit sharing instrument has positive effort-augmenting and wage-moderating effects, which exactly offset the negative dilution effect in equilibrium. For a given profit share a higher leverage rate by the firm moderates the wage rate.***

The optimality conditions (21 and (22) highlight a number of interesting features of performance-based evaluation in the form of profit sharing and capital structure as strategic instruments for a firm facing a union in wage negotiations. In the absence of performance-based profit sharing there would be no strategic reason for the firm to make use of debt financing. Namely, if $t = 0$ there would be no wage-moderating effect of debt financing simply because then an increase in the firm's leverage would only raise the effective wage cost of labor $w(1 + r d)$ by wr**.** Consequently, we can conclude from (22) that in our framework the optimal leverage rate would be zero in the absence of a profit-sharing system.[9] In fact, debt financing offers a stronger strategic instrument the higher is the profit share offered to the union.

In (21) the optimal profit share is determined in way such that this share is multiplied by the factor $w(1+rd)$. For that reason the leverage rate impacts on the optimal profit share in a way which is analogous to that of the interest rate. As an increase in the leverage rate (like the interest rate) will have a moderating effect on the negotiated base wage it follows that it will increase the optimal profit share**.** Consequently, as strategic commitment devices designed to shift rents from the union to the firm the leverage rate and the profit share represent complementary instruments.

Earlier, in section 3, when we derived the optimal employment decision (8), we observed that labour demand depends negatively on the effective labour cost including the wage rate, the interest rate, the leverage rate and the hazard rate, while it is positively related to the effort provision, ceteris paribus. Now after having carried out the analysis we are ready to discuss the total employment effect of various variables. First, profit sharing will increase employment through its wage moderating effect, and this effect is reinforced by higher effort provision. Our finding of a positive employment effect of profit sharing lies in line with Jerger and Michaelis (1999). In contrast to our approach they, however, focus on an environment with no uncertainty. Further, they abstract from aspects of capital structure as well as from efficiency wage considerations, but introduce capital stock decisions. As for the total employment effect of the leverage rate as well as the interest rate, there are three mechanisms. Firstly, employment is negatively affected by an increase in these variables as such an increase directly raise the effective labour cost. This direct effect is offset by an effort-enhancing effect on the one hand, and by a wage-moderating effect on the other hand. Both of these effects will increase employment. As a summarizing conclusion we can observe that, in our framework, profit sharing serves as an employment-enhancing instrument, while the sum of the direct and indirect effects for

[9] Of course, the firm might have no other alternative than to seek debt financing in case it faces financial constraints. However, our present analysis with its emphasis on the strategic commitment value of debt in relationship to the wage negotiations has not focused on financially constrainted firms with no other alternatives than debt financing.

employment of changes in the interest rate and the leverage rate are ambiguous a priori, while their direct effects are negative.

Earlier we discussed existing empirical evidence concerning the employment effect of leverage and found that it lies in conformity with our specification of employment determination (8). It is an area for further empirical research to evaluate also the potential effects of interest rates and profit-sharing on employment, ceteris paribus. As for the impact of these factors on wage determination, very little empirical research has been done. The existing reported results are mixed. Sarig (1998), while not doing econometric research, has examined the cross-sectional intra-industry relationship between leverage and employee compensation and he found this relationship to be positive. On the other hand, in their econometric study using panel data on a large number of UK companies Nickell and Nicolitsas (1999) produced evidence according to which the leverage rate will have a negative effect on the wage determination, ceteris paribus. This finding lies in conformity with our analysis presented in section IV. An area for further empircal research is to test for the potential role of the interest rate as well as profit sharing in the wage formation.

VI. Profit Shares: Commitment versus Bargaining

A few contributions to the literature on wage bargaining, for example Jerger and Michaelis (1999), Holmlund (1991), Pohjola (1987) and Anderson and Devereux (1989), have analyzed profit sharing within a framework where the union-firm negotiations include profit shares in addition to base wages. In this literature the profit shares are determined at the stage of bargaining simultaneously with wages, a feature which can be questioned on grounds of realism.[10] Further, as emphasized by Jerger and Michaelis (1999), incorporation of the profit sharing instrument at the stage of union-firm bargaining implicitly means that the union has a right to strike for a higher share of the

[10] At least the authors are not aware of cases where the nature of the incentive scheme offered to unionized workers would have been subject to negotiations with unions within the framework of collective bargaining.

firm's profits in case an agreement is not reached. Such a feature, however, seems to contradict the legal framework according to which the property rights for profits are with the firm. For these reasons we have assumed that the firm irreversibly commits itself to an incentive scheme, a profit-sharing system, prior to the stage of wage bargaining. Nevertheless it is interesting and enlightening to ask: What difference does it make that the firm commits itself to a profit-sharing system prior to bargaining relative to a situation, where the profit share would be determined at the bargaining stage simultaneously with the wage determination? In order to highlight the implications of the commitment in a transparent way we will, in fact, compare the optimal profit share determined by (21) to the profit share which would emerge as the outcome of bargaining in the extreme case where all the bargaining power is concentrated to the firm.

