Incentives and motivation in agency contracts

John Quiggin and Robert G. Chambers

December 19, 2001
Incentives and motivation in agency contracts

In a standard wage contract, workers receive payment in return for input of effort under the direct control of the employer. When effort is unobservable and cannot be inferred perfectly from observed output, more complex contractual structures arise.

There is a large literature (Mirrlees 1974, Grossman and Hart 1983) on principal-agent relationships in which the agent receives a monetary payment that depends on observed output. The principal is assumed to design the contract, subject to the constraints that it is consistent with incentive-compatibility by the agent and that the agent receives reservation utility (commonly, though not necessarily, supposed to be determined by the wage paid in a competitive market). Quiggin and Chambers (1998) show that the principal-agent problem may be analyzed within a state-contingent choice framework. This approach yields a simple closed-form solution for the agency-cost function, and therefore permits the derivation of a range of comparative static results. Chambers and Quiggin (2000) extend this analysis to allow for the possibility that agrarian contracting relationships may be characterized by exploitation, that is, unproductive action by the principal designed to reduce the reservation utility of agents, for example by restricting access to outside options through institutions such as debt peonage.

Not all the actions principals may take to improve their outcomes from contracting are harmful to agents. In this paper we expand the model of Quiggin and Chambers (1998) and Chambers and Quiggin (2000) by considering motivation, modelled as actions of the principal that directly raise the agent’s utility. From the principal’s perspective, effort allocated to motivating employees reduces the level of utility that must be generated by the monetary payments. Hence, motivating one’s employees has effects similar to those of exploitative behavior designed to reduce the availability and attractiveness of outside options. And so while the formal analysis closely parallels that in Chambers and Quiggin (2000, Chapter 10), the welfare implications of motivation and exploitation are radically different.
1 The Model

The model is virtually identical to that in Chambers and Quiggin (2000, Chapter 10). A risk-neutral principal, referred to as the employer, and a risk-averse agent, referred to as the worker, are contracting before engaging in a productive activity. For concreteness, the worker is assumed to produce an agricultural commodity on land owned by the employer. The employer is the residual claimant for the output and has the right to specify the contract terms. The employer has access to a competitive market in which the output can be sold at price $p$. As in Quiggin and Chambers (1998), output production is uncertain, and there is hidden action because the employer cannot observe the worker’s commitment or allocation of effort. *Ex post* output, however, is observable and contractible. Unlike Quiggin and Chambers (1998), however, by an appropriate expenditure of effort the employer can directly affect the worker’s utility by improving motivation. Contracting takes place before uncertainty is resolved, and before the worker commits any effort. After the contract is concluded, the worker commits effort prior to the resolution of uncertainty. Then uncertainty is resolved, and the employer receives the output and makes the payment to the worker on that basis. Both parties to the contract can commit and the contracts, once agreed upon, are enforceable at zero cost.

The production model is the same as that used in Quiggin and Chambers (1998) and Chambers and Quiggin (2000). There are two states of nature, which may be interpreted as adverse or favorable weather. There is a single stochastic output—the output for which the employer is the residual claimant. The information structure is as follows: Only the worker observes the actual conditions under which production takes place, i.e., only the worker can observe which state of nature occurs and what input levels are committed. The employer cannot observe the worker’s effort but, being the residual claimant, can observe and has the rights to the output that occurs. Both the employer and the worker know the technology and each other’s preferences. They also share common *a priori* beliefs about the probability with which each state of nature will occur.

The worker’s *ex post* preferences are additively separable in income and the vector of inputs committed to production. As in the model of exploitation in agrarian contracting
considered by Chambers and Quiggin (2000), we simplify by assuming that the utility of returns exhibits the logarithmic constant-relative-risk-aversion form. Hence,

$$w(y, x) = \ln y - g(x).$$

Here $y$ is the worker’s consumption, and $g$ is a strictly increasing and strictly convex function of the effort vector, $x$. The worker is not directly concerned about output.

