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Bargaining Power and Efficiency in Principal-Agent Relationships

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Abstract

Agrarian contracts such as sharecropping are frequently modelled as principal agent relationships. Although it is commonly assumed that the principal has complete freedom to design the contract, the problem formulation in much of the principal agent literature presumes that the sharecropping contract is constrained-Pareto-efficient. In the present paper, we consider the implications of a richer specification of the choices available to peasants. In particular, we consider the entire spectrum of possible power differentials in the contracting relationship between landlords and peasants. Our central result is that the agent can exploit information asymmetries to offset the bargaining power of the principal, but that this process is socially costly.

1 Introduction

In a tradition going back at least to Marshall, it has been argued that land reform which gives peasants ownership over their land may eliminate some of the inefficiencies associated with sharecropping. This tradition has been challenged by principal–agent models in which arrangements such as sharecropping are interpreted as providing benefits through the sharing of risk. In the prototypical principal–agent model of agrarian relations, the principal, usually a landlord, contracts with the agent, usually a peasant farmer, subject to informational constraints. All such contracts involve some element of bargaining, frequently under conditions of unequal bargaining power. In agrarian societies, for example, landlords commonly have more bargaining power than sharecroppers. It is commonly assumed that the asymmetry of bargaining power is so extreme that the principal has complete freedom to design the contract.

Despite this asymmetry in bargaining power, the problem formulation in much of the principal–agent literature presumes that the sharecropping contract is constrained-Pareto-efficient subject to the informational constraints associated with the presence of moral hazard. Although the principal can exercise monopsony power (and is therefore perfectly exploitative in Basu's (1989) sense), because the principal acts as an 'expected-utility taker' in the words of Braverman and Stiglitz (1986), it is difficult to characterize the contracts that emerge as either inefficient or truly coercive. Apart from distributional concerns, they resemble those that would emerge in a competitive market where the landlord has no ability to exploit the peasant. Moreover, the landlord is explicitly presumed to be competing with the peasant's next best alternative and cannot reduce the peasant's welfare below the level defined by that alternative.

In principal–agent models of sharecropping, the range of actions available to both the landlord and peasant are quite limited. On the landlord's side there is no consideration of directly unproductive profit-seeking (DUP) activity, where valuable economic resources are diverted from productive activity to enhancing the landlord's ability to exploit the peasant. On the peasant's side, the only choice variable is a scalar effort level. The peasant can do nothing to influence the riskiness of production and therefore must accept insurance on the terms offered by the principal.

Bell (1989), following Bell and Zusman (1976), has argued that in many instances it is plausible to believe that peasants possess some bargaining power in contracting with landlords, and he has explored the relationship between principal–agent and Nash bargaining solutions in the presence of both costless monitoring and prohibitively costly monitoring. He shows that under costless monitoring the principal–agent and Nash bargaining solutions, assuming an affine payment structure, are identical up to a side payment. This finding reflects our earlier observation that principal–agent models are Paretian efficient and the well-known Paretian efficiency of Nash-bargaining solutions. In the presence of costless monitoring, with no incentive problems, the only difference, therefore, is where on the utility-possibility frontier one locates. With prohibitively costly, monitoring Bell shows that the solutions diverge.

Following the earlier work by Basu (1986) on triadic relationships, Chambers and Quiggin (2000) extended the standard principal–agent model of agrarian contracts to allow for the possibility that individual or collective action by landlords might reduce peasants' reservation utility in agrarian economies. Means by which this might occur include: restricting peasants' access to unoccupied lands; differential taxation of peasants not contracting with members of the landlord class; restricting market access of free peasant populations; and confining the availability of public goods (roads, infrastructure, social-insurance programs) to landlords (Boserup 1979; Binswanger, Deininger and Feder 1993). Because the Chambers and Quiggin (2000) approach allowed for the presence of DUP activity on the part of the landlord class, one of their key findings was that social welfare might be improved by the existence of asymmetric information. They also showed that, under appropriate cost conditions, landlords would always engage in exploitative activity intended to lower the peasant's reservation utility.

In the present paper, we consider the implications of a richer specification of the choices available to peasants, considered as agents, in their dealings with landlords or moneylenders, considered as principals, than either Bell (1989) or Chambers and Quiggin (2000). In particular, pursuing Bell's (1989) observation to its logical limit, we consider the entire spectrum of possible power differentials in the contracting relationship between landlords and peasants. The analysis is undertaken in a framework of state-contingent production, which allows modelling of self-protection and self-insurance by the agent. Our central result is that the agent can exploit information asymmetries to offset the bargaining power of the principal, but that this process is socially costly. Hence, where the agent has private information, an increase in her bargaining power will, in general, enhance welfare.

In the case where the principal has all the bargaining power, we show that the agent engages in costly self-protection to enhance her subsequent bargaining position vis-a-vis the principal. This results in a loss of efficiency relative to the case in which the services provided by the principal are in competitive supply, subject to a zero-expected-profit constraint. A range of intermediate cases may be represented in a bargaining framework.

2 State-contingent production

We use upper-case letters to denote state-independent scalars such as the expected output Z and the principal's expected profit P, lower-case letters to denote state-dependent scalars such as output z_s in state s and boldface to denote vectors such as the state-contingent output vector $\mathbf{z}$.

Production is undertaken by the agent, assumed to be a peasant farmer, who uses a vector of inputs $\mathbf{x}$ to produce a vector of state-contingent outputs $\mathbf{z} \in \Re^{M \times S}$. The output z_s observed if state of nature s is realized is, in general, an element of $\Re^M$. To simplify notation, we will focus on the case $M = 1$, $S = 2$. The general properties of state-contingent production technologies are discussed by Chambers and Quiggin (2000).

2.1 The effort cost function

The agent's ex post preferences are of the net returns form

$$w(y, \mathbf{x}) = u(y - g(\mathbf{x})),$$

where u is a differentiable, concave, strictly increasing von Neumann–Morgenstern utility function, y is the return to the agent, and g is a strictly convex and increasing function. This objective function, referred to as *utility of net returns*, differs from that commonly used in the literature on principal–agent relationships, in which the objective function is additively separable in income and effort (Grossman and Hart 1983, Quiggin and Chambers 1998). The alternative formulations of the objective function are equivalent if the utility function displays constant absolute risk aversion, as in Holmstrom and Milgrom (1987).

Chambers and Quiggin (1996; 2000) show that, under plausible conditions on g , there exists a nondecreasing and convex effort-cost function

$C(z_1, z_2)$ which represents the minimum of $g(\mathbf{x})$ consistent with $\mathbf{x}$ producing (z_1, z_2). Thus, the agent's maximum expected utility, given state-contingent payments y_1 and y_2, and consistent with producing the state-contingent output vector (z_1, z_2), is

$$E[w(y, \mathbf{x})] = \pi_1 u(y_1 - C(z_1, z_2)) + \pi_2 u(y_2 - C(z_1, z_2)),$$

where E is the expectations operator. As is shown by Chambers and Quiggin (1996; 2000), standard conditions on the technology set and the effort cost function ensure that C is well-behaved.

