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PROFIT SHARING MAY STABILIZE WAGES

by

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PROFIT SHARING MAY STABILIZE WAGES

Abstract

We consider a contract between a risk neutral firm and its risk averse workers, which is signed before product demand is known. Unemployment insurance is imperfect. A fixed wage contract that allows the firm to choose the level of employment leads to too many layoffs in bad states. We show that a profit-sharing contract can be used to attain the efficient level of employment, while at the same time preserving optimal risk sharing between the parties. Under this contract wages are stabilised across states. Thus, a profit sharing contract may be useful when workers are risk averse and concerned about layoffs.

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1. **Introduction**

In order to understand unemployment, and the potential role for policy in eliminating inefficient unemployment, we need a better understanding of labor contracts. If labor contracts were perfect, then all gains from trade would be realized, and the unemployed workers would be those who preferred being unemployed to working and being paid their marginal product. Actual labor contracts appear far from fully efficient, however, and most of the literature on wage formation and unemployment considers contracts that are highly inefficient.

An often used model of union wage bargaining, the "right-to-manage" model, postulates, first, that employment is not specified in the union contract, and, secondly, that no payments are made to unemployed union members. But within the model workers and firms would be much better off if they could write a contract that specifies employment and/or payments to unemployed union members.

One reason why employment is usually not specified in the contract is emphasised by Oswald (1985, 1987) and Gottfries (1992): unions represent insiders, who have relatively secure jobs and little interest in contracts that specify employment and payments to unemployed workers. But clearly there are situations when jobs of insiders are at risk. In such situations, there should be an incentive to write contracts that specify employment and/or payments to workers who are laid off. Yet, contracts that regulate employment are uncommon, and there is hardly any private unemployment insurance. Severance payments are fairly common, but the size of such payments is small. Workers are far from fully insured.

When unemployment insurance is imperfect (or nonexistent) there should be good reasons to specify the level of employment in the contract. Under certainty, this should not be too difficult, but if product demand (or price) is uncertain, a contract that specifies
a fixed employment level may be highly inefficient. At the same time, a contract that makes employment a function of the underlying shocks (e.g. to product price) may be considered too complicated. Whatever the reason, we see very few contracts that directly regulate the level of employment. At the same time, there is one form of contingency that does occur in reality: profit sharing.

The question that we pose in this paper is: Can a profit sharing contract be a substitute for contract that relates wages and employment to underlying state variables? Our answer is yes. We consider a generalised profit sharing contract of the form \( w = B + H(\pi) / \ell \), where \( w \) is the total wage payment to a worker, \( B \) is the base wage, \( H(\pi) \) is an increasing function of profit, \( \pi \), and \( \ell \) is employment. We show that this contract may be a perfect substitute for a full state contingent contract.

On the general level, this is perhaps not too surprising. Hart (1983) noted that a contract that makes the wage contingent on revenue may be equivalent to a state–contingent contract. But the situation we consider is quite different from that considered by Hart. In his model there is a case for profit sharing because firms are risk averse, and they want to sell risk to workers. This may be relevant for small firms where workers have inside information, e.g. small consulting firms, but in most cases one would expect outside financers to know more about the firm’s finances than workers and union representatives. In such cases it should be better to sell the risk to financers than to workers. Furthermore, if the value of workers’ human capital is correlated with the state of the firm (industry), this makes workers particularly unsuitable for taking on risk associated with fluctuations in industry demand.

Our motivation for profit sharing is quite different. In the model discussed here, profit sharing is a way to avoid inefficient layoffs, while at the same time stabilising the incomes of the workers. In fact, our analysis can be seen as an extension of the results of Pohjola (1987) and Anderson and Devereux (1989), who showed that a profit–sharing contract can be used to achieve the efficient–bargain solution under certainty. As we will
show below, however, it is only in the presence of uncertainty that there is a real motivation for profit sharing.

First of all, there seems to be no reason why employment could not be written into the contract if future demand etc. was known with certainty. Furthermore, even if this is not possible, a contract that relates the wage to employment, but not to profit, suffices to achieve efficiency in the case of certainty. Consider, for example, a "wage fund" contract that pays the workers \( w = B + K/\ell \), where \( B \) is a base wage, and \( K \) is a constant "wage fund", and \( \ell \) is employment. By a suitable choice of \( B \), we can induce the firm to choose the efficient level of employment, and \( K \) can be adjusted to attain the desired distribution of income. This is not profit-sharing. However, the "wage–fund" contract is appropriate under uncertainty only if the workers are risk–neutral, for wages will fluctuate and the workers will carry risk.

