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Share contracts and unobserved ability

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Abstract

We present a model with a monopolistic landlord and tenants with unobservable ability. In this setting, the landlord should use a wage contract to extract the full surplus due to ability since a share or fixed rent contract leaves some of the surplus in the hands of the tenants. We combine this issue with a standard moral hazard problem on the tenants' side, which argues for a fixed rent contract. A share contract is an optimal compromise between these two forces.

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1. Introduction

Sharecropping is an agricultural land lease contract that has puzzled economists for centuries. Instead of paying a predetermined amount of rent the tenant agrees to give the landlord a share of the output. This contract has been observed in a wide variety of agricultural settings. Moreover, similar contracts are found in many other sectors, such as the fishing industry (Platteau and Nugent, 1992) and the franchising of fast food restaurants (Lafontaine, 1993).

The rise of the agency literature in the last 25 years has greatly improved our understanding of contract choice, although some of the issues involved were mentioned long before. For instance, Marshall (1890) formalized the incentive problem in sharecropping, while Higgs (1894) proposed the risk-sharing advantages. We now have a rich and extensive collection of theories that explain why sharecropping might occur. An extensive empirical literature has provided evidence both in favor and against many of these theories. And it is probably fair to say that there is no single explanation for sharecropping. This contract can

arise in a wide variety of settings for a wide variety of reasons. In this paper we propose one more reason in one more setting.

Let the amount that the tenant receives be $\alpha + \beta y$ where α and β are coefficients fixed in the contract and y is output. With $0 \leq \beta \leq 1$ there exists a continuum of share contracts with the wage contract ($\beta = 0, \alpha > 0$) and rent contract ($\beta = 1, \alpha < 0$) as the two extremes. This clarifies the underlying theme of the most widely accepted theories of sharecropping. In these theories, which we could call residual claimant theories, two opposing forces are present. One of those forces argues that the optimal contract is a wage contract, while the other force argues that it is a rent contract. The share contract arises as a compromise between these forces.

For instance, in the risk sharing theory in Stiglitz (1974), risk aversion of the tenant argues that the landlord should be the residual claimant and the contract should be a wage contract. This is combined with risk aversion of the landlord which argues for a rent contract. In the same paper, Stiglitz introduced the principal-agent problem, where the risk aversion of the tenant is combined with an incentive problem on the side of the tenant, the latter again pushing the optimal contract towards a rent contract. Later, the partnership problem, where both landlord and tenants have incentive problems, was introduced to the sharecropping

literature by Reid (1976), and Eswaran and Kotwal (1985). Limited liability (e.g., Basu, 1992) might make it impossible to make one of the parties fully residual claimant. Our contribution falls into this strand of literature by proposing a new force arguing for a wage contract.

Screening theories of sharecropping were introduced by Hallagan (1978), and Newbery and Stiglitz (1979). These authors realized that the willingness by the tenant to accept wage, share, or rent contracts can provide a signal about the ability of the tenant. Share contracts arise because of the usefulness of such a signal. In Hallagan, an (apparently) monopolistic landlord faces tenants of varying but unobservable ability.¹ By offering three contracts — wage, share, and rent contracts — the landlord can separate the low, medium, and high ability types and receive a higher utility than by offering a single contract for all types. Newbery and Stiglitz on the other hand assume competition among landlords. Risk aversion of the workers would normally argue for a wage contract. However, workers of high ability can signal their type to the landlord by accepting a share contract. While these workers dislike the increased risk, the share of output more than compensates them for this. Low ability workers do not follow suit because

¹Hallagan's result has been criticized for not being consistent with competition between landlords (e.g., Allen, 1982, and Basu, 1984). Muthoo (1998) shows that the insights of Hallagan are valid if one assumes a monopolistic landlord.

the share of output does not adequately compensate them for the increase in risk.²

In our theory, unobserved ability of the tenant plays a central role. However, since we focus on the pooling solution no signaling takes place. Rather, unobserved ability gives the tenant power in negotiations over the surplus of the contract. As in the residual claimant theories we consider two opposing forces, one arguing for a wage contract, the other arguing for a fixed rent contract. The force arguing for the fixed rent contract here is a standard moral hazard problem but risk aversion or limited liability of the landlord would do as well.