In order to carry out this comparison we have to characterize the profit share which solves the following Nash bargaining problem

$$\max_{t} \quad \Omega = [EU]^{b} \, [(1-t)\, Ep\,]^{1-b} \quad .$$

The Nash bargaining solution with respect to the profit share has to satisfy the first-order condition (with the notations analogous to those used in Section IV)

$$(23) \qquad b\,\frac{EU_t}{EU} + (1-b)\,\frac{Ep_t}{Ep} - \frac{1-b}{1-t} = 0 \ .$$

By substituting (C1) and (C4) from Appendix C into the first-order condition (23) we find that the Nash bargaining profit share has to satisfy

$$(24) \qquad b\,\frac{k\,w(1+d\,r)(c+x_t) + (h^{*}-1)x_t\,(w-b)}{t\,[w-b+t\,k\,c\,w(1+d\,r)]} + (1-b)\,\frac{x_t}{t\,c} = \frac{1-b}{1-t} \ ,$$

where the elasticity of effort with respect to the profit share, x_t, is defined by $x_t = \frac{t\, a_t}{a}$.

In general, equation (24) does not lend itself to general analytical solutions, which could be expressed in a way so as to make economic interpretations possible.[11] Even if the difficulties induced by the fairly complicated expressions for x_t and h^* were neglected (24) would generate a fairly complicated quadratic equation with respect to t. For that reason we will restrict ourselves to a characterization of the Nash bargaining profit share for the particular case where all the bargaining power lies with the firm.[12] As noticed above, this special case might actually be sufficiently interesting in order to clarify the role played by the firm's commitment to a profit-sharing system.

For the special case with $b = 0$ (24) can be significantly simplified. For this case the Nash bargaining solutions with respect to the profit share has to satisfy the relationship

$$(25) \qquad t^C = \frac{x_t}{x_t + c} .$$

Thus, with all the bargaining power concentrated to the firm the outcome of the bargaining process would be $t^C = 0$ in the absence of effort-inducing considerations ($x_t = 0$). When profit shares have effort-enhancing effects we can conclude from (25) that the bargaining outcome incorporates positive profit shares and that this outcome is an increasing function of the magnitude of these effort-enhancing effects.

In order to clarify the implications of the firm's commitment with respect to profit-sharing we rewrite the optimal profit share ($t = t^*$) characterized by (21) according to

$$t^* = \frac{1}{c} \left(x_t - \frac{t\, w_t^N}{w^N} \right) .$$

[11] Of course, numerical simulations would be possible.

By comparing t^C and t^* we can directly conclude that the relationship

$$(26) \qquad t^* > t^C$$

holds. In fact, even in the absence of a wage-moderating effect of profit sharing the ordering (26) holds true. The presence of wage-moderating effects reinforces this ordering.

In light of the arguments presented above we can conclude

Proposition 4 ***By committing itself to a profit-sharing system the firm will find it optimal to offer a higher profit share than that resulting from bargaining in a situation with all the bargaining power concentrated to the firm.***

Intuitively, the optimal profit share is higher under commitment than when it is determined at the stage of bargaining, because when optimally committing itself to a profit-sharing system the effort-enhancing considerations will be given a higher weight. In addition, the commitment is typically associated with a wage-moderating effect, which will, of course, not be present, when the profit share is determined at the stage of bargaining simultaneously with the wage determination. Also this additional effect raises the profit share under the commitment regime relative to that determined through bargaining.

VII. Aggregate Wage Setting and Equilibrium Unemployment

So far our analysis has been restricted to a partial equilibrium perspective. In this section we will outline the implications of profit sharing, union bargaining power, leverage and

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[12] Another conclusion to draw from this intractability is that the approach developed by Holmlund (1991) and Jerger and Michaelis (1999) does not seem to lend itself generalizations of the type present in our analysis.

the benefit-replacement ratio on equilibrium unemployment in a general equilibrium sense.