For a fixed vector of inputs, $x \in \mathbb{R}_+^n$ (notice, in particular, there is no need to assume that effort is a scalar), the worker’s state-contingent output set, as defined by Chambers and Quiggin (2000), is

$$Z(x) = \{(z_1, z_2) : x \text{ can produce } (z_1, z_2) \},$$

where $z_s$ is output that occurs in state $s$ and uncertainty is resolved after the vector of inputs is committed. $Z(x)$, thus, gives the range of state-contingent outputs that can emerge after inputs are committed and after uncertainty is resolved, that is, after either state-1 or state-2 occurs.

The worker’s effort-cost function is denoted by

$$C(z) = \min \{g(x) : z \in Z(x)\}$$

Under standard assumptions on $Z(x)$, Chambers and Quiggin (2000) show that $C(z)$ is convex, strictly increasing, twice continuously differentiable, and positively linearly homogeneous in $z$.

For given $y$ and $z$, the worker’s maximum expected utility is, therefore,

$$\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z).$$

Relative probabilities are such that a risk-neutral individual would always consider state-2 to be the good state of nature in the sense that

$$\frac{C_2(z_1)}{\pi_2} \leq \frac{C_1(z_1)}{\pi_1},$$
where $1$ is the two-dimensional unit vector. We therefore say that $z$ is monotonic if $z_1 \leq z_2$. If prices do not differ across states of nature, a risk-averse producer would never choose to produce an output $z$ unless

$$C(z) \leq C(\bar{z}, \bar{z})$$

(1)

where

$$\bar{z} = \pi_1 z_1 + \pi_2 z_2$$

since $(\bar{z}, \bar{z})$ has the same mean as $z$ and is less risky. We will describe output vectors $z$ satisfying (1), as inherently risky.

### 1.1 Reservation utility and motivation

We will denote the worker’s reservation utility by $u^r$. In most principal-agent models, $u^r$ is exogenously given, and the employer must meet the participation constraint

$$E[w(y, x)] \geq u^r$$

In the present case, however, we assume that the employer may increase the utility associated with participation through motivational activities. This is modelled by a direct transfer of utility to the worker of $u(m)$ where $m$ is the employer’s commitment of resources to motivation. We assume that $u$ is an increasing, concave, bounded function of $m$. We write

$$u(m) = u^r - u(m)$$

and observe that $u$ is decreasing and convex in $m$ and bounded below. Motivational effort has a linear cost $c_m$. We can hence derive the cost of utility transfers

$$c(u) = c_m m^{-1}(u)$$

The contract between the worker and the employer is of the following form: the employer nominates for each state of nature a payment $y_i$ and asks the worker to report both
the unobservable state and the observable output \( z_i \) to receive that payment. If the worker is to receive \( y_i \), she must report that state \( i \) occurred and the observable output must be \( z_i \). We refer to \([(y_1, z_1), (y_2, z_2)]\) as the contract.

Specifying a state-contingent payoff-production contract creates an incentive problem, however, because the employer cannot observe the worker’s effort or which state of nature occurs. Only the worker has this information. Therefore, the worker may find it advantageous to misrepresent which state of nature actually occurs unless the employer designs a contract that makes doing so irrational. Thus, by the results in Quiggin and Chambers (1998), any contract that the employer can implement must satisfy the following constraints:

\[
\begin{align*}
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) & \geq \ln y_1 - C(z_1, z_1) \\
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) & \geq \ln y_2 - C(z_2, z_2) \\
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) & \geq \pi_1 \ln y_2 + \pi_2 \ln y_1 - C(z_2, z_1)
\end{align*}
\]  

and we have:

**Lemma 1** Any contract satisfying (2) must also satisfy:

\[
(y_1, z_1) \prec (y_2, z_2), \text{ or} \quad (y_1, z_1) = (y_2, z_2).
\]

We can now state the employer’s problem formally. The employer chooses \((m, z_1, z_2, y_1, y_2)\) to:

\[
\max \left\{ \pi_1 (p_{z_1} - y_1) + \pi_2 (p_{z_2} - y_2) - c_m m \right\}
\]

subject to:
\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq u(m)
\]

\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq \ln y_1 - C(z_1, z_1)
\]

\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq \ln y_2 - C(z_2, z_2)
\]

\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq \pi_1 \ln y_2 + \pi_2 \ln y_1 - C(z_2, z_1)
\]

The first inequality represents the worker’s *participation constraint*. Even though the employer can affect the reservation utility, he cannot determine where the worker works. The last three inequalities correspond to (2). A standard result for additively separable utility structures is that:

**Lemma 2** For given \(u\), the employer specifies a contract that yields the worker exactly his or her reservation utility.

