

Profit-sharing and optimal labour contracts

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Abstract. This paper examines the effect of introducing profit-sharing arrangements into union-firm contracts. It is shown that if bargaining is efficient (using the generalized Nash bargain), profit-sharing has no effect on the bargaining outcome. This is true both when the profit-sharing restriction is exogenously imposed by legislation and when profit-sharing is part of the optimal contract. However, if the initial bargaining process is inefficient because direct negotiation on total employment is precluded, an optimal contract can use profit-sharing to establish the efficient bargaining outcome. Both types of bargaining models have been employed in the literature.

Partage des profits et contrats de travail optimaux. Ce mémoire examine les effets de l'introduction d'accords de partage des profits dans les conventions collectives entre entreprises et syndicats ouvriers. On montre que si la négociation est efficiente (utilisant la négociation généralisée à la Nash), le partage des profits n'a aucun effet sur le résultat de la négociation. Cela est le cas à la fois quand le partage des profits est imposé par législation et quand il fait partie du contrat optimal. Cependant, si le processus initial de négociation est inefficace, parce que la négociation directe sur l'emploi total n'est pas possible, un contrat optimal peut utiliser le partage des profits pour en arriver à un résultat efficace de négociation. Les deux types de modèles de négociation ont été utilisés dans la littérature spécialisée.

Most jobs involve compensation in terms of a wage rate independent of the profitability of the firm. We frequently witness calls for the introduction of some element of profit-sharing in payment systems. Why should profit-sharing be desired? One answer is given by Weitzman (1983, 1984, 1985). He argues that a profit-sharing economy would display characteristics strikingly different at the aggregate level from one based solely on a conventional wage payment system, including a tendency in the former system towards full employment.¹

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¹ Weitzman's thesis has been the subject of keen debate. See, for example, Nordhaus and John (1986).

Our paper provides a quite different rationale for profit-sharing, arguing that it may be a necessary part of an efficient contract when union-firm bargaining is constrained by the assumption that total employment is determined unilaterally by the firm. More generally, we examine the effect of introducing a profit-sharing element into a standard union-firm bargaining environment.²

Two main results are derived. First, it is shown that when bargaining is efficient, with bargaining over *both* wage and employment, then the introduction of a profit-sharing contract is irrelevant; it affects neither the welfare of the union or the firm, nor the efficient employment level. This holds both when profit-sharing is imposed by legislation and when it is chosen endogenously as part of an optimal contract.

However, if bargaining is constrained by the inability directly to negotiate an employment, with employment determined unilaterally by the firm, the move from a contract specifying the wage alone to a profit-sharing contract has a significant effect on the bargaining outcome. In general, the bargaining outcome will be inefficient when restricted in this way. An optimal profit-sharing contract however, re-establishes the fully efficient contract, replicating the original contract, where both wage and employment are subject to negotiation. Profit-sharing, therefore, eliminates the inefficiency arising from the inability to negotiate over employment.

Both these types of bargaining models have been used in previous literature (see Oswald, 1985, for a survey). It is well known that efficiency generally requires bargaining over both wages and employment (exceptions are Hall and Lilien, 1979, and Oswald, 1984). Nevertheless, it does seem to be widely observed that actual labour contracts specify wages alone, and seldom contain employment provisions (e.g., Oswald, 1984). Farber (1986) suggests that this may be the result of an incentive problem for the firm when it does not operate along its labour demand curve, as it does in the efficient contract model. The profit-sharing equilibrium outlined in this paper allows for the efficient bargaining outcome to be achieved while the firm is still constrained to determine employment along its labour demand curve.

The paper is structured as follows. The next section briefly describes the generalized Nash bargain, where both wage and employment are part of the bargaining set, and shows that profit-sharing has no effect on the outcome of this bargain. The second section then describes a restricted contract in which only the wage is bargained over. A profit-sharing contract is then defined, and the bargaining outcome under this contract is derived.