It is under uncertainty, and with risk–averse workers, that we find a real reason to make wages contingent on profits, in addition to being related to employment. Intuitively, the reason why profit sharing is optimal under uncertainty is the following: In order to induce the firm to maintain high employment, the total wage per worker should be a decreasing function of employment. But since employment increases in good times, this creates a tendency for wages to fall in good times, which is undesirable when workers are risk averse. By making the wage a suitably increasing function of profit, it is possible to stabilize wages across states. So wages should be increasing in profits in order to reduce fluctuations in wages. This turns the usual argument against profit sharing—that workers have to carry excessive risk—precisely on its head.\(^1\)

In section 2 we describe the model, and in section 3 we characterize the optimal

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\(^1\) Pohjola (1990) considers profit sharing under uncertainty, but since he imposes linearity on the profit sharing contract he does not derive the equivalence that we find—in unless the profit sharing parameters are state–contingent.
contract. In section 4 we show that the same outcome can be achieved with a generalised profit-sharing contract. Section 5 considers a special case when the optimal profit sharing contract is linear, as is usually assumed in the literature. Sections 6 and 7 contain extensions and empirical implications, and a summary is given in section 8.

2. The Model

We consider optimal contracting between a risk-neutral employer and risk-averse workers. The contract is signed before the state of the world is known. Throughout we assume that a binding contract can be written, and we do not emphasise verifiability as an important constraint on the contract.\(^2\)

The revenue of the risk-neutral firm is \(R(\ell, \theta)\), where \(\ell\) is employment and \(\theta\) is a stochastic disturbance taking values in some parameter-space \(\Theta\). Assume that \(R_{\ell} > 0\), \(R_{\ell\ell} < 0\), \(R_{\theta} > 0\), and \(R_{\ell\theta} > 0\) (subindices denote partial derivatives). Employment is indivisible: the worker either works full time or not at all.

Workers have strictly concave utility functions \(U(c)\), where \(c\) is consumption. Let \(n\) be the number of workers who sign the contract.\(^3\) When the contract has been signed, some workers get outside offers. With probability \(\mu\) a worker gets an outside offer \(w^1\). We assume that \(w^1\) is so high that workers who get this offer leave the firm. If a worker

\(^2\) As emphasised by MacLeod and Malcomson (1989) and Stiglitz (1992), many contracts are enforced without being verifiable by a third party or (effectively) legally binding. Such self-enforcing contracts can be understood as a subgame perfect equilibrium in a repeated game – see e.g. MacLeod and Malcomson (1989).

\(^3\) We may think of \(n\) as the number of insiders, that is, the workers employed by the firm in the previous period. The focus of the paper is on situations when insiders risk layoff. Hiring of outsiders during the contract period is excluded. This will be discussed in section 6.
does not get an outside offer his alternative income is \( w^0 \), which may be thought of as the (outside) unemployment benefit.\(^4\)

Workers must get expected utility \( \bar{u} \) in order to participate, where \( U(w^0) < \bar{u} < U(w^1) \). The inequality \( \bar{u} > U(w^0) \) may arise because workers (unions) have bargaining power and/or because there are moving costs which workers have to incur if they switch jobs after the contract has been signed. The determination of \( \bar{u} \) will not be discussed in this paper.

If outside offers are observable by the firm, the contract can specify one level of severance pay, \( z^1 \), to workers who move to another job with wage \( w^1 \), and another, \( z^0 \), to workers who are laid off without an outside offer. If outside offers are not observable, workers will be imperfectly insured, and imperfect insurance will play a key role in the analysis below.

3. The Optimal Contract

Let us initially assume that both outside offers to workers and the state \( \theta \) are observable by both parties, and that the firm and the workers can write a complete state–contingent contract. Denote the contract \( \{ W(\theta), Z^1(\theta), Z^0(\theta), L(\theta) \}_{\theta \in \Theta} \). Under this contract, \( L(\theta) \) workers are employed at state \( \theta \), where \( L(\theta) \leq (1-\mu)n \), \( \mu n \) workers get a new job with wage \( w^1 \) and \( (1-\mu)n-L(\theta) \) workers become unemployed. The wage is \( w=W(\theta) \), the firm pays \( z^1=Z^1(\theta) \) to those who get a job at wage \( w^1 \), and \( z^0=Z^0(\theta) \) to those who become unemployed. We allow \( z^1 \) and \( z^0 \) to be negative.

The efficient contract maximizes the firm's expected profits subject to the constraints: (i) the representative worker gets an expected utility of at least \( \bar{u} \), and (ii) no more than \( (1-\mu)n \) workers are employed in any state:

\(^4\) Alternatively, \( w^0 \) may be the wage in an alternative job minus moving cost.
\[ \int \left[ R(L(\theta), \theta) - L(\theta) W(\theta) - n_\mu Z^1(\theta) - ((1-\mu)n - L(\theta)) Z^0(\theta) \right] dF(\theta) \]

subject to:

\[ \int \left[ L(\theta) U(W(\theta)) + n_\mu U(w^1 + Z^1(\theta)) + ((1-\mu)n - L(\theta)) U(w^0 + Z^0(\theta)) \right] dF(\theta) \geq n\bar{\mu}, \]

\[ L(\theta) \leq (1-\mu)n \text{ for all } \theta \in \Theta. \]

The solution to this problem is to set the wage and severance payments independent of the state: \( \hat{W}(\theta) = \hat{w}, \hat{Z}^1(\theta) = \hat{z}_1, \hat{Z}^0(\theta) = \hat{z}_0, \) such that \( w^0 < \hat{w} < w^1, \) and \( \hat{w} = w^1 + \hat{z}^1 = w^0 + z^0. \) Since the contract is complete, it will lead to efficient risk-sharing, and since workers are risk averse and the firm risk neutral, there is no reason to let workers bear risk.