We consider below the implications of bargaining models in which the worker may receive more than their reservation utility.

### 1.2 The Agency-Cost Function

As in Quiggin and Chambers (1998), we solve the employer’s problem in stages. In the first-stage agency-cost problem, \(z_1, z_2\) and \(m\) are held fixed. The employer chooses \((y_1, y_2)\) to

\[
\min \{\pi_1 y_1 + \pi_2 y_2\}
\]

subject to:

\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq u(m)
\]

\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq \ln y_1 - C(z_1, z_1)
\]

\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq \ln y_2 - C(z_2, z_2)
\]

\[
\pi_1 \ln y_1 + \pi_2 \ln y_2 - C(z_1, z_2) \geq \pi_1 \ln y_2 + \pi_2 \ln y_1 - C(z_2, z_1).
\]
Now applying the solution derived in Quiggin and Chambers (1998) for the special case of logarithmic utility gives:

**Lemma 3** If \( z \) is monotonic and inherently risky, the agency-cost function is given by the twice differentiable function:

\[
Y(z_1, z_2; m) = \exp(u(m)) \phi(z_1, z_2),
\]

where

\[
\phi(z_1, z_2) = \pi_1 \exp(C(z_1, z_1)) + \pi_2 \exp\left(\frac{C(z_1, z_2)}{\pi_2} - \frac{\pi_1}{\pi_2} C(z_1, z_1)\right)
\]

**Corollary 1** If \( z \) is monotonic and inherently risky, then a) \( Y \) is strictly increasing and strictly convex in \( u \), and \( Y_u = Y \), and b) \( Y \) is increasing in \( z_2 \) and convex in \( z \).

Corollary 1.a shows why the employer should commit resources to motivation: As the worker’s motivation increases, the payment required to achieve any given level of reservation utility declines and the employer’s cost of getting the worker to adopt any state-contingent output vector falls. Hence, the employer always gains from a costless improvement in motivation. For each unit of utility transferred directly to employers, the employer can reduce the utility associated with the state-contingent payment to the worker in each state by a like amount.

The fact that agency cost may be expressed in the multiplicative form \( \exp(u(m)) \phi(z_1, z_2) \) reflects the constant relative risk aversion property of the logarithmic utility function assumed here. This property allows for a multiplicative separation between the effects of the reservation utility level, given by \( \exp(u(m)) \) and the relative payments \((y_1, y_2)\) needed to elicit a given output \( z \).

**Result 1** If \( z \) is monotonic and inherently risky, an increase in \( m \) leads to equiproportionate increases in \( \exp(u(m)), y_1, y_2 \) and \( Y \).

The worker’s certainty equivalent for the state-contingent payment scheme \((y_1, y_2)\) is \( \exp(C(z_1, z_2) + u(m)) \) while its expected value is \( Y(z_1, z_2; m) \). Hence, the worker’s risk premium for the payment scheme \((y_1, y_2)\) is
\[
\exp(u(m)) \left( \pi_2 \left( \exp \left( C(z_1, z_2)/\pi_2 - \frac{1 - \pi_2}{\pi_2} C(z_1, z_1) \right) - \exp(C(z_1, z_1)) \right) \right)
\]

Result 1, and this recognition yield:

**Corollary 2** If \( z \) is monotonic and inherently risky, an increase in \( m \) leads the employer to offer the worker a payment scheme with a higher risk premium. The increase in the risk premium is proportional to the increase in \( \exp u(m) \).

## 2 An Optimal Contract for an ‘Expected-Utility’ Taker

In this section, we solve the second stage of the employer’s problem, and in so doing solve the standard optimal contract for given \( m \) and \( u(m) \). By Lemma 1 we can restrict attention to output vectors \( z \) that are monotonic and inherently risky. The second-stage problem is formally stated as the following concave program:

\[
V(p; u(m)) = \text{zmax} \left\{ p(\pi_1 z_1 + \pi_2 z_2) - Y(z_1, z_2; m) \right\}.
\]