The force arguing for the wage contract is new and appears to be unexplored in the literature. The wage contract is the contract that optimally extracts the surplus due to heterogeneity in ability. A monopolistic landlord can hire a worker for the reservation wage and get the surplus of the worker's ability. A rent contract on the other hand leaves the surplus in the hands of the tenant (unless the rent can be made dependent on the tenant's ability, but this is impossible when ability is unknown to the landlord). It is, of course, important to assume a monopolistic

²Screening theories have attracted various criticisms. An important problem that we have not seen mentioned before is that they fail an important empirical test. A stylized fact of share contracts is that the contracts are almost completely uniform within a region. (e.g. Bardhan and Rudra, 1980). None of the residual claimant explains this striking regularity and it remains one of the puzzles in sharecropping. However, screening theories seem to be especially at odds with the uniformity of share contracts and predict exactly the opposite: in a world where ability is continuous distributed, we would expect to observe a continuum of share contracts with different shares signaling different levels of ability.

setting (or, for that matter, a setting where landlords collude efficiently), otherwise the tenant will be able to use the competition between landlords to obtain a rent contract and keep the surplus resulting from his ability.

We start by explaining the technological and institutional settings in section 2. Section 3 discusses the optimal pooling contract and provides various reasons why separation equilibria are often unattainable. Section 4 contains policy implications and section 5 concludes.

2. Institutional Setting, Technology, and Efficiency

2.1. Institutional Setting and Technology

A risk-neutral landlord has N plots of equal quality. He faces M potential workers, who are also assumed to be risk neutral. Each worker can either get a contract for production on one plot or no contract at all.³ For now, we will assume that $M = N$, so that screening of potential workers has no role in the model. We will see that the optimal contract will automatically perform this function perfectly when $M > N$. The potential workers have different levels of ability, denoted by a .⁴

³This assumption reduces the complexity of the model by making plot size and land quality of the contract fixed. In separating equilibria, the plot size might be used as an additional screening device (see Newbery and Stiglitz, 1979).

⁴Ability can be any type of input that is non-marketable and unobservable to the landlord.

Each worker knows his ability a , but the landlord knows only the distribution of a in the population. Without loss of generality we assume that the lowest level of ability in the population is $a = 0$.

Workers that get contracts choose a level of effort, given by $e \geq 0$, which is not directly observable to the landlord. The cost of applying effort is $c(e)$, which is strictly increasing and strictly convex in e : $c_e(e) > 0$ and $c_{ee}(e) > 0$. For convenience we assume $c_e(0) = 0$.⁵

Output is a function of effort and ability

$$y = f(e, a) \tag{1}$$

and strictly increasing in both: $f_e(e, a) > 0$, and $f_a(e, a) > 0$. Output is weakly concave in effort: $f_{ee}(e, a) \leq 0$. While output is generally a stochastic function of effort and ability, we simply suppress this since the landlord and tenants are risk-neutral. That is, all results in this paper can be interpreted as expected values.

⁵Note that we have assumed that the cost of effort does not depend on ability. The model can be easily generalized assuming that more able laborers have lower cost and lower marginal cost of effort, but this does not lead to any additional insights.

2.2. Efficiency

The social surplus of production is given by

$$s(e, a) = f(e, a) - c(e) - r \quad (2)$$

where r is the reservation utility of the worker and we assume that the reservation utility for the landlord is zero.⁶ The socially efficient levels of effort and production are given by the optimization problem

$$\max_e s(e, a) \quad (3)$$

subject to the non-negativity constraint for e . Since $f_e(0, a) > c_e(0) = 0$, the solution for e is interior. The social optimum e^* is uniquely defined by

$$f_e(e^*, a) = c_e(e^*) \quad (4)$$

Note that in general e^* is a function of a , which we make explicit by writing $e^*(a)$ when this is helpful. In the special case where $f_{ea}(e, a) = 0$, e^* does not depend on a . That the maximum social surplus of production is increasing in ability follows directly from the envelope theorem

$$\frac{ds(e^*, a)}{da} = f_a(e^*, a) > 0 \quad (5)$$

⁶We assume that the reservation utility is independent of ability. This assumption can be somewhat relaxed without any consequences. In section 3.4 we show that the participation constraint is only binding for the tenant with the lowest ability. As long as the reservation utility does not increase ‘too much’ with ability the participation constraint will still only bind for the tenant with the lowest ability.