Note that \( \hat{z}^1 \) is negative since \( w^1 > \hat{w} \): workers who get a good outside offer must make a payment to the firm. If it is impossible to enforce a contract stipulating such payments, a constraint \( \hat{z}^1 \geq 0 \) must be imposed, and this constraint will be binding so that \( \hat{z}^1 \) equals zero.

\[ \text{The first-order conditions for the wage and severance payment are:} \]

\[ - \hat{L} + \lambda \hat{L} U_c(\hat{W}) = 0, \]

\[ - \mu_n + \lambda \mu_n U_c(w^1 + \hat{Z}^1) = 0, \]

\[ - ((1-\mu)n - \hat{L}) + \lambda ((1-\mu)n - \hat{L}) U_c(w^0 + \hat{Z}^0) = 0, \]

where \( \lambda \) is the Lagrangean multiplier associated with (2). When employment is chosen optimally, complementary slackness holds for all \( \theta \in \Theta: \)

\[ R(\hat{L}(\theta), \theta) - \hat{w} + \hat{z}^0 + \lambda [U(\hat{w}) - U(w^0 + \hat{z}^0)] \geq 0, \]

\[ \hat{L}(\theta) \leq (1-\mu)n, \]

\[ \{R(\hat{L}(\theta), \theta) - \hat{w} + \hat{z}^0 + \lambda [U(\hat{w}) - U(w^0 + \hat{z}^0)]\} \{L(\theta)-(1-\mu)n\} = 0. \]
For states such that $ \ell \leq (1-\mu)n$, employment should be set so that
\[ R_L(L(\theta), \theta) = \hat{w} - \hat{z}^0 = w^0. \]
This is the employment level that will be chosen by the firm if it is allowed to choose employment so as to maximize profit, given $\hat{w}$ and $\hat{z}^0$. Thus, it is not necessary to specify a state-contingent employment schedule, $L(\theta)$, in the contract: a simple fixed wage/benefit contract, which gives the firm the right to set employment unilaterally, is efficient. This result is well known in the implicit-contract literature (see e.g. Rosen (1985)).

The evidence shows that private unemployment insurance in the form of regular payments is unusual, presumably because it is difficult for a firm to monitor whether a worker gets another job. Severance payments are relatively common in some industries, but the size of payments is small. Thus, workers appear to be far from fully insured against layoff risk.

There may be several reasons why private unemployment insurance is imperfect. Here we suggest that one reason for this: firms (and unions) cannot distinguish quits from layoffs. Thus quits can masquerade as layoffs, and a contract specifying different payments to workers who quit and workers who are laid off cannot be enforced. This

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6Oswald and Turnbull (1985) and Oswald (1986) show that private unemployment insurance in the form of recurrent payments is unusual in Britain. In the US, Supplementary Unemployment Benefit (SUB) plans exist for about half the workers in manufacturing, but they are almost nonexistent outside manufacturing. Severance payments are fairly common, but the size of the payments is small in both countries.

7 If outside offers are not observed by firms (or unions), severance payments cannot be made contingent on them. Furthermore, a worker who wants to leave the firm may refuse to accept reassignments of tasks, or in other ways make himself less useful to the firm, so as to induce layoff. A similar argument is made by Parsons (1986). Other reasons for imperfect insurance have been discussed by Bean (1984) and Oswald (1986).
implies that all workers who leave the firm get the same severance pay:

\[ Z^1(\theta) = Z^0(\theta) = Z(\theta) \quad \text{for all } \theta \in \Theta. \]

We also assume that severance payment must be nonnegative:

\[ Z(\theta) \geq 0. \]

Substituting (4) into (1) and maximizing subject to (2), (3) and (5), we get first the first order condition with respect to \( w \):\(^8\)

\[ -\hat{L}(\theta) + \lambda \hat{L}(\theta) U_c(\hat{W}(\theta)) = 0, \]

implying that the wage should still be constant across states: \( \hat{W}(\theta) = \hat{w} \) for all \( \theta \in \Theta \). The complementary slackness conditions for severance payment are

\[ -(n-\hat{L}(\theta)) + \lambda \mu U_c(w^1 + \hat{Z}(\theta)) + \lambda((1-\mu)n-\hat{L}(\theta))U_c(w^0 + \hat{Z}(\theta)) \leq 0. \]

\[ \hat{Z}(\theta) \geq 0. \]

\[ \left[ -(n-\hat{L}(\theta)) + \lambda \mu U_c(w^1 + \hat{Z}(\theta)) + \lambda((1-\mu)n-\hat{L}(\theta))U_c(w^0 + \hat{Z}(\theta)) \right] \hat{Z}(\theta) = 0. \]

Conditions (6) and (7) imply that if \( \hat{Z}(\theta) > 0 \)