A little manipulation reveals that:

\[
V(p; u(m)) = \exp(u(m))v \left( \frac{p}{\exp(u(m))}, \pi \right),
\]

where

\[
v \left( \frac{p}{\exp(u(m))}, \pi \right) = z_1, z_2 \text{max} \left\{ \frac{p}{\exp(u(m))}(\pi_1 z_1 + \pi_2 z_2) - \phi(z_1, z_2; \pi) \right\}
\]

Standard comparative-static manipulations determine how expected output size and expected employer cost (the worker’s expected payment) respond to changes in \( p \) and \( m \). Let \( q = p/\exp(u(m)) \), and

\[
z(q) \in \text{arg max} \left\{ \frac{p}{\exp(u(m))}(\pi_1 z_1 + \pi_2 z_2) - \phi(z_1, z_2) \right\}.
\]

By formal arguments in Chambers and Quiggin (2000, Chapter 10), it now follows that:
**Result 2** For given \( m \) and \( u(m) \): the expected value of the employer’s optimal output vector \((E[z(q)])\) is non-decreasing in the output price \((p)\) and non-increasing in the worker’s reservation utility \(u(m)\); and the worker’s expected payment is non-decreasing in \( p \).

The employer responds to an increase in \( p \) by asking the worker to produce a higher expected output which necessarily requires a greater effort committal. At the margin, to induce the worker to increase effort the employer must offer the worker a higher expected payment. An increase in reservation utility increases agency cost proportionally for all state-contingent output pairs. Faced with this increased cost, the employer reduces expected output size.

As an aside, it is interesting to note that \( V \) and \( Y \) are convex conjugates (Rockefeller, 1970) so that a dual relationship between them also exists. Because, this is true, it immediately follows by elementary optimization arguments (Chambers and Quiggin 2000, Chapter 10) that:

**Result 3** For given \( u(m) \): a) \( V(p; u(m)) \) is decreasing and concave in \( u(m) \) with \( V_u = -Y \);

and b) \( V(p; u(m)) \) is non-decreasing and convex in \( p \) with \( V_p(p; u(m)) = E[z(q)] \).

The first part of Result 3 is particularly important because it establishes:

**Corollary 4** For given \( p \), the employer’s optimal expected payment to the worker (agency cost) is non-decreasing in the worker’s reservation utility and non-increasing in the level of motivation \( m \).

If the worker’s reservation utility rises, the employer must respond by offering the worker a higher expected payment to encourage her to decline the alternative. Or put another way, the employer would always find it in his interest to try to costlessly reduce the worker’s reservation utility. At the margin, there seems to be some potential for the commitment of resources to motivation.

By Corollary 1, the objective function for the second-stage problem is concave. As in Quiggin and Chambers (1998), define \( \alpha \geq 0 \) by:
\[ z_2 \equiv z_1 + \alpha. \]

The resulting necessary and sufficient first-order conditions for \( z_1 \) and \( \alpha \) in the employer’s optimization problem are:

\[
\begin{align*}
    p - Y_1(z_1, z_2, m) - Y_2(z_1, z_2, m) & \leq 0, \quad z_1 \geq 0 \\
    p\pi_2 - Y_2(z_1, z_2, m) & \leq 0, \quad \alpha \geq 0
\end{align*}
\]

in the notation of complementary slackness.

The first of these conditions is a state-arbitrage result for the employer: It implies that the employer should design the contract so that the worker increases \( z \) to the point where there is no marginal increase in the employer’s expected profit from increasing both state-contingent outputs by the same positive amount. For an interior solution, a one unit increase in both state-contingent outputs breaks even at the margin. The second condition is more transparent if it is rewritten as:

\[
p\pi_2 - \exp(u_2)C_2(z_1, z_2) \leq 0,
\]

which is the first-order condition for setting \( z_2 \) for a risk-averse worker who is the residual claimant for the output (see Quiggin and Chambers (1998), for example). Therefore, the optimal contract effectively makes the worker the residual claimant in state 2. As in Quiggin and Chambers (1998), the reason is also apparent; the incentive problem is to induce the worker to choose the state-contingent output vector \((z_1, z_2)\) and not \((z_1, z_1)\). One way to do this is to make the worker the residual claimant for all marginal increases in the high-state output.