EFFICIENT BARGAINING

We take a single firm that employs labour L and has gross profit function given by

$$\pi(w, L) = R(L) - wL, \quad (1)$$

where w is the wage per worker. The revenue function $R(L)$ is assumed to be

2 Tracy (1986) investigates the effect of profit-sharing in a monopoly trade union model. However, his structure differs from ours considerably. See footnote 6 below.

strictly concave and twice differentiable in L . Labour is assumed to be essential for production, so that profit is zero if no wage-employment bargain can be agreed on with the union.

The union's preferences are represented by the function

$$U(w, L) = Lu(w) + (\bar{L} - L)u(\bar{w}). \quad (2)$$

The function $u(w)$ is increasing and concave in w . \bar{L} is total union membership, and we restrict analysis to cases where $L < \bar{L}$. Variable \bar{w} represents the outside opportunity wage available to each worker.³ The function (2) may be thought of as representing the preferences of a utilitarian trade union or else as expected utility per worker (see, e.g., Oswald, 1982). If no bargain can be agreed on with the firm, then union utility is $\bar{L}u(\bar{w})$.

We characterize the bargaining process by the generalized Nash solution. This is described by Svejnar (1986), who derives it from an axiomatic approach. The solution to the *wage-employment bargain* is the pair, w^* , L^* which solves problem P1

$$\text{Maximize } B^* = \pi(w, L)^{(1-\alpha)}(L(u(w) - u(\bar{w})))^\alpha \quad \alpha \in [0, 1]. \quad (P1) \\ \{w, L\}$$

The parameter α represents the relative bargaining strength of the union. In the original Nash bargaining framework, $\alpha = 1/2$ is assumed.

The solution to problem (P1) is characterized by equations (3) and (4)

$$R_L = w^* - [(u(w^*) - u(\bar{w})) / u'(w^*)] \quad (3)$$

$$w^* = (1 - \alpha)R_L + (\alpha(R) / L^*). \quad (4)$$

Equation (3) describes the optimal employment rule for the efficient bargain. This specifies that the marginal product of labour should be *less* than the per worker wage w^* . Thus the firm operates above the labour demand curve. In figure 1 this is depicted as point N , which represents a point on the (upward-sloping) union-firm contract curve cc' . Equation (4) states that the wage in the efficient bargain is a linear combination of the marginal product of labour and the average product of labour, with the respective weights being determined by firm and union strength. A similar result is reported in McDonald and Solow (1981). When the union has no power, workers merely get \bar{w} , whereas when the firm has no power, each worker gets R/L , and profits accruing to the firm are zero.

What effect will the introduction of profit-sharing have on this bargain? Assume now that instead of a given wage rate the firm is presented with a base wage per worker equal to w_b , and it pays an equal share λ/L of its gross profits to each employed worker. Total income per worker in the profit-sharing scheme is then