Assumption 1: The effort-cost function $C{:}\Re^2 \to \Re$ is convex, strictly increasing and twice differentiable in each argument.

Following Chambers and Quiggin (2000), we define a state-contingent output vector (z_1, z_2) as *inherently risky* if

$$C(z_1, z_2) \leq C(\bar{\mathbf{z}}) \tag{1}$$

where

$$\bar{\mathbf{z}} = (\pi_1 z_1 + \pi_2 z_2, \pi_1 z_1 + \pi_2 z_2).$$

Here the terminology reflects the fact that, at a given level of cost for inherently risky outputs, the producer must sacrifice expected output to remove uncertainty from production. Notice, in particular, that if this condition is not satisfied, a risk-averse agent can always costlessly self-insure by choosing to produce the riskless output $\bar{\mathbf{z}}$ which yields the same expected output as the risky (z_1, z_2), but at lower cost. By the monotonicity of the agent's preference function and his risk aversion, the riskless output vector will thus always be strongly preferred to the risky output vector.[1]

We define (z_1, z_2) as *monotonic* if $z_1 \leq z_2$ and impose

Assumption 2: Any inherently risky (z_1, z_2) is monotonic.

To guarantee the existence of a non-trivial optimum we require

Assumption 3: There exists $\mathbf{z}$ such that:

$$Z = \pi_1 z_1 + \pi_2 z_2 > C(\mathbf{z}).$$

[1] It may appear that all stochastic technologies are inherently risky. This is false. Chambers and Quiggin (2000) define a class of stochastic technologies (the generalized Schur convex) which are nowhere inherently risky.

3 The production problem

3.1 The peasant's problem without contracting

We first consider the problem where the peasant producer is the residual claimant. In the agrarian setting, this problem arises for independent peasants without access to moneylenders or other financial intermediaries. The case of a peasant paying a fixed (money or goods) rent to a landlord may also be modelled by treating the rent as a fixed cost component of $C(\mathbf{z})$. In a general principal–agent interpretation, this is the case where no contracting takes place.

The agent receives net return

$$n_s = z_s - C(\mathbf{z})$$

in state s, occurring with probability π_s.

Thus for the case of two states of nature, the agent seeks to maximize

$$W(\mathbf{n}) = \pi_1 u(n_1) + \pi_2 u(n_2)$$

This problem has been analyzed by Quiggin and Chambers (2000) for general preferences and S states of nature. In this section some crucial results are summarized. The agent's first-order conditions are of the form

$$\pi_s u'(z_s - C(z_1, z_2)) - (\pi_1 u'(z_1 - C(z_1, z_2)) + \pi_2 u'(z_2 - C(z_1, z_2)))\, C_s = 0 \quad s = 1, 2$$

with equality at an interior solution. Under the stated conditions, a unique interior optimum will exist. We define

$$\hat{\mathbf{z}} = \arg\max W(\mathbf{z} - C(\mathbf{z})\mathbf{1})$$

to be the solution to the agent's maximization problem, and denote the associated vector of net returns by $\hat{\mathbf{n}}$.

We first observe:

Lemma 1 : *Under the stated conditions, the optimal choice $(\hat{z}_1, \hat{z}_2)$ is inherently risky and monotonic.*

Proof: That $(\hat{z}_1, \hat{z}_2)$ is inherently risky follows from the fact that preferences preserve second-order stochastic dominance, since for $(\hat{z}_1, \hat{z}_2)$ not inherently risky, the vector $(z_1 - C(\mathbf{z}), z_2 - C(\mathbf{z}))$ is dominated by $(\hat{Z} - C(\bar{\mathbf{z}}), \hat{Z} - C(\bar{\mathbf{z}}))$ where

$$\hat{Z} = \pi_1 \hat{z}_1 + \pi_2 \hat{z}_2.$$

Monotonicity follows by Assumption 2.■

Adding and rearranging the first-order conditions yields the arbitrage condition

$$C_1 + C_2 = 1.$$

Suppose on the contrary, that $C_1 + C_2 < 1$. Then it would be possible to increase output in both states by one unit, while increasing costs by less than one unit. Hence, net returns would increase in both states, and the agent would be better off with probability1. A symmetrical argument applies when $C_1 + C_2 > 1$. Chambers and Quiggin (2000) define the set of vectors $\mathbf{z}$ satisfying the arbitrage condition as the *efficient set.*

A risk-neutral agent chooses $\mathbf{z}$ to maximize expected net return

$$\begin{aligned} N(\mathbf{z}) &= Z - C(\mathbf{z}) \\ &= \pi_1 z_1 + \pi_2 z_2 - C(z_1, z_2) \end{aligned}$$

The risk-neutral optimum choice of $\mathbf{z}$, represented by B in Figure 1, is denoted $\mathbf{z}^{RN}$ and the associated expected profit is denoted N^{RN}.

3.2 Self-protection and self-insurance

A central theme of the principal–agent literature on agrarian contracting is that seemingly inefficient contractual mechanisms, such as sharecropping may be explained as devices to spread risk. In the standard principal–agent model, the risk faced by the peasant is exogenous except for a scaling factor determined by the peasant's effort level. In reality, agricultural producers can respond more creatively to risk, through the use of risk-reducing agricultural technologies such as irrigation, through crop diversification, through timely application of pesticides and other pest-controlling activities, and through the informal sharing of risks with family members and other producers. Although terminology on this point is not uniform, we will use the terms *self-protection* to refer to the use of risk-reducing technologies and *self-insurance* to refer to methods such as informal risk-sharing that may be used to cushion the impact of income risk.

Chambers and Quiggin (2000) show how the choice of more or less risky technologies can be modelled in the state-contingent framework. In the single-output technology modelled here, crop diversification cannot be modelled explicitly. However, if z is regarded as a generic output, diversification may be seen as a particular sort of risk-reducing technology. If the states of nature represent more or less favorable conditions for the production of the primary cash crop, self-protection may be undertaken by increasing the allocation of effort and other resources to the production of subsistence crops, thereby reducing the variability of returns.

The peasant's cost of self-protection is defined as the loss in expected net return associated with the choice of a given $\mathbf{z}$ and is given by

$$\begin{aligned}\Delta_1(\mathbf{z}) &= N^{RN} - N(\mathbf{z}) \\ &= (Z^{RN} - C(\mathbf{z}^{RN})) - (Z - C(\mathbf{z})).\end{aligned}$$

Self-insurance will also not be modelled explicitly. Rather the utility function u will be assumed to incorporate the effects of self-insurance. With this convention, the cost of self-insurance for any $\mathbf{z}$ may be defined as

$$\Delta_2(\mathbf{z}) = Z - C(\mathbf{z}) - CE(\mathbf{n})$$

where $CE(\mathbf{n})$ is the certainty equivalent net income associated with the risky net return vector $\mathbf{z}$ and is determined by

$$CE(\mathbf{n}) = u^{-1}\left(W(\mathbf{z} - C(\mathbf{z})\mathbf{1})\right).$$

The peasant's problem, therefore, may be reinterpreted as that of choosing $\mathbf{z}$ to minimize the cost of self protection and cost of self insurance:

$$\begin{aligned}\Delta_1(\mathbf{z}) + \Delta_2(\mathbf{z}) &= N^{RN} - CE(\mathbf{n}) \\ &= Z^{RN} - C(\mathbf{z}^{RN}) - CE(\mathbf{n}).\end{aligned}$$

Since the maximum profit available to a risk-neutral peasant is exogenously given by the technology and since u is monotone increasing, this is exactly the same as maximizing $W(\mathbf{z} - C(\mathbf{z})\mathbf{1}) = u(CE(\mathbf{n}))$. Hence, the optimal choice is $\hat{\mathbf{z}}$, yielding certainty equivalent net returns $CE(\hat{\mathbf{n}})$.