3. Optimal Contract Choice

3.1. Observable effort and ability

To explain the workings of the model and introduce some additional notation, we first analyze contract choice in a world where both effort and ability are observed. We then analyze the effect of making effort unobservable and the effect of making ability unobservable. The last step involves combining both effects and characterize the optimal contract when both ability and effort are unobservable. We discuss in detail the optimal pooling solution and the situations under which a pooling solution dominates a separating solution.

When effort, output, and ability are all observable, the share of output going to the tenant is $s_t(y, e, a)$ and the share of output going the landlord is $s_l(y, e, a) = y - s_t(y, e, a)$. We assume that the contract is linear in output and additive separate between output and effort so that

$$s_t(y, e, a) = \alpha + \beta y + \gamma(e) \tag{6}$$

$$s_l(y, e, a) = -\alpha + (1 - \beta) y - \gamma(e) \tag{7}$$

where we have suppressed the dependence of the contract terms α , β , and the function $\gamma(\cdot)$ on ability. A fixed rent contract is given by $\alpha < 0$ and $\beta = 1$, while

a wage contract is $\alpha > 0$ and $\beta = 0$.

The assumption that output and effort are additive separate is useful for heuristic reasons. Furthermore, neither the landlord nor the tenant will be able to do better under a more general contract. In any case, the main part of the paper is the case where effort is unobservable and the contract can no longer depend directly on effort.

Linearity in output is one of the unsolved puzzles in sharecropping. Most theories (including the one presented here) have optimal contracts that are generally non-linear functions of output. We note that in reality contracts are almost always linear in output and we follow a large literature that imposes this restriction.

The utilities of the risk neutral tenant and landlord are respectively given by

$$U_t(\alpha, \beta, \gamma(\cdot), e, a) = s_t(y, e, a) - c(e) = \alpha + \beta f(e, a) + \gamma(e) - c(e) \quad (8)$$

and

$$U_l(\alpha, \beta, \gamma(\cdot), e, a) = s_l(y, e, a) = -\alpha + (1 - \beta) f(e, a) - \gamma(e) \quad (9)$$

The optimization problem for the landlord designing a contract for a particular tenant is

$$\max_{\alpha, \beta, \gamma(\cdot), e} U_l(\alpha, \beta, \gamma(\cdot), e, a) = -\alpha + (1 - \beta) f(e, a) - \gamma(e) \quad (10)$$

subject to the participation constraint

$$U_t(\alpha, \beta, \gamma(\cdot), e, a) = \alpha + \beta f(e, a) + \gamma(e) - c(e) \geq r \quad (11)$$

where r is the reservation utility of the tenant.⁷ The participation constraint will be binding and effort will be set to the socially efficient level: $e = e^*$. The contract is indeterminate and the contract terms α , β , and $\gamma(\cdot)$ can depend on ability. However, the terms have to satisfy

$$\alpha + \beta f(e^*, a) + \gamma(e^*) - c(e^*) = r \quad (12)$$

The landlord is able to obtain the maximum social surplus of the contract:

$$\begin{aligned} U_l^*(\alpha, \beta, e, a) &= -\alpha + (1 - \beta) f(e^*, a) - \gamma(e^*) \\ &= \beta f(e^*, a) + \gamma(e^*) - c(e^*) - r + (1 - \beta) f(e^*, a) - \gamma(e^*) \\ &= f(e^*, a) - c(e^*) - r \\ &= s(e^*, a) \end{aligned} \quad (13)$$

⁷Note that this formulation assumes that the landlord holds all the bargaining power and can push the tenant down to his reservation utility.