$$y = w_b + \frac{\lambda}{L} [R(\cdot) - w_b L]. \quad (5)$$

3 The slopes of the isowelfare and isoprofit loci easily may be derived from (1) and (2).

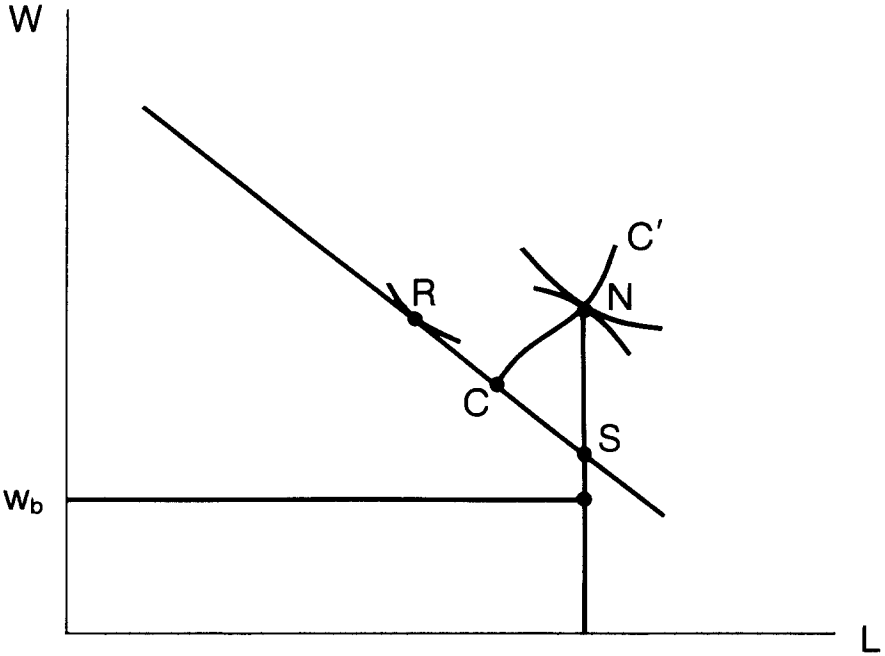


FIGURE 1

Given y , the firm's net profit is

$$\pi(w_b, L, \lambda) = R - yL = (1 - \lambda)(R - w_b L). \tag{6}$$

Now define the *wage-employment bargain under profit-sharing* as the pair $\{\bar{w}_b, \bar{L}\}$, which solves the problem (P2) given by

$$\text{Maximize } \hat{B} = \pi(w_b, L, \lambda)^{(1-\alpha)}(L(u(y) - u(\bar{w})))^\alpha \quad \alpha \in [0, 1]. \tag{P2}$$

$$\{ \bar{w}_b, \bar{L} \}$$

From (P2) we may establish the following result:

PROPOSITION 1. *The solution to (P2) satisfies (a) $\hat{L} = L^*$; (b) $\hat{y} = w^*$.*

Proof. The first-order conditions for (P2) may be expressed as

$$R_L = \hat{w}_b + (\lambda(R - \hat{w}_b L)/\hat{L}) - [(u(\hat{y}) - u(\bar{w}))/u'(\hat{y})] \tag{7}$$

$$y = \hat{w}_b + (\lambda(R - \hat{w}_b \hat{L})/\hat{L}) = (1 - \alpha)R_L + (\alpha(R)/\hat{L}). \tag{8}$$

Comparing equations (3) and (4) with (7) and (8), using the definition (5), it is apparent that the two sets of conditions are equivalent. Thus the imposition of profit-sharing on the union firm bargain will leave employment, worker remuneration, and firm profit all unchanged. The base wage will be adjusted so as to leave total income per worker unchanged. Since the base wage and profit-share component of

the contract are interchangeable, it follows immediately that the same result would hold if the profit-share parameter λ were actually incorporated into the bargain. Of the two instruments w_b and λ , one will be redundant. Profit-sharing is thus irrelevant once an efficient contract is already in effect.

It is straightforward to show that the above proposition is more general than has been presented here. In particular, the result will hold for any union welfare function $U(y, L)$ and any bargaining maximand which allows for a unique interior solution to the original bargaining problem. This is proved in appendix A.

We now turn to a more restricted bargaining environment, where direct negotiation on employment is precluded.

RESTRICTED BARGAINING WITH PROFIT-SHARING

It has been argued (e.g., Oswald, 1984) that trade union contracts generally do not contain explicit provisions on hiring, allowing this to be determined almost exclusively by the firm. This is reflected in many bargaining models in which the firm chooses employment unilaterally, given the per worker wage rate, while bargaining takes place over the wage alone (e.g. Oswald 1985).⁴ Farber (1986) provides a rationale for this as follows. In the efficient contracts model the marginal revenue product of labour is less than the per-worker wage. This gives an incentive for the firm to deviate from the optimal contract by cutting employment at the given wage. On the other hand, an efficient contract which ensures that the firm is on its labour demand curve will entail a low wage combined with a lump-sum payment to the union. But this solution may be impossible if internal union redistribution is not feasible.⁵

We now make use of these arguments to impose the restriction that employment be determined by the firm. In the absence of profit-sharing, the union and firm would then bargain over the wage alone, and the outcome would necessarily lie on the labour demand curve. Clearly this is inefficient; unless the union has no power, the wage-employment outcome is off the contract curve. Point *R* in figure 1 is such a case. Employment will always be *below* the employment level under efficient contracting.