\(^8\) The choice of a wage function \( W(\theta) \), when \( \theta \) is continuous corresponds to the choice of one wage for every state when \( \theta \) is discrete.
\[ (10) \quad U_C(\hat{w}) = \frac{\mu n}{n-L(\theta)} U_C(w^1 + \hat{Z}(\theta)) + \left[1 - \frac{\mu n}{n-L(\theta)} \right] U_C(w^0 + \hat{Z}(\theta)). \]

Since \( w^1 > \hat{w} \), \( U_C(w^1 + \hat{Z}(\theta)) < U_C(\hat{w}) \), implying that \( U_C(w^0 + \hat{Z}(\theta)) > U_C(\hat{w}) \), and

\[ (11) \quad w^0 + \hat{Z}(\theta) < \hat{w}. \]

If \( \hat{Z}(\theta) = 0 \), (11) is fullfilled by assumption, so whether the constraint on \( z \) is binding or not, the worker who is fired without an alternative offer is strictly worse off. Since some of the severance payments will go to workers who are effectively quitting, but masquerade as layoffs, insurance is imperfect and workers who are truly laid off suffer a loss of utility.\(^9\)

When employment is chosen optimally, complementary slackness holds for all \( \theta \in \theta \):

\[ (12) \quad R(\hat{L}(\theta), \theta) - \hat{w} + \hat{Z}(\theta) + \lambda [U(\hat{w}) - U(w^0 + \hat{Z}(\theta))] \geq 0, \]

\[ (13) \quad \hat{L}(\theta) \leq (1-\mu)n, \]

\[ (14) \quad \{R(\hat{L}(\theta), \theta) - \hat{w} + \hat{Z}(\theta) + \lambda [U(\hat{w}) - U(w^0 + \hat{Z}(\theta))]\} \{\hat{L}(\theta) - (1-\mu)n\} = 0. \]

Equations (12), (14) and (6) imply that employment in states of less than full employment is set so that

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\(^9\) An implication of condition (10) is that when the nonnegativity constraint on \( z \) is not binding, severance pay should be higher in bad states. The reason is that when many workers are laid off, the fraction of layoffs that are actually disguised quits is smaller. This may be a reason why supplementary unemployment benefit plans (SUBs) are sometimes introduced in depressed industries (see Mitchell (1982)).
\[ R_{\hat{L}(\theta)}(\theta) = \hat{w} - \hat{Z}(\theta) + \left[ U(\hat{w}) - U(w^0 + \hat{Z}(\theta)) \right] / U_c(\hat{w}). \]

As we have just shown, the last term on the right-hand-side is positive. If the firm were allowed to make employment decisions unilaterally, given \( \hat{w} \) and \( \hat{Z}(\theta) \), it would hire too few workers (it would set \( R_{\hat{L}(\theta)}(\theta) = \hat{w} - \hat{Z}(\theta) \)). Therefore, we can no longer leave employment out of the contract, but the state contingent employment schedule \( \hat{L}(\theta) \) should be written into the contract.

In the next section we ask the question whether a profit sharing contract can be a substitute for the above described contract, but before we go on to analyze profit sharing, we will make two assumptions. The first is that there is no severance payment in the optimal contract:

**Assumption A:** The nonnegativity constraint on \( Z(\theta) \) is binding, so that \( Z(\theta) = 0 \).

This is likely to be the case if the number of quits which can masquerade as layoffs is large, and the outside offer, \( w^1 \), is high. The second assumption is

**Assumption B:** Under the optimal state-contingent contract, the firm is made better off by an increase in \( \theta \), that is,

\[ [R_{\hat{L}(\theta)}(\theta) - \hat{w}] \hat{L}_{\theta}(\theta) + R_{\theta}(\hat{L}(\theta),\theta) > 0 \text{ for all } \theta. \]

\[ ^{10}\text{Suppose } \theta \text{ represents the demand for the firm's products, which can be observed by the workers. If the firm prefers lower demand (the bad state) to higher demand (the good state), it may destroy order forms, harass customers etc. If such "downward" manipulation of } \theta \text{ cannot be monitored, then the optimal contract cannot be implemented} \]
From our assumptions, $\hat{L}_\theta > 0$ and $R_\theta > 0$. But when employment is chosen optimally, the marginal revenue obtained from an extra worker, $R_\xi(\hat{L}(\emptyset), \emptyset)$, is less than the wage whenever there are some layoffs. Therefore, (16) will not necessarily hold.

The role of these assumptions will be discussed later.

4. Profit Sharing

State contingent contracts of the form discussed above are uncommon. On the other hand, contracts that relate wages to revenue, profit, or profit per employee are sometimes used. Consider a non-linear profit-sharing contract, where the wage is given by:

$$W(R, \ell) = B + \frac{H(R-B\ell)}{\ell},$$

and where the firm is allowed to choose employment freely (the firm has the "right to manage"). Here, $R$ is revenue, $B$ is the base wage and $H(R-B\ell)$ is the total bonus component distributed to the workers. Can such a contract be a substitute for the state-contingent contract discussed in the previous section? The answer is given in the following proposition:

Proposition. Let $C^*$ denote the state contingent contract which maximizes (1) subject to (2), (3), (4) and (5), and assume that (5) is binding. If assumptions I and II hold, then the allocation resulting from $C^*$ can be attained by an incentive-compatible contract that uses profit sharing as in (17). This contract is not state contingent, and the employer is allowed to choose employment unilaterally.

unless assumption II holds.