We note that in this framework share contracts can also be obtained as bargaining outcomes. Assume that there is a surplus of available laborers and that \bar{a} is the marginal laborer such that all laborers with $a > \bar{a}$ get a contract while laborers with $a \leq \bar{a}$ do not get a contract. Then the outside option for the landlord is only $s(e^*, \bar{a}) - r$. The tenant of ability $a > \bar{a}$ does have some power to negotiate contracts with a utility higher than r . Share contracts might be viewed as easily implementable, straightforward bargaining outcomes. Commonly observed shares of $\frac{1}{2}$ could be considered ‘fair’ and become focal points.

3.2. Unobservable ability and observable effort.

When ability is unobservable the contract terms α , β , and $\gamma(\cdot)$ can no longer depend on the level of ability. Moreover, the landlord can not simply specify the level of effort since the optimal level will usually depend on the unobserved ability. The landlord, however, can specify an effort function $e(a_c)$, where a_c is the ability level that the tenant claims to be. But because ability is unobserved, the landlord faces the additional incentive constraint that the tenant weakly prefers to claim to have ability a_c rather than any other ability.

Assume that all tenants are offered the same contract. The landlord now chooses the contract terms to maximize the expected value of the profit ⁸

$$\begin{aligned} \max_{\alpha, \beta, \gamma(\cdot), e(\cdot), a_c} E \{U_t(\alpha, \beta, \gamma(\cdot), e(a_c), a)\} = \\ \max_{\alpha, \beta, \gamma(\cdot), e(\cdot), a_c} E \{-\alpha + (1 - \beta) f(e(a_c), a) - \gamma(e(a_c))\} \end{aligned} \quad (14)$$

subject to the participation constraint

$$\begin{aligned} U_t(\alpha, \beta, \gamma(\cdot), e(a_c), a) = \\ \alpha + \beta f(e(a_c), a) + \gamma(e(a_c)) - c(e(a_c)) \geq r \quad \text{for all } a \end{aligned} \quad (15)$$

⁸The landlord maximizes $\sum_{i=1}^N s_i(y, e, a)$ or equivalently $\frac{1}{N} \sum_{i=1}^N s_i(y, e, a) = E \{s_i(y, e, a)\}$.

and the incentive constraint

$$\begin{aligned} \alpha + \beta f(e(a_c), a) + \gamma(e(a_c)) - c(e(a_c)) &\geq \\ \alpha + \beta f(e(\bar{a}), a) + \gamma(e(\bar{a})) - c(e(\bar{a})) &\quad \text{for all } \bar{a} \end{aligned} \quad (16)$$

The solution is again straightforward. Set $a_c = a$, $e(a_c) = e^*(a)$, $\beta = 0$, $\alpha = r$, and $\gamma(e) = c(e)$. That is, the optimal contract is a wage contract with full compensation for applied effort. Whatever level of ability he claims to be, the tenant is exactly pushed down to their reservation utility, and is therefore indifferent between revealing his true ability and claiming to be of any other ability.

The landlord gets the expected maximum social surplus of the contract:

$$\begin{aligned} E\{U_l^*(\alpha, \beta, \gamma(\cdot), e(a_c), a)\} &= E\{-\alpha + (1 - \beta)f(e^*, a) - \gamma(e^*)\} \\ &= E\{-r + f(e^*, a) - \gamma(e^*)\} \\ &= E\{s(e^*, a)\} \end{aligned} \quad (17)$$

Since all workers are brought down to their reservation utility and socially efficient production is achieved there is no need for screening. The landlord can not do any better by designing a menu of contracts from which the tenant can choose.

We stress again that this section describes the crucial insight in this paper. When ability is unobservable a monopolistic landlord optimally and completely extracts the surplus due to ability by offering the tenant a wage contract. A share or rent contract which does not depend on ability leaves some of the surplus in the hands of the tenants.