Retaining the assumption that employment is determined unilaterally by the firm, we now investigate the effects of introducing profit-sharing into the contract. Given any w_b and λ , the firm chooses L to maximize net profits as given by (6). Optimal

4 Nickell and Andrews (1982) have called this the 'right to manage model.' The most popular variant of this model is the monopoly trade union model, which corresponds to a case where the union has all the bargaining power.

5 There are a number of cases where an efficient outcome may be consistent with unilateral determination of employment by the firm. Hall and Lilien (1979) show, for a case where there are no income effects on labour supply, that a unique wage schedule increasing in hours worked may be presented to the firm to achieve an efficient outcome. Oswald (1984) shows that the median voter model of trade union behaviour implies that efficient contracts are on the labour demand curve. Finally, if the union can impose a seniority rule for lay-offs and wages are determined by seniority, then an efficient outcome may once again be achieved by an optimal choice of wage-seniority profile. Kuhn (1988) describes an optimal seniority wage profile in a monopoly union context.

employment is given by

$$R_L = w_b. \quad (9)$$

Employment is independent of the profit share parameter λ , since this acts like a neutral profits tax. Equation (9) defines the labour demand curve $L(w_b)$, where $L'(\cdot) < 0$.

Now suppose that the union and firm bargain over w_b and λ subject to the restriction that employment is determined by (9).⁶ Define the *wage profit-sharing bargain* as the pair $\{\tilde{w}_b, \tilde{\lambda}\}$ which solves the problem (P3):

$$\begin{aligned} \text{Maximize } \tilde{B} &= \pi(w_b, L, \lambda)^{(1-\alpha)}(L(u(y) - u(\tilde{w})))^\alpha & \alpha \in [0, 1] & \quad (P3) \\ \{w_b, \lambda\} & & & \\ \text{subject to (5) and (9).} & & & \end{aligned}$$

PROPOSITION 2. *The solution to (P3) satisfies (a) $\tilde{L} = L^*$, and (b) $\tilde{y} = w^*$. Furthermore the solution gives $\tilde{\lambda} = \alpha$.*

Proof. The first-order condition with respect to λ and w_b yield (10) and (11), respectively:

$$\partial \tilde{B} / \partial \lambda = [-(1 - \alpha)\tilde{B}/(1 - \lambda)] + [\alpha u'(\cdot)(R - w_b L)\tilde{B}/(u(y) - u(\tilde{w}))] = 0 \quad (10)$$

$$[L(1 - \tilde{\lambda})(R - w_b L)](\partial \tilde{B} / \partial \lambda) + (\partial \tilde{B} / \partial L) L'(\cdot) = 0. \quad (11)$$

For both (10) and (11) to hold simultaneously we require

$$\partial \tilde{B} / \partial L = \frac{-\alpha(u'(\cdot)\tilde{\lambda}(R - w_b L))}{L(u(y) - u(\tilde{w}))} + (\alpha/L) = 0. \quad (12)$$

Then with (10), this condition holds only if $\alpha = \tilde{\lambda}$. Thus the optimal profit share equals union power in the bargain. Using (5) and (6) this implies that

$$\tilde{y} = (1 - \alpha)R_L + \alpha(R/L). \quad (13)$$

Then equation (10) implies that $\tilde{w}_b = \tilde{y} - (u(\tilde{y}) - u(\tilde{w}))/u'(\tilde{y})$. Given this, it is clear that conditions (9) and (13) are equivalent to conditions (3) and (4) of the previous section. Thus the solution to problem (P3) is identical to that of problem (P1).