Until now our analysis of wage bargaining has referred to a representative industry, say i. By (14), for each representative industry the generalized Nash bargaining solution has the implicit form

$$(27) \qquad w_i^N = y_i(w_i^N)\, b \quad ,$$

where

$$y_i(w_i^N) = \frac{c\, b\, h^* + (1-x_w)(1-b)}{c\, b\,(h^*-1) + (1-x_w)(1-b) + (1-x_w)\, t\, k\, c\,(1+rd)}$$

and where the variables on the RHS are industry-specific. However, for simplicity we have abstracted from industry-specific notation. In fact, (27) would be a representation in explicit form of the negotiated base wage in the absence of efficiency wage considerations ($x_w = 0$), because in that case that relationship between the base wage and the outside option would be given by (27) with (28)

$$(28) \qquad y_i(w_i^N) = y_i = \frac{c\, b\, h + (1-b)}{c\, b\,(h-1) + (1-b) + t\, k\, c\,(1+rd)} \quad .$$

We assume that $y_i = y$, i.e. that all the industries are identical in the sense of negotiating with unions having identical bargaining power and facing identical elasticity of labour demand, identical profits shares, capital structures as well as interest rates.[13]

In a general equilibrium context the term b should be re-interpreted to be the outside option. With this interpretation the outside option is given by

[13] For a detailed analysis of the complications introduced when incorporating efficiency wage considerations in a related context we refer to Altenburg and Straub (1998).

(29) $$b \;=\; (1-u)\,w^N \;+\; u\,B \quad ,$$

where u denotes unemployment rate, B the unemployment benefit and w^N is the negotiated wage rate in all the identical industries [for a standard justification we refer to, for example, Layard et. al. (1991), p. 100-101]. We follow Jerger and Michaelis (1999) insofar as we further restrict ourselves to the case of a constant replacement ratio $q \equiv B/w^N$.

Combining (27), (28) and (29) we find that the aggregate unemployment rate can be expressed according to

(30) $$u^N \;=\; \frac{c\,b \;-\; t\;k\,c\,(1+rd)}{(1-q)\,[b\;(c\,h-1)+1]} \quad .$$

From (30) we can conclude that our model offers fairly detailed insights regarding the determination of aggregate unemployment. We can formulate these insights in

Proposition 5 ***In the absence of efficiency wage considerations the aggregate unemployment rate depends positively on the relative bargaining power of the union as well as on the benefit-replacement ratio, and negatively on the profit share, on the firm's probability of solvency as well as on the firm's leverage rate.***

The properties incorporated in Proposition 5 all appeal to intuition. It is particularly interesting to observe that our model lends support to the view of profit sharing as a policy instrument with the effect of reducing the aggregate unemployment rate. This employment-enhancing effect of profit sharing can be seen as a consequence of its wage-moderating effect. The similar result have been established in different models by Holmlund (1991) and by Jerger and Michaelis (1999).

When placing into perspective that the leverage rate would reduce the unemployment rate, it should be remembered that our model incorporates neither imperfections in the product market nor optimizing behaviour by the institutions operating in the credit market. If the product market is imperfectly competitive, the firm's leverage can be expected to affect the mark-ups positively and thereby to increase equilibrium unemployment. We have excluded effects whereby an increased leverage rate would generate higher interest rates, which can be expected both to reduce investment and to increase mark-ups.[14] Consequently, the employment-enhancing effect of leverage (or interest rate) is simply a reflection of the labour market effect according to which an increased leverage rate will induce a wage moderation at the bargaining stage.

VIII. Concluding Comments

This study has offered a unified framework for simultaneously analyzing the determination of employment, effort provided by employed union members, wages, profit sharing as well as capital structure under uncertainty generated by a stochastic revenue shock. The following time sequence of decisions was postulated: At stage 1 the firm commits itself to a profit-sharing scheme and to a leverage rate, at stage 2 there is union-firm wage bargaining, and at stage 3 employment is unilaterally determined by the firm and effort by the employee before the resolution of the stochastic revenue shock. Using backward induction the game was solved in reverse order.

We initially showed that employment depends negatively on the effective labour cost as well as on the hazard rate capturing the uncertainty associated with the firm's production. The effective labour cost consists not only of the wage rate, but it also incorporates the interest rate and importantly the firm's rate of leverage. Further, the effort provision by union members was shown to depend positively not only on the usual efficiency wage considerations, but we also characterized the effort-enhancing effects of profit sharing.