4 Contracting

We now consider the principal–agent problem that arises when a risk-neutral landlord contracts with a risk-averse peasant who is engaged in production under uncertainty. The landlord has the right to specify contract provisions involving a payment y to a peasant for an observed output z, with the landlord receiving $z - y$. Hence, if the contract is accepted, the peasant receives a state-contingent payment vector $\mathbf{y}(\mathbf{z})$ and the landlord receives the state-contingent income vector $\mathbf{z} - \mathbf{y}$. The peasant is free to take the contract offered by the landlord or to reject it. If the peasant rejects the contract, he retains the rights to the state-contingent output vector $\mathbf{z}$. In our framework, therefore, the contracting problem reduces to one of simultaneously picking a state-contingent output vector for the agent and a state-contingent payment vector for the principal. The approach, therefore, is perfectly general, and in particular is general enough to permit any degree of interlinkage of contract stipulations between the peasant and the landlord.

We consider two polar cases in relation to the landlord's objective function. In the competitive case, we assume that competition among potential landlords drives expected profit to zero. Hence, the problem is one of designing a contract to maximize the peasant's expected utility subject to the constraint that the landlord must make zero expected profit. In the other polar case, we assume the landlord has complete monopoly power. Thus the problem is one of maximizing the landlord's expected profit, subject to the constraint associated with the peasant's right to reject the contract proposed by the landlord and receive instead the state-contingent output vector $\mathbf{z}$.

This interaction is represented as an extensive-form game, and we focus on incentive-compatible subgame-perfect equilibria. We consider three possible information structures. In all cases the peasant can observe the state of nature s *ex post*. In the *first-best* case, the landlord can observe the state of nature *ex post*, and can commit in advance of the game to offer a payment schedule $\mathbf{y}(\mathbf{z})$ if the peasant chooses state-contingent output vector $\mathbf{z}$. The timing is as follows:

1. The landlord commits to a payment schedule $\mathbf{y}^{FB}$ contingent on the peasant producing $\mathbf{z}^{FB}$.

2. The peasant accepts or rejects the landlord's contract (rejection is represented as setting $\mathbf{y} = \mathbf{z}$).

3. The peasant chooses a state-contingent output vector $\mathbf{z} = (z_1, z_2)$.

4. Nature chooses $s \in \{1, 2\}$.

5. The peasant observes the state of nature s.

6. If the peasant accepted the contract and produced $\mathbf{z}^{FB}$, she receives $n_s^{FB} = y_s^{FB} - C(\mathbf{z}^{FB})$, and the landlord receives $z_s^{FB} - y_s^{FB}$. If the contract was rejected, the peasant receives $n_s = z_s - C(\mathbf{z})$ and the landlord receives zero.

In the second-best or *symmetric-information* case, the landlord can observe the state of nature s, but the peasant chooses the output vector $\mathbf{z}$ before the landlord can commit to a payment schedule. Thus, the bargaining sequence is:

1 The peasant chooses a state-contingent output vector $\mathbf{z}^{SB} = (z_1^{SB}, z_2^{SB})$.

2 The landlord offers a payment schedule $\mathbf{y}^{SB} = (y_1^{SB}, y_2^{SB})$ for output $\mathbf{z}^{SB}$.

3. The peasant accepts or rejects the landlord's contract.

4. Nature chooses $s \in \{1, 2\}$.

5. If the peasant accepted the contract, she receives $n_s^{SB} = y_s^{SB} - C(\mathbf{z}^{SB})$, and the landlord receives $z_s^{SB} - y_s^{SB}$. If the contract was rejected, the peasant receives $n_s = z_s^{SB} - C(\mathbf{z})$ and the landlord receives zero.

In the third-best or *asymmetric-information* case, the landlord can observe *ex post* output z_s, but not the state of nature. Hence the contract offered by the landlord must be incentive-compatible. The timing is:

1 The peasant chooses a state-contingent output vector $\mathbf{z}^{TB} = (z_1^{TB}, z_2^{TB})$.

2. The peasant announces an output plan $\tilde{\mathbf{z}}^{TB} = (\tilde{z}_1^{TB}, \tilde{z}_2^{TB})$ (in incentive-compatible subgame-perfect equilibria, $\mathbf{z}^{TB} = \tilde{\mathbf{z}}^{TB}$).

3 The landlord offers a payment schedule $\mathbf{y}^{TB} = (y_1^{TB}, y_2^{TB})$ for output $\tilde{\mathbf{z}}^{TB} = (\tilde{z}_1^{TB}, \tilde{z}_2^{TB})$.

4. The peasant accepts or rejects the landlord's contract (rejection is represented as setting $\mathbf{y}^{TB} = \mathbf{z}^{TB}$**).**

5. Nature chooses $s \in \{1, 2\}$.

6. The peasant observes the state of nature s.

7. The peasant reports state $\tilde{s}$, (in incentive-compatible subgame-perfect equilibria $\tilde{s} = s$).

8. The landlord observes the ex post output z_s^{TB}.

9. If the peasant accepted the contract and $z_s^{TB} = \tilde{z}_{\tilde{s}}^{TB}$, the peasant receives $n_s^{TB} = y_s^{TB} - C(\mathbf{z}^{TB})$, but if $z_s^{TB} \neq \tilde{z}_{\tilde{s}}^{TB}$ the peasant receives an arbitrarily large negative payoff. If the contract was rejected the peasant receives $n_s = z_s^{TB} - C(\mathbf{z})$ and the landlord receives zero.

The focus of our analysis is on the interaction between the game structure and the relative bargaining power of the landlord and peasant. We first observe the following result, which is valid for any of the information structures considered in this paper.