An optimal profit-sharing scheme replicates the original bargaining outcome where both wage and employment are independently subject to negotiation. This achieves a point on the efficient firm-union contract curve while still allowing employment to be unilaterally determined by the firm. Moreover, this does not require any internal union redistribution. Each worker is paid a base wage plus a share of profits directly by the firm. The scheme thus avoids the problems of the complete bargaining solution outlined by Farber (1986).

6 In a symposium on Weitzman's book, Tracy (1986) outlines the impact of profit-sharing on the outcome of a monopoly trade union's problem. Besides the different bargaining structure, his analysis differs from ours in two important respects; (i) he allows for a choice of profit share alone, not base wage and profit share; and (ii) his profit share is actually a revenue share, so that the parameter affects optimal employment (negatively).

Figure 1 illustrates this solution. The base wage w_b is chosen so that the firm chooses the point S on the labour demand curve. The remittance of profits to individual workers then brings union utility up to UU' , thus achieving point N , the efficient bargaining point. Relative to the restricted wage contract, employment is always higher with profit-sharing. Total worker remuneration, however, may be higher or lower.

Note that when $u'' < 0$, the base wage must be set *below* the opportunity cost of the workers' time \bar{w} . In addition there are two special cases worth looking at. When the firm has no bargaining power, that is, $\alpha = 1$, the optimal profit share is unity, and the union receives the full revenue generated by the bargain. Net profits are zero. The case $\alpha = 1$ is similar to the monopoly union model. However unlike that model, here the use of profit-sharing implies an efficient level of employment. On the other hand, when $\alpha = 0$, the union receives only reservation utility, $\bar{L}u(\bar{w})$, the base wage is set at \bar{w} , and the optimal profit-share parameter is zero. In fact the absence of profit-sharing is not a constraint in this case at all.

The equivalence between the profit-sharing contract and the full bargaining optimum does not depend on the particular union preference function used here. In appendix B this is shown for general union preference functions and a general bargaining maximand. However, the result that the profit share per worker equals union power in the bargain requires that the union preference function be *linear* in employment. Nevertheless, the specification (2) is widely used in the trade union literature.

From these results, the welfare argument for profit-sharing hinges on the empirical question of which type of contract structure best characterizes union-firm relationships. An efficient contract in general requires that there be independent instruments for achieving efficient employment and division of total surplus. When direct negotiation on employment is ruled out, the wage contract alone cannot achieve both these objectives. A profit-sharing contract can do so, since it allows for an independent choice of base wage and profit-sharing parameter. That these instruments are independent is clear from equation (9). The effect of the base wage on employment is independent of the profit-share parameter.

CONCLUSIONS

We cannot directly extrapolate from these results to the conclusion that profit-sharing is desirable for policy purposes. The contract curve in this model encompasses only the welfare of the firm and the trade union, not overall social welfare. However, the result does suggest a role for profit-sharing quite different from that discussed previously. Moreover, this provides a link between two commonly used bargaining models.

APPENDIX A

In this appendix we show that the first proposition holds for general union preference functions and for a general bargaining maximand, provided the solution to the

original bargaining problem exists. Assume that union preferences are now given by $U(w, L)$, and the bargaining maximand is given by $B(\pi, U)$. We wish to show that a solution to problem (P1') is also a solution to problem (P2'), where these are defined by

$$\text{Maximize } B^* = B(R - wL, U(w, L)) \quad (\text{P1}') \\ \{w, L\}$$

$$\text{Maximize } B = B((R - w_b L)(1 - \lambda), U(y, L)) \quad (\text{P2}') \\ \{w_b, L\}$$

where $y = w_b + \lambda(R - w_b L)/L$. The solution to (P1') is characterized by

$$B_1 L^* = B_2 U_1 \quad (\text{A1})$$

$$B_1(R_L - w^*) = -B_2 U_2, \quad (\text{A2})$$

where a subscript denotes a derivative with respect to an argument. The solution to (P2') is characterized by the conditions

$$B_1 \hat{L} = B_2 U_1 \quad (\text{A3})$$

$$B_1(1 - \lambda)(R_L - \hat{w}_b) = -B_2\{\lambda U_1(R_L/\hat{L} - R/\hat{L}^2) + U_2\}. \quad (\text{A4})$$