[14] For a detailed theoretical argument and some empirical evidence from USA, see Chevalier and Scharfstein (1996)). Honkapohja and Koskela (1999) provide empirical evidence from Finland for the positive relationship between the mark-ups and the firm's leverage. Phelps (1994) has argued that higher interest rates can be expected to increase mark-ups by shortening the effective planning horizon of firms.

Wage determination was analyzed by applying a generalized Nash bargaining solution, which extended the wage bargaining literature by incorporating not only efficiency wage considerations in the presence of uncertainty, but also profit sharing and capital structure. From the generalized bargaining solution we were able to conclude how capital structure and performance-based evaluation in the form of profit sharing will have a strategic wage-moderating commitment value for a firm facing a union in wage negotiations.

We also derived the optimal profit sharing system and the optimal capital structure from the firm's point of view. The profit-sharing instrument was demonstrated to have positive effort-augmenting and wage-moderating effects, which exactly offset the negative dilution effect at the optimal profit share. We also established the mechanism whereby a higher leverage rate not only increases the effective labour cost, but also moderates the wage rate, which is a crucial feature for determining the firm's optimal capital structure. The paper ended with a brief characterization of the implications of profit sharing, bargaining power, the benefit-replacement ratio and the firm's leverage on equilibrium unemployed from a general equilibrium perspective.

Our analysis highlighted the role of capital structure and performance-based evaluation in the form of profit sharing as strategic commitment devices designed to shift rents from the union to the firm as strategic instruments for a firm facing a union in wage negotiations. The leverage rate and the profit share were shown to typically represent complementary instruments in this respect.

Our model offered support in favor of the employment-enhancing effects of profit-sharing systems. Profit sharing increases employment via its wage-moderating effect, and this effect is further reinforced by profit-sharing systems inducing higher effort provision. For an overall evaluation of the total employment effects of the degree of leverage and of the interest rate our study identified three channels. Employment was established to be discouraged through the direct effect of these variables increasing the effective labour cost. This direct effect, however, was shown to be offset both by higher effort provision and by wage moderation, both effects of which have employment-encouraging effect.

Though there is empirical evidence on the determinants of employment and wages, which lies in conformity with our findings, it still remains an important task for future research to evaluate the interactions between wages, employment and financial factors more systematically than what has been done thus far.

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Appendix A: Derivation of the Nash bargaining wage rate

This appendix develops the expressions for the terms $\frac{E\pi_w}{E\pi}$ and $\frac{EU_w}{EU}$ in the first-order condition (13) of the Nash bargaining. We start by looking at the profit response by the firm to a change in the wage rate. The optimal employment decision of the firm has to satisfy the first-order condition $Ep_L = 0$, which is equivalent to the condition $(aL)^{a-1} = \frac{w(1+rd)}{a}$. By taking account of this condition we find that

$$Ep_w = k\left[(aL)^{a-1} L \; a_w \; - \; (1+rd)L\right] = k\,(1+rd)\,L\left[\frac{w a_w}{a} - 1\right] \; = \; \frac{k\,w(1+rd)\,L}{w}\left[x_w - 1\right],$$

where the elasticity of effort with respect to wage, x_w, is defined by $x_w = \frac{w a_w}{a}$. In particular, we can observe that if the firm could unilaterally decide on w so as to maximize its expected profit such a profit-maximizing wage would satisfy that x_w = 1, which is the well-known "Solow condition" for the efficiency wage determination in the absence of wage bargaining.

Consequently, in light of equation (12') we can conclude that

$$(A1) \qquad \frac{Ep_w}{Ep} \; = \; \frac{1}{c\,w}\left[x_w - 1\right].$$

As for the trade union side we find that by combination of (11) and (12') the expected rent of the union can be expressed as

$$(A2) \qquad EU \; = \; L\left[\, w\,(1 \; + \; t\,k\,c(1+rd)) \; - \; b\,\right].$$

By differentiating equation (11) with respect to w we obtain

$$EU_w \quad = \quad L \quad + \quad L_w\,(w - b) \quad + \quad t\; Ep_w \quad ,$$

which can be expressed as

$$(A3) \qquad EU_w \;=\; \frac{L}{w}\Big[\,w(1-h^*) \quad + \quad t\;k\,w(1+rd)\,(x_w - 1) \quad + \quad h^*\,b\;\Big] \quad ,$$

where $h^* = -\dfrac{w L_w}{L}$. Consequently, we can substitute the ratio

$$(A4) \qquad \frac{EU_w}{EU} \quad = \quad \frac{\dfrac{L}{w}\Big[\,w(1-h^*) \quad + \quad b\,h^* \quad + \quad t\;wk\,(1+rd)\,(x_w - 1)\Big]}{L\,\big[\,w - b + t\;k\,c\,w(1+rd)\big]}$$

into (13).