3.3. Unobservable effort and observable ability.

It is of course well known that moral hazard problems on the tenant's side argue for fixed rent contracts. Under moral hazard the effort levels are not observable and the contract becomes

$$s_t(y, a) = \alpha + \beta y \tag{18}$$

$$s_l(y, a) = -\alpha + (1 - \beta) y \tag{19}$$

The utility of the contract becomes

$$U_t(\alpha, \beta, e, a) = \alpha + \beta f(e, a) - c(e) \tag{20}$$

$$U_l(\alpha, \beta, e, a) = -\alpha + (1 - \beta) f(e, a) \tag{21}$$

Since effort is unobservable the tenant will choose effort according to

$$\max_e U_t(\alpha, \beta, e, a) \quad (22)$$

so that⁹

$$\beta f_e(e, a) = c_e(e) \quad (23)$$

The landlord chooses the contract terms according to

$$\max_{\alpha, \beta, e} U_l(\alpha, \beta, e, a) = -\alpha + (1 - \beta) f(e, a) \quad (24)$$

subject to the incentive constraint (23) and the participation constraint

$$U_t(\alpha, \beta, e, a) = \alpha + \beta f(e, a) - c(e) \geq r \quad (25)$$

Note that the contract terms α and β can be functions of ability. Productive efficiency is obtained by setting $\beta = 1$, which encourages the tenant to set $e = e^*$.

The tenant is pushed down to reservation utility by setting

$$\alpha(a) = r + c(e^*(a)) - f(e^*(a), a) \quad (26)$$

The optimal contract is a fixed rent contract with the rent being a function of ability. The landlord gets the maximum social surplus of the contract:

$$U_l(\alpha, \beta, e, a) = -\alpha + (1 - \beta) f(e, a)$$

⁹The assumption that $c_e(0) = 0$ is convenient here, because the first order conditions are correct even for the boundary solution: $e = 0$ when $\beta = 0$.

$$\begin{aligned}
&= f(e^*, a) - c(e^*) - r \\
&= s(e^*, a)
\end{aligned} \tag{27}$$

3.4. Optimal Pooling Equilibrium with Unobservable Effort and Ability

We are now in a position to combine the two main issues. Moral hazard argues for a fixed rent contract. But extraction of surpluses due to unobserved ability argues for a fixed wage contract. The share contract is a compromise between these two forces.

The moral hazard issue imposes the incentive constraint (23) repeated here for convenience

$$\beta f_e(e, a) = c_e(e) \tag{28}$$

In a pooling equilibrium the landlord chooses

$$\max_{\alpha, \beta, e(a)} E \{U_l(\alpha, \beta, e, a)\} = E \{-\alpha + (1 - \beta) f(e, a)\} \tag{29}$$

subject to the incentive constraint (23) and the participation constraint

$$U_t(\alpha, \beta, e, a) = \alpha + \beta f(e, a) - c(e) \geq r \text{ for all } a \tag{30}$$

The incentive constraint defines the effort level as a function of share β and

ability a . We denote this by $e = e(\beta, a)$, with $e_\beta > 0$.¹⁰ The participation constraint will be binding for the tenant with the lowest ability since

$$\begin{aligned}
\frac{dU_t(\alpha, \beta, e, a)}{da} &= \frac{d[\alpha + \beta f(e, a) - c(e)]}{da} \\
&= \{\beta f_e(e, a) - c_e(e)\} \frac{de}{da} + \beta f_a(e, a) \\
&= \beta f_a(e, a) \geq 0
\end{aligned} \tag{31}$$

Note that, unless $\beta = 0$, the participation constraint is not binding for tenants with ability larger than zero, that is, high ability workers are not pushed down to their reservation utility. The participation constraint can be solved for α

$$\alpha = r + c(e(\beta, 0)) - \beta f(e(\beta, 0), 0) \tag{32}$$

and the optimization problem for the landlord becomes

$$\begin{aligned}
\max_{\beta} U_l(\alpha(\beta), \beta, e(\beta, a), a) = \\
-r - c(e(\beta, 0)) + \beta f(e(\beta, 0), 0) + (1 - \beta) E\{f(e(\beta, a), a)\}
\end{aligned} \tag{33}$$

¹⁰Totally differentiating the incentive constraint

$$d\beta f_e(e, a) + \beta f_{ee}(e, a) de = c_{ee}(e) de$$

gives

$$\frac{de}{d\beta} = \frac{f_e(e, a)}{c_{ee}(e) - \beta f_{ee}(e, a)} > 0$$

Differentiation of the objective function $U_l(\alpha(\beta), \beta, e(\beta, a), a)$ with respect to β