Suppose $z_1 \leq z_2$. Then any contract which is acceptable to the peasant and which yields non-negative profits to the landlord must satisfy

$$z_1 \leq y_1, y_2 \leq z_2.$$

Proof Suppose to the contrary that $y_2 > z_2$. Then the contract can only be profitable if $y_1 < z_1$ and

$$\pi_1 y_1 + \pi_2 y_2 < \pi_1 z_1 + \pi_2 z_2.$$

This means that (z_1, z_2) second-order stochastically dominates (y_1, y_2) so that acceptance of the contract would make the peasant worse off. Other violations of the conditions can be dealt with similarly. ■

5 Competitive insurance

5.1 First-best and symmetric information cases

In the competitive case, the landlord must offer the contract that maximizes the peasant's utility, subject to the landlord making zero expected profit. In the first-best case, the landlord will therefore choose (z_1^{FB}, z_2^{FB}) to maximize

$$N^{FB} = \pi_1 z_1 + \pi_1 z_2 - C(z_1, z_2)$$

and make the payment N^{FB} in both states of nature. It is obvious that $N^{FB} = N^{RN}$ so that the contract yields the peasant a welfare gain of

$$N^{RN} - CE(\hat{\mathbf{n}}) = \Delta_1(\hat{\mathbf{z}}) + \Delta_2(\hat{\mathbf{z}})$$

relative to the equilibrium without insurance.

Competition among landlords ensures that the landlord must offer the most appealing possible contract to the peasant, subject to the zero-expected-profit constraint. Hence, even in the absence of an *ex ante* commitment by the landlord, the first-best contract is achievable provided that the state of nature is observable. That is, the symmetric information equilibrium is the same as the first-best.

5.2 Asymmetric information case

The asymmetric information case arises when the landlord cannot observe, or at least contract on, either the state of nature or the state-contingent production vector. Hence it is possible for the peasant to misrepresent the state-contingent production vector to which she has committed, and support this misrepresentation by misreporting the state of nature where necessary. For example, the peasant might commit to (z_1, z_1) but report that she has committed to (z_1, z_2). Whatever state of nature actually occurred, the peasant would produce z_1 and report the occurrence of state 1.[2] We may confine attention to incentive-compatible equilibria, in which such misrepresentation does not occur.

For given $\mathbf{z}$, with the optimal payment vector must satisfy

$$
\begin{array}{lrcl}
(T.1) & \pi_1 y_1 + \pi_2 y_2 & = & \pi_1 z_1 + \pi_2 z_2 \\
(T.2) & \pi_1 u(y_1 - C(z_1, z_2)) + \pi_2 u(y_2 - C(z_1, z_2)) & \geq & u(y_1 - C(z_1, z_1)) \\
(T.3) & \pi_1 u(y_1 - C(z_1, z_2)) + \pi_2 u(y_2 - C(z_1, z_2)) & \geq & u(y_2 - C(z_2, z_2)) \\
(T.4) & \pi_1 u(y_1 - C(z_1, z_2)) + \pi_2 u(y_2 - C(z_1, z_2)) & \geq & \pi_1 u(y_2 - C(z_2, z_1)) + \pi_2 u(y_1 - C(z_2, z_1
\end{array}
$$

Assuming $z_1 \leq z_2$,the incentive compatibility constraints clearly require $y_1 \leq y_2$ with strict inequality whenever $z_1 < z_2$. Hence we obtain the following Corollary to Proposition 1.

Corollary 2 *Any solution to the asymmetric information problem with non-negative expected profit for the landlord must have*

$$z_1 < y_1 < y_2 < z_2.$$

Since $y_2 < z_2$, the option of producing (z_2, z_2) and receiving (y_2, y_2) under the insurance contract is dominated by the alternative of producing $\mathbf{z} = (z_2, z_2)$ and setting $\mathbf{y} = \mathbf{z}$. Also, since (z_2, z_1) is not inherently risky,

[2]This is the only relevant possibility, assuming $z_1 \leq z_2$. Since the insurance contract must have $y_2 \leq z_2$ by Proposition 1, the option of producing (z_2, z_2) and receiving (y_2, y_2) under the insurance contract is dominated by the alternative of not contracting and receiving (z_2, z_2) .Under the assumption of constant returns to scale, the option of producing (z_2, z_1) is dominated by a convex combination of the returns available by producing (z_2, z_2), yielding $z_2 - C(z_2, z_2)$ and (z_1, z_1), yielding $z_1 - C(z_1, z_1)$.

the option of producing (z_2, z_1) and receiving (y_2, y_1) is dominated by the alternative of setting $\mathbf{z} = (y_2, y_1)$ and setting $\mathbf{y} = \mathbf{z}$. In each case, the dominating alternative is dominated by the trivial contract in which the peasant produces $\hat{\mathbf{z}}$ and receives payment $\mathbf{y} = \hat{\mathbf{z}}$, yielding net returns $\hat{\mathbf{n}}$. Noting that this contract satisfies all the constraints, we observe that the set of feasible contracts yielding $W \geq W(\hat{\mathbf{z}} - C(\hat{\mathbf{z}})\mathbf{1})$ is non-empty. Assuming that C is 'sufficiently' convex, the set of feasible contracts will also be compact. Hence, we have:

Lemma: There exists an optimal pair $(\mathbf{y}, \mathbf{z})$ satisfying the constraints $(T.1)$ to $(T.4)$. For this pair, $(\mathbf{y}, \mathbf{z})$, the constraints $(T.3)$ and $(T.4)$ are not binding.

Thus, for any announced (z_1, z_2) competition will induce the landlord to offer an output-dependent payment $\mathbf{y}$ that maximizes the peasant's utility subject to the zero profit constraint

$$(T.1) \quad \pi_1 y_1 + \pi_2 y_2 = \pi_1 z_1 + \pi_2 z_2$$

and the incentive-compatibility constraint

$$(T.2) \quad \pi_1 u(y_1 - C(z_1, z_2)) + \pi_2 u(y_2 - C(z_1, z_2)) \geq u(y_1 - C(z_1, z_1)).$$

Let the optimal solution to this problem be denoted $\mathbf{y}(\mathbf{z})$. We now consider some characteristics of the equilibrium pair $(\mathbf{y}, \mathbf{z})$.

Consider first $\mathbf{y}(\hat{\mathbf{z}})$. Since $z_1 < y_1 < y_2 < z_2$ and

$$\pi_s u'(z_s - C(z_1, z_2)) - (\pi_1 u'(z_1 - C(z_1, z_2)) + \pi_2 u'(z_2 - C(z_1, z_2)))\, C_s = 0 \quad s = 1, 2$$

we must have

$$\begin{aligned}
\pi_1 u'(y_1 - C(z_1, z_2)) - (\pi_1 u'(y_1 - C(z_1, z_2)) + \pi_2 u'(y_2 - C(z_1, z_2)))\, C_1 &< 0 \quad s = 1, 2 \\
\pi_2 u'(y_2 - C(z_1, z_2)) - (\pi_1 u'(y_1 - C(z_1, z_2)) + \pi_2 u'(y_2 - C(z_1, z_2)))\, C_2 &> 0 \quad s = 1, 2.
\end{aligned}$$

Hence, the peasant would benefit from a change which increased z_2 and y_2, and reduced z_1 and y_1 in such a manner as to hold $C(z_1, z_2)$, $z_2 - y_2$ and $z_1 - y_1$ constant. Such a change would leave the expected profit equal to zero. Moreover, totally differentiating the right-hand side of the incentive-compatibility constraint yields the following expression for the change in the peasant's utility conditional on producing (z_1, z_1) :

$$u'(y_1 - C(z_1, z_1)\, [dy_1 - (C_1(z_1, z_1) + C_2(z_1, z_1))\, dz_1]$$

Observing that $C_1(z_1, z_1) + C_2(z_1, z_1) \leq 1$, and $dy_1 = dz_1 < 0$, the right-hand side declines, while the left-hand side increases. Hence, the incentive-compatibility constraint is satisfied after the change. It follows that the peasant will prefer to choose a state-contingent output vector $\mathbf{z}$ such that

$$\begin{aligned} \pi_1 z_1 + \pi_2 z_2 &> \pi_1 \hat{z}_1 + \pi_2 \hat{z}_2 \\ z_1 &< \hat{z}_1 < \hat{z}_2 < z_2. \end{aligned}$$

That is:

Proposition 3 *The optimal output* $\mathbf{z}$ *in the competitive asymmetric information solution is derived from a mean-increasing spread of* $\hat{\mathbf{z}}$.