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Appendix B: Determination of the optimal capital structure and profit-sharing

By differentiation of the expected profit function (20) with respect to t we find the necessary first-order condition to be given by

$$(B1) \quad Ep_t \;=\; -Ep \quad + \quad k\,(aL)^{a-1}\,L\,a_t\,(1-t) \quad - \quad k\,\big(1+rd\big)\,L\,w_t\,(1-t) \quad = \quad 0\,.$$

(B1) shows that there is an interior optimal profit share, which is determined so that the negative dilution effect is exactly offset by the positive effects of increased effort and a moderated wage rate on the expected profits of the firm. Remembering that the expected profit can be written by (12') and that the optimal employment decision of the firm is equivalent to the condition $(aL)^{a-1} = \dfrac{w(1+rd)}{a}$ it follows that (B1) can be rewritten according to (21).

Differentiation of (20) with respect to d directly yields the first-order condition

$$(B2) \qquad Ep_d \quad = \quad -\,k\,(1-t)\,L\,(1+rd)\,w_d \quad - \quad k\,\big(1-t\big)\,L\,w\,r \quad = \quad 0\,,$$

which can be reformulated so that the interior optimal capital structure is determined by (22).

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Appendix C: Derivation of the Nash bargaining profit share

This appendix develops the expressions for the terms $\frac{EU_\tau}{EU}$ and $\frac{E\pi_\tau}{E\pi}$ in the first-order condition (23) of the Nash bargaining. We start by looking at the reactions of the firm to a change in the profit share. The optimal employment decision of the firm has to satisfy the first-order condition $Ep_L = 0$, which is equivalent to the condition $(aL)^{a-1} = \frac{w(1+rd)}{a}$. By taking account of this condition we find that

$$Ep_t = k\left[(aL)^{a-1} L \; a_t\right] = k\, w(1+rd)\, L \frac{a_t}{a} \quad = \quad \frac{k\, w(1+d\, r)\, L}{t} x_t \,,$$

where the elasticity of effort with respect to the profit share, x_t, is defined by $x_t = \frac{t\; a_t}{a}$.

Consequently, in light of (12') we can conclude that

$$(C1) \qquad \frac{Ep_t}{Ep} \quad = \quad \frac{1}{ct}\; x_t \;.$$

As for the trade union side we find that by combination of (11) and (12') the expected rent of the union can be expressed as

$$(C2) \qquad EU \quad = \quad L\left[\, w(1 \quad + \quad \tau k\, c(1+r\delta)) \quad - \quad b\,\right].$$

By differentiating (11) with respect to t we obtain

$$EU_t \quad = \quad L_t\,(w-b) \quad + \quad Ep \quad + \quad t\, Ep_t \quad ,$$

which can be calculated to be equivalent to

$$(C3) \qquad EU_t = \frac{L}{t}\left[\, k\, w(1+rd)\left(c + x_t\right) \quad + \quad (h^* - 1)\, x_t\,(w-b)\,\right] \quad ,$$

where $h^* = -\frac{t\; L_t}{L}$. Consequently, we can substitute the ratio

$$(C4) \qquad \frac{EU_t}{EU} \quad = \quad \frac{\frac{L}{t}\left[\, k\, w(1+rd)\left(c + x_t\right) \quad + \quad (h^* - 1)\, x_t\,(w-b)\,\right]}{L\left[\, w - b + t\; k\, c\, w(1+rd)\right]}$$

into (23).

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References:

Akerlof, G.A., Yellen, J.L. (1986): *Efficiency Wage Models of the Labor Market*, Cambridge University Press.

Altenburg, L., Straub, M. (1998): Efficiency Wages, Trade Unions, and Employment, *Oxford Economic Papers*, 50, 726-746.

Anderson, S., Devereux, M. (1989): Profit-sharing and optimal labour contracts, *Canadian Journal of Economics*, 89,425-433.

Binmore, K.G., Rubinstein, A., Wolinsky, A. (1986): The Nash bargaining solution in economic modeling, *Rand Journal of Economics*, 17, 176-188.

Bronars, S.G., Deere, D.R. (1991): The Threat of Unionization, the Use of Debt, and the Preservation of Shareholder Wealth, *Quarterly Journal of Economics*, 56, 231-234.