An exception is the "sliding scales" which related wages to product prices (see Hatton (1988)).
Proof. Facing (17) in state $\theta$, the firm will choose $\ell$ to maximize

$$
(18) \quad R(\ell, \theta) - B\ell - H(R(\ell, \theta) - B\ell)
$$

subject to $\ell \leq (1-\mu)n$. Suppose $H(\pi) < 1$ for all $\pi \geq 0$. Necessary conditions for maximization are

$$
(19) \quad R(\ell, \theta) - B \geq 0, \\
(20) \quad \ell \leq (1-\mu)n, \\
(21) \quad (R(\ell, \theta) - B)(\ell - (1-\mu)n) = 0.
$$

Let $\ell(b, \theta)$ be the solution to this problem, and let $\hat{w}$ be defined implicitly by condition (6). Set $B = \hat{B}$, where $\hat{B}$ is defined as follows:

$$
(22) \quad \hat{B} = \hat{w} - [U(\hat{w}) - U(w^0)]/U_c(\hat{w})
$$

Then (19)–(21) are identical to (12)–(14), so $\ell(\hat{B}, \theta) = \hat{L}(\theta)$, and employment is efficient. We also need to insure the workers against fluctuating wages. Define

$$
(23) \quad \Pi(\hat{B}, \theta) \equiv \max_{\ell} \{R(\ell, \theta) - B\ell : \ell \leq (1-\mu)n\} = R(\ell(\hat{B}, \theta), \theta) - B\ell(\hat{B}, \theta).
$$

Let $\Pi^{-1}(\pi, \hat{B}) \equiv \{\theta \in \Theta : \Pi(\hat{B}, \theta) = \pi\}$. This is a single valued function under our assumptions, and $\Pi^{-1}(\Pi(\hat{B}, \theta), \hat{B}) = \theta$. Choose $H$ as follows:

$$
(24) \quad H(\pi) = (\hat{w} - B) \ell(\hat{B}, \Pi^{-1}(\pi, \hat{B})).
$$
If the state is \( \theta \), the firm sets employment \( \ell = \ell(\hat{B}, \theta) \), so \( R(\ell, \theta) - \hat{B} \ell = \Pi(\hat{B}, \theta) \).
For any \( \theta \), \( H(R(\ell, \theta) - \hat{B} \ell) = (\hat{w} - \hat{B}) \ell(\hat{B}, \Pi^{-1}(\Pi(\hat{B}, \theta), B)) = (\hat{w} - \hat{B}) \ell(\hat{B}, \theta) \). The income of an employed worker is constant and indeed the same as with \( C^* \):

\[
\hat{B} + \frac{H(\Pi(\hat{B}, \theta))}{\ell(\hat{B}, \theta)} = \hat{w}.
\]

(25)

It remains to check that \( H_\pi(x) < 1 \). When \( \ell(\hat{B}, \theta) = n \), then \( H_\pi(x) = 0 \). Otherwise, it is easy to check that \( H_\pi(x) < 1 \) if and only if assumption II holds. QED

We see that the base wage is set below the wage in the state–contingent contract by an amount that just induces the firm to hire the efficient number of workers (given that \( z = 0 \)). The function \( H(x) \) is then chosen so that the bonus per worker \( H(x)/\ell \) is constant across states. The total bonus \( H(R - \hat{B} \ell) \) is constant across those states where \( \ell = (1-\mu)n \): in these states there is no need for profit sharing.

If assumption I does not hold, the optimal severance payment is, in general, state–contingent. Equation (10) implies that severance pay should be higher in bad states, when a larger fraction of layoffs are true layoffs. Then it may be beneficial to make severance payment a function of profit and employment, but this would be more complicated, and we will not discuss such schemes.\(^{12}\)

If assumption II does not hold, then more than 100% of an increase in profits goes to the workers according to the optimal contract. This translates into a profit sharing contract which is not incentive compatible, for it gives the firm an incentive to minimize,

\(^{12}\) Consider a state–contingent contract as in section 3, where \( z \) is greater than zero, but constant because it is too complicated to make it state–contingent. Such a contract can also be mimicked by a profit sharing contract exactly as above, provided that the bonus component is made a function of profit net of severance payment.
not maximize profit.