Having derived this result it is possible to characterize the welfare losses in the competitive asymmetric information solution relative to the first-best. The peasant's problem at stage 1 is to choose $\mathbf{z}^{SB}$ to maximize

$$\pi_1 u(y_1(\mathbf{z}) - C(z_1, z_2)) + \pi_2 u(y_2(\mathbf{z}) - C(z_1, z_2))$$

yielding net returns $\mathbf{n}^{SB}$. Denote the expected output and net returns by Z^{SB}, N^{SB}.

Relative to the first-best, the peasant incurs a cost of self-protection

$$\Delta_1(\mathbf{z}^{SB}) = N^{RN} - N^{SB}$$

and a cost of incomplete insurance

$$\Delta_2(\mathbf{z}^{SB}) = N^{SB} - CE(\mathbf{n}^{SB}).$$

As noted above, $\mathbf{z}^{SB}$ is riskier than $\hat{\mathbf{z}}$ and $E[\mathbf{n}^{SB}] \geq E[\hat{\mathbf{n}}]$. Hence, $\Delta_1(\mathbf{z}^{SB}) \leq \Delta_1(\hat{\mathbf{z}})$. Moreover, $CE(\mathbf{n}^{SB}) \geq CE(\hat{\mathbf{n}})$. Hence,

$$\Delta_1(\mathbf{z}^{SB}) + \Delta_2(\mathbf{z}^{SB}) \leq \Delta_1(\hat{\mathbf{z}}) + \Delta_2(\hat{\mathbf{z}}).$$

Observe from the incentive-compatibility constraint that:

$$CE(\mathbf{n}^{SB}) = y_1^{SB} - C(z_1^{SB}, z_1^{SB})$$

so

$$\begin{aligned} \Delta_2(\mathbf{z}^{SB}) &= \pi_1 y_1^{SB} + \pi_2 y_2^{SB} - C(z_1^{SB}, z_2^{SB}) - CE^{SB} \\ &= \pi_2(y_2^{SB} - y_1^{SB}) - (C(z_1^{SB}, z_2^{SB}) - C(z_1^{SB}, z_1^{SB})). \end{aligned}$$

6 Monopolistic landlords

In the monopolistic case, a single landlord contracts with peasants by specifying an output vector (z_1, z_2) and payment vector (y_1, y_2). Peasants must choose whether to produce the output vector (z_1, z_2) and payment vector (y_1, y_2) proposed by the landlord, or to produce some other output vector (in which case they must self-insure). Then, after committing to (z_1, z_2), peasants have the opportunity to accept or decline the contract offered by the landlord.

The problem faced by the peasant is the need to commit to a state-contingent production vector in the knowledge that they will subsequently deal with a landlord possessing monopoly bargaining power and, therefore, the capacity to capture all available rents. For example, a peasant farmer considering a risky investment in a cash crop may anticipate subsequent dealings with a monopoly moneylender. In all such cases, unless the landlord can commit *ex ante* to guarantee the peasant some minimum utility level, the peasant must choose their output vector to maximize the utility of their outside option.

6.1 First-best case

In the first-best case, the landlord can commit in advance to providing the peasant with a given utility level, conditional on accepting the proposed contract. If the landlord's proposed contract yields the peasant less than $CE(\hat{\mathbf{n}})$, the peasant's dominant strategy is to reject the offer and produce $\hat{\mathbf{z}}$. If the contract yields at least $CE(\hat{\mathbf{n}})$, the peasant's weakly dominant strategy is to produce the output proposed by the landlord and accept the contract.

Hence,the landlord's problem is

$$\max_{\mathbf{y}}\{\ \pi_1(z_1 - y_1) + \pi_2(z_2 - y_2)\}$$

subject to the constraint

$$\pi_1 u(y_1 - C(z_1, z_2)) + \pi_2 u(y_2 - C(z_1, z_2)) \geq u\left(CE(\hat{\mathbf{n}})\right).$$

The landlord will, therefore, choose (z_1^{FB}, z_2^{FB}) to maximize

$$P = \pi_1 z_1 + \pi_1 z_2 - C(z_1, z_2)$$

and make a state-independent payment Y^{FB} such that

$$Y^{FB} - C(\mathbf{z}^{FB}) = CE(\hat{\mathbf{n}}).$$

It is obvious that $Z^{FB} = Z^{RN}$, so that the landlord's expected profit is

$$\begin{aligned} P^{FB} &= Z^{RN} - Y^{FB} \\ &= \Delta_1(\hat{\mathbf{z}}) + \Delta_2(\hat{\mathbf{z}}). \end{aligned}$$

Thus, the outcome is the same as in the first-best competitive case, except that all the benefits of the contract go to the landlord rather than the peasant.

6.2 Symmetric information case

We next consider the case when the landlord can observe the state of nature, but cannot commit in advance to a conditional payment $\mathbf{y}(\mathbf{z})$. Hence, the peasant commits to the state-contingent production vector (z_1, z_2) before negotiating with the landlord. The landlord must then offer a payment vector (y_1, y_2) which the peasant can either accept or decline. Since the landlord can observe the state of nature, the peasant must announce $\tilde{s}=s$ and must therefore announce $\tilde{\mathbf{z}} = \mathbf{z}$. Given that the peasant has committed to, and announced, the state-contingent output $\mathbf{z}$, the dominant strategy for the landlord is to offer the peasant exactly $W(\mathbf{z}-C(\mathbf{z})\mathbf{1})$, the utility the peasant would get from consuming the output (z_1, z_2) chosen in stage 1. Hence the iteratively dominant strategy for the peasant is to choose the output $\hat{\mathbf{z}}$ that maximizes this utility. Hence, this game has a unique subgame-perfect equilibrium, which we now explore in detail.

The landlord's objective function is

$$\max_{\mathbf{y}} \ \pi_1(y_1 - z_1) + \pi_2(y_2 - z_2)$$

subject to the constraint

$$\pi_1 u(y_1 - C(z_1, z_2)) + \pi_2 u(y_2 - C(z_1, z_2)) \geq u\left(CE(\hat{\mathbf{n}})\right)$$

which requires that the peasant, having committed to the (z_1, z_2), vector will find the landlord's contract at least as attractive as the alternative of consuming (z_1, z_2).