Bulkley, G., Myles, G.D. (1996): Trade Unions, Efficiency Wages and Shirking, *Oxford Economic Papers*, 48, 75-88.

Chevalier, J.A., Scharfstein, D.S. (1996): Capital Market Imperfections and Countercyclical Markups: Theory and Evidence, *American Economic Review,86 ,703-725.*

Dasgupta, S., Sengupta, K. (1993): Sunk Investment, Bargaining, and Choice of Capital Structure, *International Economic Review*, 34, 203-220.

Funke, M. Maurer, W., Strulik, H. (1999): Capital Structure and Labour Demand: Investigations Using German Micro Data, *Oxford Bulletin of Economics and Statistics*, 61, 199-215.

Garvey, G.T., Gaston, N. (1998): Getting Tough with Workers? More on the Strategic Role of Debt , mimeo.

Greedy, J., McDonald, J. (1991): Models of Trade Union Behaviour: A Synthesis, *Economic Record*, 67, 346-359.

Hanka, G. (1998): Debt and the Terms of Employment, *Journal of Financial Economics,* 48, 245-282.

Harris, M., Raviv, A. (1991): The Theory of Capital Structure, *Journal of Finance,* 46, 297-355.

Hart, O. (1995): *Firms, Contracts, and Financial Structure,* Clarendon Press, Oxford.

Holmlund, B. (1990): Profit Sharing, Wage Bargaining, and Unemployment, *Economic Inquiry,* 28, 257-268.

Honkapohja, S., Koskela, E. (1999): Finland's Depression: A Tale of Bad Luck and Bad Policies, *Economic Policy*, 29, 399-436.

Jerger, J., and Michaelis, J. (1999): Profit Sharing, Capital Formation and the NAIRU, *Scandinavian Journal of Economics*, 101, 257-275.

Koskela, E., Schöb, R. (1999a): Alleviating Unemployment: the Case for Green Tax Reforms, *European Economic Review*, 43, 1723-1746.

Koskela, E., Schöb, R. (199b): Does the Composition of Wage and Payroll Taxes Matter under Nash Bargaining?, *Economics Letters*, 64, 343-349.

Koskela, E., Schöb, R., Sinn, H.-W. (1998): Pollution, Factor Taxation and Unemployment, *International Tax and Public Finance,* 5, 379-393.

Layard, R., Nickell, S., Jackman, R. (1991): *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press.

Lindbeck, A. , Snower, D.J. (1991): Interactions between the Efficiency Wage and Insider-Outsider Theories, *Economics Letters,* 37, 193-196.

Nash, J. (1950): The Bargaining Problem, *Econometrica*, 18, 155-162.

Nickell, S., Nicolitsas, D.(1999): How does financial pressure affect firms? *European Economic Review*, 43, 1435-1456.

Nickell, S., Wadhwani, S. (1991): Employment Determination in British Industry: Investigations Using Micro-Data, *Review of Economic Studies*, 58, 955-969.

Oswald, A.J. (1985): The Economic Theory of Trade Unions: An Introductory Survey, *Scandinavian Journal of Economics*, 160-193.

Perotti, E.C., Spier, K.E. (1993): Capital Structure as a Bargaining Tool: The Role of Leverage in Contract Negotiation, *American Economic Review*, 83, 1131-1141.

Phelps, E.S. (1994): *Structural Slumps:The Modern Equilibrium Theory of Unemployment, Interest and Assets*, Harvard University Press, Cambridge, MA.

Pohjola, M. (1987): Profit-Sharing, Collective Bargaining and Employment, *Journal of Institutional and Theoretical Economics,* 334-342.

Romer, D. (1996): *Advanced Macroeconomics*, McGraw-Hill, New York.

Sanfey, P.J. (1993): On the Interaction between Efficiency Wages and Union-Firm Bargaining Models, *Economics Letters,* 41, 319-324.

Sarig, O.D. (1998): The Effect of Leverage on Bargaining with a Corporation, *The Financial Review*, 33, 1-16.

Sharpe, S.A. (1994): Financial Market Imperfections, Firm Leverage, and the Cyclicality of Employment, *American Economic Review*, 84, 1060-1074.

Solow, R. (1979): Another Possible Source of Wage Stickiness, *Journal of Macroeconomics,* 1, 79-82.

Weitzman, M. (1985): The Simple Macroeconomics of Profit-Sharing, *American Economic Review*, 75, 937-54.

Weitzman, M. (1987): Steady State Unemployment under Profit Sharing, *Economic Journal*, 97, 86-105.