5. Weitzman's Linear Contracts

Suppose $\theta = [0, 1]$ and the revenue function is

\[(26) \quad R(\ell, \theta) = \theta \ell^\alpha, \quad ^{13}\]

where $0 < \alpha < 1$. Let $\hat{B}$ be defined by (15). For states where $\lambda(\hat{B}, \theta) < n$, $\Pi(\hat{B}, \theta) = (1-\alpha)\theta^{1/(1-\alpha)}\hat{B} \alpha / (\alpha - 1) \alpha / (1-\alpha)$. Thus, $\Pi^{-1}(\pi, \hat{B}) = \pi^{(1-\alpha)\alpha - \alpha (1-\alpha)}(1-\alpha)\hat{B} \alpha$. Using (17), we get

\[(27) \quad H(\pi) = (w - \hat{B}) \lambda(\hat{B}, \Pi^{-1}(\pi, \hat{B})) = \frac{(w - \hat{B}) \alpha}{\hat{B} (1-\alpha)}.\]

Set $s = (w - \hat{B}) \alpha / \hat{B} (1-\alpha)$. Then we get the following linear contract:

\[(28) \quad w = \begin{cases} \hat{B} + s \frac{\pi}{w} & \text{if } \ell < n \\ \frac{\hat{B}}{w} & \text{if } \ell = n \end{cases}\]

where $\pi = R(\ell, \theta) - \hat{B} \ell$. This type of contract is often discussed in the literature (e. g. Weitzman (1983, 1985, 1987). Here assumption II is equivalent to $s < 1$, which is equivalent to $\alpha < \hat{B} / w$. Since $0 < \hat{B} / w < 1$, assumption II may in fact not hold for $\alpha$

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\(^{13}\) This specification includes the case of a monopolistic firm with Cobb–Douglas production function, facing a stochastic constant–elastic demand curve. The results below apply also when there is a fixed cost, provided that $\pi$ is measured before the deduction of the fixed cost.
close to one.\textsuperscript{14}

6. Discussion and Extensions

Why not state contingent contracts?

So far, we have assumed that the state, $\theta$, is observable by both parties, but for some reason a state–contingent contract about employment ($L(\theta)$) is not used. We showed that a profit sharing contract can sometimes be equivalent to such a contract. Within the model, there was no reason why a profit–sharing contract would be preferred to the state–contingent contract, however.

In many situations, it may be reasonable to assume that the state variable, e. g. product demand, is not directly observed by the workers. If profit is observable (which we assume) it is still possible to enforce a contract of the form $L(\theta)$, however. The contract can specify that the firm should choose employment according to the function $L(\theta)$, and then, when profits and employment are observed, workers can infer the value of $\theta$, and check whether the firm complied with the contract. The firm can then be made to pay a fine if it cheated. Such a contract may be considered more complicated that the profit–sharing contract discussed above.

Several State Variables

Our proof that a profit–sharing contract can be equivalent to a full state–contingent contract relied on the fact that there was only one state variable. It was not necessary for the workers to be able to observe the state directly for, as in Hart (1983), profits perfectly reveal the state. In a more realistic model, there are many state variables, so profits do

\textsuperscript{14} Equation (22) implies $\hat{w} > \hat{B}$. Fitzroy (1992) does note that in the Cobb–Douglas case, total wage payment may be independent of the state, but he does not relate this to the optimal state–contingent contract.
not perfectly reveal the relevant state variables. Suppose, for example, that revenue is
given by

\[(29) \quad R(\ell, \theta, \epsilon) = \theta \ell^C + \epsilon,\]

where neither $\theta$ nor $\epsilon$ are observed by workers. In this situation, profit-sharing
necessarily implies that workers bear part of the risk associated with $\epsilon$, which is
undesirable. Consequently, a profit-sharing contract cannot imitate the optimal
state-contingent contract, but if the variance of $\epsilon$ is small, a profit-sharing contract of
the form (17) can be a good approximation of the state-contingent contract. If a profit
sharing contract is used, the choice of parameters involves a trade-off: the more of the
wage that is paid out in profit share, the fewer layoffs will occur, but at the same time,
more risk is borne by workers.

*Stochastic Alternative Wage*

Suppose that the alternative wage, $w^0$, is stochastic, but uncorrelated with the state $\theta$,
and not observed by the firm. Then the results are the same, with the expectation of
$U(w^0)$ replacing $U(w^0)$. If $w^0$ is positively correlated with the state, as seems plausible
when there are industry-wide shocks, a contract of the form (17) is no longer efficient. A
more general contract that makes the wage depend on revenue and employment,
$w = W(R, t)$, may be efficient, but this is more complicated. Again, a simple profit
sharing contract may be a useful approximation.

If the number of workers that get an outside offer ($\mu$) depends on the state, the
analysis still goes through, provided that the nonnegativity constraint on $z$ is binding in
all states. If it is not binding, state-dependence of $\mu$ is a further reason to make severance
payment vary with the state.
Hiring of Outsiders in Good States

We found that the optimal contract involves profit sharing in states where the firm lays off workers, but when all contracted workers (insiders) are employed, there should be no profit sharing. Profit sharing in such states would only imply that workers' incomes become uncertain.

What happens if we allow the firm to hire "outsiders" in good states? As long as the firm is free to write a separate contract with outsiders, this does not change the analysis in section 4: we can interpret $\ell$ as employment of insiders, and $R(\ell, \theta)$ as revenue minus the cost of outsiders, when the number of outsiders is set optimally.