In the optimal solution, the landlord will offer a state-independent payment of $\hat{Y}$, where

$$\hat{Y} - C(\hat{\mathbf{z}}) = CE(\hat{\mathbf{n}}).$$

The landlord's expected profit is

$$\begin{aligned} \hat{P} &= \hat{Z} - \hat{Y} \\ &= P^{FB} - \Delta_1(\hat{\mathbf{z}}) \\ &= \Delta_2(\hat{\mathbf{z}}) \end{aligned}$$

where

$$\Delta_1(\hat{\mathbf{z}}) = [Z^{FB} - C(z_1^{FB}, z_2^{FB})] - [\hat{Z} - C(\hat{z}_1, \hat{z}_2)]$$

which is the cost of self-protection by the peasant and

$$\Delta_2(\hat{\mathbf{z}}) = \hat{P} - CE(\hat{\mathbf{n}})$$

is the peasant's risk premium, as before.

That is, relative to the competitive symmetric information case, the peasant is worse off and the landlord is better off, as would be expected. However, whereas the outcome in the competitive symmetric information case is Pareto-efficient, the monopolistic symmetric information case involves a welfare loss of $\Delta_1(\hat{\mathbf{z}})$ relative to the first-best. This loss reflects the cost of self-protection undertaken by the peasant in anticipation of the landlord's use of monopoly power.

6.3 Asymmetric information case

The asymmetric information monopolistic case will be referred to as the third-best, since both the landlord's monopoly power and the peasant's private information reduce aggregate welfare relative to the first-best The landlord's dominant strategy, given an announced output $\tilde{\mathbf{z}}$ is to offer a payment schedule $\mathbf{y}$ yielding the peasant $W(\tilde{\mathbf{z}}-C(\tilde{\mathbf{z}})\mathbf{1})$ if $\tilde{\mathbf{z}}$ is produced and $W \leq W(\tilde{\mathbf{z}}-C(\tilde{\mathbf{z}})\mathbf{1})$ if any $\mathbf{z} \neq \tilde{\mathbf{z}}$ is produced. Hence, in any subgame-perfect equilibrium, the peasant produces and announces $\hat{\mathbf{z}}$, yielding certainty-equivalent outcome $CE(\hat{\mathbf{n}})$.

The outcome in state s is that the landlord's payoff is $z_s - y_s$, and the peasant's payoff is $y_s - C(z_1, z_2)$. Hence the landlord's problem becomes

$$\max_{\mathbf{y}} \ \pi_1(y_1 - \hat{z}_1) + \pi_2(y_2 - \hat{z}_2)$$

subject to constraints analogous to those in the competitive case:

$$
\begin{aligned}
\pi_1 u(y_1 - C(\hat{z}_1, \hat{z}_2)) + \pi_2 u(y_2 - C(\hat{z}_1, \hat{z}_2)) &\geq u\left(CE(\hat{\mathbf{n}})\right). \\
\pi_1 u(y_1 - C(\hat{z}_1, \hat{z}_2)) + \pi_2 u(y_2 - C(\hat{z}_1, \hat{z}_2)) &\geq u(y_1 - C(\hat{z}_1, \hat{z}_1)) \\
\pi_1 u(y_1 - C(\hat{z}_1, \hat{z}_2)) + \pi_2 u(y_2 - C(\hat{z}_1, \hat{z}_2)) &\geq u(y_2 - C(\hat{z}_2, \hat{z}_2)) \\
\pi_1 u(y_1 - C(\hat{z}_1, \hat{z}_2)) + \pi_2 u(y_2 - C(\hat{z}_1, \hat{z}_2)) &\geq \pi_1 u(y_2 - C(\hat{z}_2, \hat{z}_1)) + \pi_2 u(y_1 - C(\hat{z}_2, \hat{z}_1)).
\end{aligned}
$$

As in the competitive case, only the first and second constraints will bind in equilibrium.

We have proved the following result, previously derived by Grossman and Hart (1983) for the case of an objective function additively separable in income and effort.

Proposition 4 *In the asymmetric information problem with competitive insurance and a net returns objective function, the equilibrium will yield the peasant reservation utility.*

We can derive an explicit solution to the insurance problem. Let u_i denote $u(y_i - C(\hat{z}_1, \hat{z}_2))$, $i = 1, 2$. Then the solution to the problem takes the form

$$
\begin{aligned}
\pi_1 u_1 + \pi_2 u_2 &= u\left(CE(\hat{\mathbf{n}})\right) \\
&= u(y_1 - C(\hat{z}_1, \hat{z}_1)).
\end{aligned}
$$

Hence,

$$
y_1 - C(\hat{z}_1, \hat{z}_1) = CE(\hat{\mathbf{n}})
$$

or

$$
\begin{aligned}
y_1(\hat{\mathbf{z}}) &= CE(\hat{\mathbf{n}}) + C(\hat{z}_1, \hat{z}_1) \\
&= \hat{Y} + C(\hat{z}_1, \hat{z}_1) - C(\hat{z}_1, \hat{z}_2)
\end{aligned}
$$

and

$$
\begin{aligned}
y_2(\hat{\mathbf{z}}) - C(\hat{z}_1, \hat{z}_2) &= u^{-1}\left(\frac{u\left(CE(\hat{\mathbf{n}})\right) - \pi_1 u(y_1(\hat{\mathbf{z}}) - C(\hat{z}_1, \hat{z}_2))}{\pi_2}\right) \\
&= u^{-1}\left(\frac{u\left(CE(\hat{\mathbf{n}})\right) - \pi_1 u(CE(\hat{\mathbf{n}}) + C(\hat{z}_1, \hat{z}_1) - C(\hat{z}_1, \hat{z}_2))}{\pi_2}\right).
\end{aligned}
$$

Thus, the landlord's expected profit is

$$\begin{aligned} P^{TB} &= \hat{z} - \pi_1 y_1(\hat{z}_1, \hat{z}_2) - \pi_2 y_2(\hat{z}_1, \hat{z}_2) \\ &= P^{FB} - \Delta_1(\hat{\mathbf{z}}) - \Delta_2^{TB}(\hat{\mathbf{z}}), \end{aligned}$$

where Δ_1 is the peasant's cost of self-protection as before, and

$$\Delta_2^{TB}(\hat{\mathbf{z}}) = (\pi_1 y_1(\hat{\mathbf{z}}) + \pi_2 y_2(\hat{\mathbf{z}}) - C(\hat{\mathbf{z}})) - CE(\hat{\mathbf{n}})$$

is the peasant's risk premium associated with the requirement for incentive-compatibility. Moreover, we note that $0 \leq \Delta_2^{TB}(\hat{\mathbf{z}}) \leq \Delta_2(\hat{\mathbf{z}})$ and

$$P^{TB} = \Delta_2(\hat{\mathbf{z}}) - \Delta_2^{TB}(\hat{\mathbf{z}}).$$

The existence of asymmetric information prevents the landlord from fully insuring the peasant and capturing the entire risk premium. Moreover, since the choice of $\hat{\mathbf{z}}$ is available in the competitive case,

$$\Delta_1^{TB} + \Delta_2^{TB} \geq \Delta_1^{SB} + \Delta_2^{SB}.$$

As in the competitive case, the incentive-compatibility constraint implies:

$$CE^{TB} = \hat{y}_1 - C(\hat{z}_1, \hat{z}_1)$$

so

$$\begin{aligned} \Delta_2^{TB} &= \pi_1 \hat{y}_1 + \pi_2 \hat{y}_2 - C(\hat{z}_1, \hat{z}_2) - CE^{TB} \\ &= \pi_2(\hat{y}_2 - \hat{y}_1) - (C(\hat{z}_1, \hat{z}_2) - C(\hat{z}_1, \hat{z}_1)). \end{aligned}$$