The solution to these two equations yields a given value of \hat{y} . We wish to show that if (\hat{w}_b, \hat{L}) is a solution to (A3) and (A4), then $\{\hat{y}, \hat{L}\}$ is a solution to (A1) and (A2). Clearly there is no contradiction between (A1) and (A3). Rewriting (A4) and (A3) gives

$$B_1[(1 - \lambda)R_L - \hat{y} + \lambda R/L] = -B_2 U_2 - B_1 \lambda R_L + B_1 \lambda R/\hat{L}. \quad (\text{A5})$$

Rearranging and using $\hat{y} = w^*$ yields (A2). Hence the solutions are equivalent.

APPENDIX B

Here we show that the solution to (P3') is also equivalent to (P1'), where (P3') is defined as

$$\text{Maximize } \tilde{B} = B((1 - \lambda)(R - w_b L), U(y, L)), \quad (\text{P3}') \\ \{w_b, \lambda\}$$

subject to

$$R_L = w_b. \quad (\text{A6})$$

It is straightforward to show that a solution requires $\partial \tilde{B} / \partial L = \partial \tilde{B} / \partial \lambda = 0$. This implies

$$B_1 \tilde{L} = B_2 U_1$$

$$\lambda U_1 [R/\tilde{L}^2 - R_L/\tilde{L}] = U_2.$$

Let the implied value for y for this solution be \tilde{y} . We wish to show that $\tilde{y} = w^*$ and

$\bar{L} = L^*$ is also the solution to (P1'). Clearly a solution for (A7) will also satisfy (A1). Now substitute (A6) and (A7) in (A8). This gives

$$\lambda B_1[R - \bar{w}_b \bar{L}] = B_2 U_2 \bar{L}.$$

Thus we get

$$B_1[\bar{y} - \bar{w}_b] = B_2 U_2.$$

Now for $\bar{y} = w^*$ and $R_L = \bar{w}_b$, this is equivalent to (A2).

REFERENCES

- Farber, H.S. (1986) 'The analysis of union behaviour.' In *Handbook of Labour Economics*. Ashenfelter and P.R.G. Layard, eds, (Amsterdam: North-Holland)
- Hall, R.E. and D.M. Lilien (1979) 'Efficient wage bargains under uncertain demand and supply.' *American Economic Review* 69, 868–79
- Kuhn, P. (1988) 'A nonuniform pricing model of union wages and employment.' *Journal of Political Economy* 90, 473–508
- McDonald, I.M. and R.M. Solow (1981) 'Wage bargaining and employment.' *American Economic Review* 71, 896–908
- Nickell, S.J. and M. Andrews (1982) 'Unions, real wages, and employment in Britain, 1951–79.' *Oxford Economic Papers* (Supplement), 183–206
- Nordhaus, W. and A. John, ed. (1986) 'The share economy: a symposium.' *Journal of Comparative Economics* 10,
- Oswald, A.J. (1982) 'The microeconomic theory of the trade union.' *Economic Journal* 92, 576–95
- (1984) 'Efficient contracts are on the labour demand curve; theory and evidence.' Mimeo
- (1985) 'Trade unions, an introductory survey.' *Scandinavian Journal of Economics*
- Svejnar, J. (1986) 'Bargaining power, fear of disagreement, and wage settlements: theory and evidence from U.S. industry.' *Econometrica* 54, 1055–78
- Tracy, J. (1986) 'Unions and the share economy.' *Journal of Comparative Economics* 10, 433–7
- Weitzman, M.L. (1983) 'Some macroeconomic implications of alternative compensation systems.' *Economic Journal* 93, 763–83
- (1984) *Share Economy* (Cambridge, MA: Harvard University Press)
- (1985) 'The simple macroeconomics of profit-sharing.' *American Economic Review* 75, 937–54