If the wage contract between the $n$ insiders and the firm imposes restrictions on the contract with outsiders the situation is different. Oswald (1987) and Gottfries (1992) assume that the wage must be the same for insiders and outsiders. Gottfries (1992) shows that if the firm is expected to hire workers, and the firm is slightly risk averse, a fixed wage contract may be optimal. A profit sharing contract that applies to all workers, including new hires, is clearly not in the interest of the insiders and the firm since such a contract gives the firm an incentive to hire outsiders, who are paid more than their marginal product, thus reducing the surplus to be shared between insiders and the firm. 15

Other Applications

15 The fact that insiders may lose from profit sharing has been pointed out in discussions of Weitzman's proposals, see e. g. Estrin and Wilson (1986), Estrin, Grout and Wadhwani (1987), Mitchell (1987). Weitzman suggests subsidies to profit sharing which, in effect, would be subsidies to hiring. Meade (1986) suggested that only insiders should get a share in the profit, which is an indirect way of introducing wage differentiation between insiders and new hires. Such wage differentiation may be difficult, however, as discussed by Estrin, Grout and Wadhwani (1987) and Gottfries (1992).
On a general level, the analysis may be applicable to other buyer–seller relationships, where one or both parties are risk averse. Consider, for example, a firm selling an input to another firm, where the latter faces a stochastic demand curve. If the seller sets a fixed price and lets the buyer purchase the desired amount, production (sales) will be inefficiently low. A contract that fixes both price and quantity independent of the state is undesirable if there is substantial uncertainty. A pure quantity discount induces the buyer to buy more, which is desirable, but it also shifts risk to the buyer. If, for example, the buyer pays a lump sum payment and then the marginal cost for every unit, all the demand side risk is borne by the buyer.

If both parties are risk averse, it may be desirable that part of the payment from buyer to seller is made in the form of a share of profits of the buyer. Of course, there may be observability and agency problems that make such a solution impractical. A franchise contract often contains a fixed franchise fee although a profit share would give better risk sharing (assuming that the retailer is risk averse). Presumably, the reason is that profits of the retailer are unobservable and/or that it is important to give the retailer maximal incentives to provide effort. Similar problems may impede profit sharing contracts in the labor market, but the evidence shows that profit sharing contracts are sometimes feasible.

*Bargaining Strength*

In the above analysis we have only been concerned with efficiency aspects of the contract. The level of the wage depends on the exact bargaining setup and market conditions. Contracts could be offered by firms in an ex ante competitive market, or they could be negotiated between firms and unions (see e. g. Horn and Svensson, 1986). In the latter case, the wage will depend on the factors that affect the bargaining power of the two parties. The higher the union’s bargaining power, the higher will the profit share be, and the lower will the base wage be. The reason is that the contract curve is upward sloping in the wage–employment space: if the union is stronger it wants more employment, which
requires a lower base wage.\footnote{The result follows immediately from the fact that $\hat{B}$ is decreasing in $\hat{w}$ according to (22). The upward sloping contract curve has been discussed in the union literature, see Oswald (1985).}

7. Empirical Implications

In this paper we have shown that a profit sharing contract may be useful when the following conditions are fulfilled:

i) workers have bargaining power, so that the wage exceeds the alternative wage,

ii) employed workers (insiders) are threatened by layoff,

iii) unemployment insurance is imperfect,

iv) demand or productivity is uncertain,

v) workers are risk averse,

vi) profits are observable and a good indicator of shocks to the marginal product of labor, and

Under the efficient state-contingent contract the firm prefers good states to bad.

Within the model, these conditions are not only sufficient, but each one of them is also necessary to create a case for profit sharing. If workers are paid their reservation wage, or if employed workers have secure jobs, or if unemployment insurance is perfect, insiders do not care about employment. Then, a fixed wage/fixed benefit contract may be sufficient — there is no need to make wages contingent on employment and profit. If there is no uncertainty, or workers are risk neutral, a "wage fund" contract of the form $w = B + K/\ell$, where $K$ is constant, suffices. If profits are poorly correlated with shocks to the marginal product, profit sharing implies that workers take on risk associated with the
other shocks, which makes profit sharing less efficient. Finally, condition vi) is prompted by the restriction that, if the firm is to have any incentive for profit-maximization, no more than 100% of an increase in profits can be paid out to the workers.

These conditions give some indications of when profit sharing contracts might be expected. Profit sharing should be more common in volatile industries, where workers are paid above their reservation wages. Profit sharing should be more likely when insiders' jobs are at risk. In a large firm it is probably necessary to have a union that monitors profits since it is very hard for individual workers to do this. Thus, profit sharing may be expected to be more common in unionised industries.\(^{17}\)

In practice, the most common argument for profit sharing is that profit sharing improves workers' incentives and industrial relations in one way or another (see e.g. Hatton (1986), Estrin, Grout and Wadhwani (1987), Blanchflower and Oswald (1988), FitzRoy and Kraft (1992)). Such considerations were absent in the present analysis.\(^{18}\)

Our analysis has focused on profit sharing as a way of reducing layoffs, while at the same time stabilising the incomes of the workers. The key qualitative features of the contract are that renumeration is decreasing in employment and increasing in profit.