7 Bargaining solutions

In the monopolistic solutions considered above, the landlord's monopoly power allows him to capture the entire rent. Compared to the competitive case, however, the landlord's profit is less than the reduction in the certainty-equivalent income of the peasant, and there is, therefore, a net social loss. In both the symmetric information and asymmetric information cases, the peasant must precommit to an inefficient production vector to secure his reservation utility. In asymmetric information problems, there is an additional loss relative to the first-best arising from the landlord's need to offer an incentive-compatible contract.

We now consider the possibility of co-operative solutions, in which the peasant and landlord can contract, *ex ante,* so as to avoid one or both of these sources of divergence from the first-best. The solution concept applied is that of a Nash bargaining solution. The disagreement point is either the symmetric information solution or the asymmetric information solution derived above for the monopoly case. The agreement point may be either the first-best or an asymmetric information solution in which the landlord commits to a payment schedule based on observed output, but the state of nature is not contractible.

Co-operative bargaining solutions may arise either because peasants gain an increase in bargaining power relative to monopolistic landlords or because the externality associated with the peasant's private information is partially internalized. As an example of the former process, individual bargaining with a monopoly landlord may be replaced by collective bargaining, with peasants or workers being represented by co-operatives or unions. Alternatively, policies such as land reform or employee stock ownership plans may produce some commonality of interest between peasants and landlords and thereby lead to the internalization of externalities.

7.1 First-best case

We first consider the case where the landlord and peasant can reach the first-best outcome through bargaining. The disagreement point is one in which the peasant chooses some $\tilde{\mathbf{z}}$, yielding the reservation certainty-equivalent income $CE(\tilde{\mathbf{n}})$. No contracting takes place and the landlord therefore receives zero.[3] The agreement point is one in which the peasant produces the first-best output $\mathbf{z}^{FB} = \mathbf{z}^{RN}$ and receives a nonstochastic payment Y, yielding net income $Y - C\left(\mathbf{z}^{FB}\right)$. Bargaining therefore determines the payment Y received by the peasant and the landlord's profit $Z - Y$.

Analysis of bargaining problems requires a cardinal specification of the utility of income under certainty. Diminishing marginal utility of certain income is not necessarily equivalent to risk-aversion under certainty even

[3]Note that the landlord may contract with other peasants, so that his income in the event of disagreement is not equal to zero. The existence of outside income will be reflected in relative bargaining power.

though both may be represented by concavity of the utility function. For simplicity, we assume that utility for both parties is linear in certainty-equivalent income. (For the risk-neutral landlord, certainty-equivalent income is equal to expected income.)

The relative bargaining power of the two parties is represented by a parameter α [4] . Thus, the bargaining problem is to choose Y to maximize

$$\hat{V} = \left(\left(Y - C\left(\mathbf{z}^{FB}\right)\right) - CE(\tilde{\mathbf{n}})\right)^{\alpha} P^{1-\alpha},$$

where $P = Z - Y$.

The first-order condition on Y is:

$$\alpha\left(\left(Y - C\left(\mathbf{z}^{FB}\right)\right) - CE(\tilde{\mathbf{n}})\right)^{\alpha-1} P^{1-\alpha} = (1-\alpha)\left(\left(Y - C\left(\mathbf{z}^{FB}\right)\right) - CE(\tilde{\mathbf{n}})\right)^{\alpha} P^{-\alpha}$$

or:

$$\frac{\left(\left(Y - C\left(\mathbf{z}^{FB}\right)\right) - CE(\tilde{\mathbf{n}})\right)}{P} = \frac{\alpha}{(1-\alpha)}.$$

As would be expected, the greater the bargaining power of the peasant, the higher is the payment Y.

Totally differentiating with respect to $CE(\tilde{\mathbf{n}})$ and rearranging yields

$$(1-\alpha) = (1-\alpha)\frac{\partial Y}{\partial CE(\tilde{\mathbf{n}})} - \alpha\frac{\partial P}{\partial CE(\tilde{\mathbf{n}})}$$

or, since

$$\frac{\partial Y}{\partial CE(\tilde{\mathbf{n}})} + \frac{\partial P}{\partial CE(\tilde{\mathbf{n}})} = 0$$

$$\frac{\partial Y}{\partial CE(\tilde{\mathbf{n}})} = (1-\alpha).$$

Hence, the peasant's final share of income is increasing in $CE(\tilde{\mathbf{n}})$, and the optimal choice for the peasant is $\tilde{\mathbf{z}} = \hat{\mathbf{z}}$. However, since the actual output is $\mathbf{z}^{FB}$, the choice of $\tilde{\mathbf{z}}$ only affects the division of the surplus. The analysis of the first-best case confirms the result derived by Bell (1989), that, under costless monitoring, the principal–agent and Nash bargaining

[4]If utility functions display diminishing marginal utility of income, commonly referred to in the bargaining literature as risk-aversion, the curvature of the cardinal utility functions may be incorporated in the determination of α.

solutions, assuming an affine payment structure, are identical up to a side payment.

Since, the more risk-averse is the peasant, the lower is $CE(\hat{\mathbf{n}})$,we obtain the result that, the more risk-averse is the peasant, the better off is the landlord. Note that this is not the standard bargaining theory result: the less risk-averse party, that is, the one with the less concave cardinal utility of wealth, has more bargaining power. In the present case, both the landlord and the peasant have cardinal utility linear in certainty-equivalent wealth. The result arises because, the more risk-averse is the peasant, the greater are the gains from insurance. Since these gains are shared in proportion to bargaining power, the landlord is better off. On the other hand, since the peasant receives only part of the gains from insurance, a reduction in $CE(\hat{\mathbf{n}})$ leaves her strictly worse off whenever $\alpha < 1$.