If \( \alpha > 0 \), it follows immediately that:

\[
p(1 - \pi_2) - Y_1(z_1, z_2, m) \leq 0,
\]
implying that $z_1$ also should be increased to the point where the employer can make no positive expected profit by increasing it further. It does not imply, however, that the worker should be made the residual claimant of state-1 output as can be easily verified by computing $Y_1$ using Lemma 3. If the worker were the true residual claimant for the state-1 output, optimality would require instead that

$$\pi_1 p - \exp(u_1)C_1(z_1, z_2) = 0.$$ 

Summarizing, we have the following special case of the characterization derived by Quiggin and Chambers (1998):

**Result 4** Under the stated conditions, an interior ‘expected-utility taking’ optimal contract satisfies:

a) $\pi_1 p - \exp(u_2)C_2(z_1, z_2) = 0$;

b) $\frac{Y_1}{\pi_1} = \frac{Y_2}{\pi_2}$.

### 3 The Profit Maximizing Level of Motivation

The final stage of the employer’s optimization problem is the choice of the optimal level of motivational input. Given preceding developments, this problem can be formulated mathematically as the following concave program:

$$W(p, c_m) = \max \{V(p, u(m)) - c_m m\}.$$ 

We first determine whether motivation activity, defined by a positive value of $m$, is profitable for the employer. The first-order condition on $m$ is

$$-u'(m)V_u(p, u) - c_m \geq 0,$$

with equality for an interior optimum. Hence, some input to motivation is always optimal if $u''(0) = 0$ ($u'(0) = 0$).
**Result 5** The worker’s effective reservation utility is non-decreasing in \( c_m \) and the expected value of the output is non-increasing in \( c_m \).

The second part of Result 5 follows because Result 2 establishes that, for given \( u \), the expected value of the output is non-increasing in the worker’s effective reservation utility. Hence, anything that increases the worker’s effective reservation utility and which has no direct impact on expected output (for example, an increase in \( c_m \)) also decreases expected output.

Corollary 4 and Result 5 give:

**Corollary 5** The expected payment to the worker (agency cost) is non-decreasing in \( c_m \).

> From the viewpoint of the worker, motivation and monetary payments are substitutes. Thus, if the cost to the employer of motivating the employee declines, a rational response is to shift resources from monetary payments to motivational effort.

> From the discussions of the agency-cost function and the ‘expected-utility taking’ problem and standard results in optimization theory we obtain:

**Result 6** a) \( W(p, c_m) \) is non-increasing and convex in \( c_m \); and b) \( W(p, c_m) \) is non-decreasing and convex in \( p \) with \( W_p(p, c_m) \) equal to expected output.

The fact that \( W(p, c_m) \) is convex in \( p \) and the derivative property imply that increases in the market price lead the employer to design a contract that requires the worker to increase the average output produced. Naturally we expect this increase in expected output to be associated with an increase in effort on the part of the worker and an increase in motivational activities by the employer. By the first-order condition to this problem:

\[
u'(m)V_u(p, u) - c_m \geq 0,
\]

whence:

\[
m_p = \frac{-V_{up}(p, u)}{u''(m)V_{uu}(p, u)}.
\]
By Result 3 and our assumptions on the cost of exploitation the denominator of this last expression is negative, hence the whole expression is negative if $V_{up}(p, u) < 0$, and positive if this last inequality is reversed. Using Result 3a:

$$V_u(p, u) = -Y(z_1, z_2; u)$$

whence

$$V_{up}(p, u) = -\frac{d}{dp} Y(z_1, z_2; u)$$

for fixed $u$. Result 2 establishes that the worker’s expected payment is non-decreasing in $p$. Hence, we have

**Result 7** Expenditure on motivation is non-decreasing in the output price. The worker’s effective reservation utility is non-increasing in the output price.

Principals respond to more favorable market opportunities for the output by increasing their motivational activities at the same time that they require the worker to raise average output. As the output price rises, the employer wants the worker to produce more of the output on average. To make the worker more amenable to doing so, the employer increases his motivational activities.