:

$$\begin{aligned}
& \frac{d[U_l(\alpha(\beta), \beta, e(\beta, a), a)]}{d\beta} & (34) \\
& = -c_e(e(\beta, 0))e_\beta(\beta, 0) + f(e(\beta, 0), 0) + \beta f_e(e(\beta, 0), 0)e_\beta(\beta, 0) \\
& \quad - E\{f(e(\beta, a), a)\} + (1 - \beta)E\{f_e(e(\beta, a), a)e_\beta(\beta, a)\} \\
& = f(e(\beta, 0), 0) - E\{f(e(\beta, a), a)\} + (1 - \beta)E\{f_e(e(\beta, a), a)e_\beta(\beta, a)\} \\
& = (1 - \beta)E\{f_e(e(\beta, a), a)e_\beta(\beta, a)\} - \{E\{f(e(\beta, a), a)\} - f(e(\beta, 0), 0)\}
\end{aligned}$$

where we have used the incentive constraint for the lowest ability worker $\beta f_e(e(\beta, 0), 0) = c_e(e(\beta, 0))$. This directly shows the two effects of a change in β . The first effect is that an increase in β increases the effort of the tenant, which in turn increases the output, thus resulting in a marginal benefit of $(1 - \beta)E\{f_e(e(\beta, a), a)e_\beta(\beta, a)\}$. The second effect is that an increase in β (combined with a decrease in α) directly leads to a lower share of total output for the landlord, thus resulting in a marginal cost of $\{E\{f(e(\beta, a), a)\} - f(e(\beta, 0), 0)\}$.

The main result of the paper is contained in the following theorem.

Theorem 1. *A landlord maximizing (29) subject to (23) and (30) will choose either a wage contract or a share contract. If the landlord chooses a wage contract*

then

$$E \{f_e(0, a) e_\beta(0, a)\} - [E \{f(0, a)\} - f(0, 0)] \leq 0 \quad (35)$$

If the landlord chooses a share contract, the optimal share β^* is characterized by

$$(1 - \beta^*) E \{f_e(e(\beta^*, a), a) e_\beta(\beta^*, a)\} - \{E \{f(e(\beta^*, a), a)\} - f(e(\beta^*, 0), 0)\} = 0 \quad (36)$$

Proof. For the wage contract to be optimal $\left. \frac{d[U_l(\alpha(\beta), \beta, e(\beta, a), a)]}{d\beta} \right|_{\beta=0} \leq 0$ is a necessary condition. When the solution is interior $\left. \frac{d[U_l(\alpha(\beta), \beta, e(\beta, a), a)]}{d\beta} \right|_{\beta^*} = 0$. Finally, a rent contract can never be optimal because

$$\begin{aligned} & \left. \frac{d[U_l(\alpha(\beta), \beta, e(\beta, a), a)]}{d\beta} \right|_{\beta=1} = - \{E \{f(e(1, a), a)\} - f(e(1, 0), 0)\} \\ & = - \{E \{f(e^*(a), a)\} - f(e^*(0), 0)\} \end{aligned} \quad (37)$$

which is strictly negative since $f(e^*(a), a)$ is strictly increasing in a . We refer to the empirical example below, to show that both wage and share contracts are possible obtained as optimal pooling contracts. \square

So far we have assumed that the number of plots and potential tenants is the same. When the landlord has fewer plots than the number of potential workers ($M > N$) it is important for her to screen the tenants so that only the tenants

with highest ability get a contract. This is obtained by making the participation constraint binding for the worker who has just enough ability to get a contract. Since the utility of the contract is increasing in ability, the low ability workers will not accept such a contract. Specifically, when $M > N$ the participation constraint becomes

$$U_t(\alpha, \beta, e, a) = \alpha + \beta f(e, a) - c(e) \geq r \text{ for all } a > \tilde{a} \quad (38)$$

where \tilde{a} is chosen so that the number of tenants with $a > \tilde{a}$ is equal to N . Then

$$\alpha = r + c(e(\beta, \tilde{a})) - \beta f(e(\beta, \tilde{a}), \tilde{a}) \quad (39)$$

and the model can be solved as before.