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\(^{17}\) This is also pointed out by Bell and Neumark (1991).

\(^{18}\) There is also the risk-sharing motive, which was discussed in the introduction. One may also argue that by proposing profit sharing, the firm may convey information in a situation with asymmetric information ex ante. Greenwald and Stiglitz (1987) and Spier (1989) argue that union (workers) are often distrustful when management suggests profit sharing, taking this as a signal that profits will be low. On the other hand, one could imagine a firm in a bilateral monopoly situation proposing profit sharing in order to signal to the union that "things are really as bad as we say", so as to induce the union to make concessions. (Note, however, that this reasoning applies to situations where profit sharing involves risk sharing, and hence not to the situation discussed in the present paper.)
Profit sharing contracts with these characteristics are used in practice, but there is often a provision that only profits above a certain level are shared with the workers. This is not consistent with our theory, which predicts that profit sharing should occur for bad states.

We have found no cases reported in the literature, where actual profit sharing plans were explicitly introduced to avoid layoffs. However, Mitchell (1982) found that several firms in serious economic difficulties in the 1981 recession agreed with their unions on a wage cut (or freeze), combined with a profit sharing plan. This may be taken as support for our prediction that profit sharing is used when insiders' jobs are at risk. The data reported by Bell and Neumark (1991) shows that profit sharing and wage concessions are correlated.

Blanchflower and Oswald (1988) found that, in the UK, profit sharing is relatively common in the minerals and chemicals industries. These industries have the characteristics suggested above: they are highly volatile, with a relatively high degree of unionisation, and since a plant is often the dominating employer in a small town, moving costs for workers are high. Hence layoffs are a serious worry, and one reason why profit sharing is common in these industries may be that profit sharing reduces layoffs in bad times.

Some authors have tried to estimate employment effects of profit sharing, with mixed results (see e.g. Jones and Pliskin (1989), Fitzroy and Kraft (1992), and references therein), and some have found that profit sharing is more common in unionised industries (Estrin and Wilson (1986), Gregg and Machin (1988)).

Our finding that the wage is constant across states leads us to question the results of Wadhwani (1987), who regressed the bonus component of the wage, \( H(R-B\ell)/\ell \), on the base wage and corporate profits for Japanese firms. The apparent interpretation was that a positive coefficient for corporate profits would be evidence of profit-sharing. In our model, such a regression would not reveal the presence of profit-sharing: the model
predicts a zero coefficient for corporate profit in this regression.\(^{19}\)

8. Summary
In this paper we considered a risk neutral firm that signs a contract with its risk averse workers before the state of product demand (or price or productivity) is known. The workers may be represented by a union. Unemployment insurance is imperfect, so workers who are laid off suffer a loss of utility.

When workers risk layoff, a fixed wage contract that allows the firm to choose the level of employment leads to too many layoffs. A contract that makes employment a function of the state of demand, would yield efficient employment, but such contracts are unusual.

We show in this paper that the efficient state contingent contract can be mimicked by a generalised profit-sharing contract of the form  \( w = B + H(\pi)/\ell \), where \( w \) is the wage, \( B \) is the base wage, \( H \) is an increasing function of profit, \( \pi \), and \( \ell \) is employment, and where employment is set unilaterally by the firm. Under this contract, the marginal cost of labor for the firm is \( B \), which can be set so that the firm chooses the efficient employment. The function \( H \) can be chosen such that the bonus component of the wage, \( H(\pi)/\ell \), is constant across states. In this case, workers do not carry any risk, and the outcome is efficient (given the imperfection in unemployment insurance).

Some authors, e. g. Mitchell (1987) and the UK Green Paper (1986), have argued that a major advantage of profit sharing is that wages become more flexible. This is not the case in our model since the total renumeration of a worker is constant across states. Profit sharing does not mean that workers share risk. Rather, profit sharing is a way to obtain the efficient level of employment, while at the same time stabilising wages of the

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\(^{19}\) If there are more state variables, the regression coefficient may be positive, but the estimated coefficient still says nothing about the importance of profit sharing.
workers.\textsuperscript{20} 

In a special case the function $H$ should be linear. Such a contract was proposed by Weitzman (1984). Weitzman argued that profit-sharing leads to increased employment, since the marginal cost of labor is reduced. However, in general the restriction of linearity implies that wages will fluctuate, which is inefficient. On the other hand, linear contracts have the advantage of being simple.

Our analysis suggests that the case for profit sharing should be strong when layoffs are a serious concern for workers. This is the case when workers earn a wage above their reservation wage and workers (insiders) are threatened by layoff, either because the outlook for the firm is bad, or because there is considerable uncertainty about product demand. Another requirement is that profits are observable and closely correlated with shocks to the marginal product of labor.

Some of the empirical evidence, e. g. the observation that firms in trouble sometimes introduce profit sharing, can be taken as preliminary support for our theory. The empirical picture is quite complex, however, which is not surprising since there are also other motives for profit sharing than the one emphasised here.

\textsuperscript{20} From a social point of view, it may be good if wages are made more flexible, but if firms are considerably less risk averse than workers, it is not privately optimal.
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