We now examine the effect a change in $p$ has on the expected payment to the worker. Our interest is in calculating

$$\frac{dY(z_1(p), z_2(p); u(p))}{dp}.$$ 

Following the line of argument established in Chambers and Quiggin (2000, Chapter 10), we have:

**Result 8** If $c(u; c_m)$ is linear, an increase in the output price results in a decrease in the worker’s expected payment (agency cost). When $-\frac{c''}{c'} > 1$, an increase in the output price results in an increase in the worker’s expected payment (agency cost).
When \( p \) increases, two things happen: First, the expected size of the output increases as the employer takes advantage of the increased opportunities for profit in the output market. At the same time, as Result 7 shows, the employer also increases the resources devoted to motivating the worker. As expected output size increases, the employer wants the worker to commit more effort for a given level of motivation, which tends to increase the employer’s payment to the worker. However, as motivation rises, Corollary 4 implies that the employer can pay the worker less and still keep her employed in output production. This latter ‘motivation effect’ diminishes the worker’s expected payment. If the employer’s marginal cost of motivation is low and constant, the employer’s desired level of motivation rises rapidly as the output price increases: The increased motivation effect dominates and pushes down the total expected payment to the worker. However, when the marginal cost of motivation rises sufficiently rapidly, an increase in the output price leads to only a small change in motivation and the direct effect encouraging a larger expected output size dominates.

> From the viewpoint of the employer, motivational effort and monetary payments are alternative methods of eliciting effort from workers. When the output price rises, so does the derived demand for worker effort. To meet these demand, the employer adjusts on two margins, increasing both motivational effort and monetary payments.

### 3.1 Welfare

We can get a quantitative measure of aggregate welfare by writing the worker’s welfare in terms of the certainty equivalent

\[
e = u^{-1}(u')
\]

\[
= u^{-1}(u + u(m))
\]

\[
= \exp(u(y)-C(z) + u(m))
\]

while the employer’s expected profit is

\[
\Pi = \pi \bullet (z - y)
\]
Since both welfare measures are expressed in terms of certain income, \( \Pi + e \) is an aggregate welfare measure in the sense that any increase in \( \Pi + e \) represents a potential Pareto-improvement.

We now consider the welfare consequences of motivational activity on the part of the employer. Under the assumption that the worker always receives reservation utility, the consequences of motivational activity are clear. The extra utility transferred directly by the employer is fully offset by increased work effort, leaving the worker’s welfare unchanged. Since the employer will only undertake motivational activity if it is beneficial, the availability of the option must increase her welfare. The surplus accruing to the employer from motivation level \( m \) is given by

\[
V(p; u(m)) - V(p; u(0)) - c(m)
\]

The analysis thus far has been based on the assumption that the employer acts as a monopolist, leaving the worker only the reservation utility level required for a given level of motivation. However, the analytical framework allows for a much richer range of possibilities, many of which can be represented in a Nash bargaining model. Take the case \( m = 0 \), in which the employer does not engage in motivation and the worker receives reservation utility as the baseline, representing an employment relationship governed entirely by the ‘cash nexus’ between the self-interested preferences of the parties. We can then imagine two kinds of bargaining solution. In the first, the problem of asymmetric information is unresolved, but the worker commits additional effort and the employer transfers utility through motivational activity. The feasible aggregate welfare level \( \Pi + e \) is consistent with a range of divisions of welfare between the parties, in which the employer’s monetary payment to the worker varies according to the relative bargaining power of the parties. The optimal allocation of employer effort to motivation will be jointly determined with the outcome of the bargaining solution. The higher the level of the monetary payment to the worker, the more cost-effective is motivation and therefore the higher is the optimal level of motivation.

A second possibility is that co-operation between the parties may allow the achievement of the first-best outcome. In this case, \( z \) will be chosen to maximize \( E[z] - c(z) \), and as
before, the optimal allocation of employer effort to motivation will be jointly determined with the outcome of the bargaining solution.

4 Concluding comments

The state-contingent approach to the analysis of production under uncertainty provides a natural representation of a wide range of problems involving principal-agent relationships. The availability of simple closed-form solutions to the basic principal-agent problem opens the way for extensive comparative static analysis. In the present paper, we have considered the impact of employer efforts at motivating workers in a simple two-state model with logarithmic utility. The analysis could be extended to encompass more states, and general homothetic preferences, not necessarily satisfying the expected-utility hypothesis. More interestingly, perhaps, we could consider the possibility of a hierarchy of agents in which middle managers provide motivation to, and supervision of, their subordinates.

5 References