7.2 Bargaining solution with symmetric information

In the symmetric information case, the disagreement point, as before, is one in which the peasant chooses some $\tilde{\mathbf{z}}$, receiving $CE(\ \tilde{\mathbf{n}})$ and the landlord receives zero. The agreement point is one in which the output $\tilde{\mathbf{z}}$ is produced and the landlord offers full insurance, giving the agent a non-stochastic payment Y and receiving the profit

$$P(\tilde{\mathbf{z}},Y) = E[\tilde{\mathbf{z}}] - Y.$$

Thus, the bargaining problem is to choose Y to maximize

$$\hat{V} = ((Y - C(\tilde{\mathbf{z}})) - CE(\tilde{\mathbf{n}}))^{\alpha} P(\tilde{\mathbf{z}},Y)^{1-\alpha},$$

which, as before, yields the solution condition

$$\frac{((Y - C(\tilde{\mathbf{z}})) - CE(\tilde{\mathbf{n}}))}{P(\tilde{\mathbf{z}},Y)} = \frac{\alpha}{(1-\alpha)}.$$

Totally differentiating with respect to $\tilde{\mathbf{z}}$ and rearranging yields

$$\begin{aligned}(1-\alpha)\nabla_{\tilde{\mathbf{z}}}(Y - C - CE(\tilde{\mathbf{n}})) &= \alpha \nabla_{\tilde{\mathbf{z}}} P(\tilde{\mathbf{z}},Y) \\ &= \alpha\left(\nabla_{\tilde{\mathbf{z}}} E[\tilde{\mathbf{z}}] - \nabla_{\tilde{\mathbf{z}}} Y\right),\end{aligned}$$

where $\nabla_{\tilde{\mathbf{z}}}$ denotes the gradient with respect to the subscripted vector. Hence

$$\nabla_{\tilde{\mathbf{z}}} Y - (1-\alpha)\nabla_{\tilde{\mathbf{z}}} C = (1-\alpha)\nabla_{\tilde{\mathbf{z}}} CE(\tilde{\mathbf{n}}) + \alpha\nabla_{\tilde{\mathbf{z}}} E[\tilde{\mathbf{z}}]$$

In the case $\alpha = 0$, we have

$$\nabla_{\tilde{\mathbf{z}}} (Y - C) = \nabla_{\tilde{\mathbf{z}}} CE(\tilde{\mathbf{n}}),$$

and the peasant will maximize $Y - C(\tilde{\mathbf{z}}) = CE(\tilde{\mathbf{n}})$ by choosing $\tilde{\mathbf{z}} = \hat{\mathbf{z}}$. On the other hand, if $\alpha = 1$,

$$\nabla_{\tilde{\mathbf{z}}} (Y - C) = \nabla_{\tilde{\mathbf{z}}} E[\tilde{\mathbf{z}}] - \nabla_{\tilde{\mathbf{z}}} C,$$

and the peasant will maximize $Y - C(\tilde{\mathbf{z}}) = E[\tilde{\mathbf{z}}] - C(\tilde{\mathbf{z}})$ by choosing $\tilde{\mathbf{z}} = \mathbf{z}^{FB}$. More generally, the greater the value of α, the greater the optimal value of $E[\tilde{\mathbf{z}}] - C(\tilde{\mathbf{z}})$ and therefore the greater the total surplus. Thus, if the peasant chooses the output vector $\mathbf{z}$ before the landlord can commit to a payment schedule, bargaining power matters not only to the division of the surplus but to the size of the surplus. It is straightforward to show, however, that an increase in α cannot make the landlord better off, so that the bargaining solution is always constrained-Pareto-efficient.

7.3 Bargaining solution with asymmetric information

In the asymmetric information case, the agreement point is one in which the output $\tilde{\mathbf{z}}$ is produced and the landlord offers an incentive compatible payment schedule $\mathbf{y}$ receiving profit

$$P(\tilde{\mathbf{z}}, N) = E[\tilde{\mathbf{z}}] - E[\mathbf{y}(\mathbf{z}, N)],$$

where N is the peasant's certainty-equivalent net income

$$N = u^{-1}(W(\mathbf{y} - C(\mathbf{z}))).$$

Suppose that the peasant's preferences display constant absolute risk aversion. Then

$$\frac{\partial P(\tilde{\mathbf{z}}, N)}{\partial N} = 1.$$

Thus, the bargaining problem is to choose N to maximize:

$$\hat{V} = (N - CE(\tilde{\mathbf{n}}))^{\alpha} \, P(\tilde{\mathbf{z}}, N)^{1-\alpha},$$

which, assuming constant absolute risk aversion, yields the solution condition

$$\frac{(N-CE(\tilde{\mathbf{n}}))}{P(\tilde{\mathbf{z}},u)} = \frac{\alpha}{(1-\alpha)}.$$

Totally differentiating with respect to $\tilde{\mathbf{z}}$ and rearranging yields

$$\begin{aligned}(1-\alpha)\nabla_{\tilde{z}}\left(N - CE(\tilde{\mathbf{n}})\right) &= \alpha\nabla_{\tilde{z}}\frac{\partial P(\tilde{\mathbf{z}},u)}{\partial\tilde{\mathbf{z}}} \\ &= \alpha\nabla_{\tilde{z}}\left(E[\tilde{\mathbf{z}}] - E[\mathbf{y}(\mathbf{z})]\right).\end{aligned}$$

In the case $\alpha = 0$, we have

$$\nabla_{\tilde{z}}\left(N - CE(\tilde{\mathbf{n}})\right) = 0,$$

and the peasant will maximize N by choosing $\tilde{\mathbf{z}} = \hat{\mathbf{z}}$. On the other hand, if $\alpha = 1$,the peasant will maximize N by choosing $\tilde{\mathbf{z}} = \mathbf{z}^{TB}$. Thus, once again, the greater the peasant's bargaining power, the greater the total surplus.

In the model of socially costly exploitation analyzed by Chambers and Quiggin (2000), the presence of asymmetric information makes the peasant better off, by reducing the landlord's return to efforts aimed at reducing reservation utility. By contrast, in the present case, asymmetric information never improves the welfare of either party, and makes both the landlord and the peasant strictly worse off whenever $0 < \alpha < 1$.

8 Concluding comments

This paper has explored the contracting behavior of landlords and peasants under conditions of asymmetric information and differential bargaining power. The main focus of attention has been the interaction between differential bargaining power and two potential sources of departure from the first-best. The first, which is applicable to a wide variety of contracting situations, is that peasants anticipating the need to deal with a landlord with monopoly power (or, more generally, with substantial bargaining power) will undertake costly self-protection to improve the outside option that will form the basis of subsequent bargaining. The second is the problem of moral hazard, in which the peasant has private information about the state of nature.

The crucial result is that differential bargaining power will affect not only the distribution of surplus but the total surplus generated. Where peasants have the capacity to undertake costly self-protection, an increase in their bargaining power will raise the total surplus. The results derived here represent a significant extension of those presented by Bell (1989).

The analysis has been undertaken using a state-contingent representation of production, developed by Chambers and Quiggin (2000). A key advantage of the state-contingent approach is the ease with which self-protection and asymmetric information can be represented. A variety of extensions of the analysis undertaken here might be considered. Problems of adverse selection might be modelled by allowing for a richer state space, with the peasant observing a signal, represented by a partition of the state space, prior to contracting. In addition, the possibility of action by the landlord designed to reduce the attractiveness of the outside option as in Chambers and Quiggin (2000) might be considered.

More generally, the analysis above suggests that principal–agent theory may usefully be applied to problems involving collective action, using the concept of state-contingent production. The allocation of risk is a central issue in collective choice, and the state-contingent framework makes this issue explicit.

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