3.5. A numerical example

To show the optimal contract in a simplified setting consider

$$f(e, a) = e + a \quad (40)$$

$$c(e) = \frac{1}{2}e^2 \quad (41)$$

and we assume that a is uniformly distributed over the interval $[0, 1]$. In a pooling equilibrium the landlord chooses

$$\max_{\alpha, \beta, e(a)} = E \{-\alpha + (1 - \beta)(e + a)\} \quad (42)$$

subject to the incentive constraint

$$e = \beta \tag{43}$$

and the participation constraint

$$\alpha + \beta(e + a) - \frac{1}{2}e^2 \geq r \text{ for all } a \tag{44}$$

After simplification we find

$$\max_{\beta} -r + \frac{1}{2} + \frac{1}{2}\beta(1 - \beta) \tag{45}$$

so that the optimal contract is a share contract with $\beta = \frac{1}{2}$, and $e = \frac{1}{2}$, $\alpha = r - \frac{1}{8}$.

To obtain the wage contract as an optimal solution we change the example to make the surplus extraction issue more prominent. Now

$$f(e, a) = e + 3a \tag{46}$$

with the same cost function $c(e) = \frac{1}{2}e^2$ as before and ability still uniformly distributed over the interval $[0, 1]$. The incentive constraint and the participation constraint for the tenant with lowest ability are the same as before so that the landlord's optimization problem simplifies to

$$\max_{\beta} -r - \frac{1}{2}\beta^2 + \beta^2 + (1 - \beta) E(\beta + 3a) = -r + \frac{3}{2} - \frac{1}{2}\beta^2 - \frac{1}{2}\beta \tag{47}$$

which is maximized by setting β as small as possible, so that the wage contract is optimal.

3.6. Pooling or separation?

The observant reader will have noticed that the pooling solution does not seem to be optimal. Why does the landlord not try to separate the tenants by offering a menu of contracts? For instance, consider an optimal pooling contract (α^*, β^*) . Now suppose that the landlord offers an additional rent contract $(\alpha_h, 1)$ designed for the tenants with the highest ability a_h . If $(\alpha_h, 1)$ is such that $U_t(\alpha^*, \beta^*, e(\beta^*, a_h), a_h) = U_t(\alpha_h, 1, e(1, a_h), a_h)$ the high ability tenant is willing to accept this contract. Tenants with lower ability, $a < a_h$, will not accept this contract. The landlord will pocket the efficiency gain from providing the high ability tenants with the correct incentives.

A simple, but powerful, argument against the possibility of a separation solution is that it is often difficult and costly for the landlord to monitor transfers of inputs or output from one tenant to another. In this case when shares vary across tenants, they have a strong incentive to transfer inputs and output from a tenant who receives a low share to a tenant who receives a high share.

A second situation where the separation solution might not be feasible is in a repeated game setting. Suppose that the game is repeated for a finite number of periods, the separation will of course appear in the final period. But for earlier periods the worker will have an incentive to hide his ability, since revealing it

will push his utility in future periods to his reservation utility. A full analysis of repeated games is beyond the scope of this article, but in the appendix we show for a simple two period game that pooling dominates separation in the first period.

A third situation which can preclude the separation solution is when the landlord is boundedly rational (e.g., Simon, 1981). While bounded rationality is hard to model, it seems that the pooling solution requires lower calculating skills than the separating solution. In particular, the pooling solution requires only that the landlord can optimize over only two parameters, α and β , while in a separating solution the number of parameters is 2 times the number of contracts offered.

A fourth argument is unusual and requires a lengthier explanation and justification. Assume that the tenancy contracts has an explicit or implicit ‘escape clause’. Many written contracts in the real world contain clauses that allow one or both of the parties to opt out of the contract. For instance, apartment rent contracts often contain a clause that the tenant can cancel the contract without reason upon payment of a penalty. Of course, the existence of an escape clause is presumably endogenously determined. In particular, one would expect these clauses to exist in situations where unusual and unforeseen circumstances would

lead to high inefficiencies.¹¹ Whether such escape clauses are widely used in this setting is an empirical question, which has not been addressed as far as we know. Since many share, wage, and rental contracts are not written down, it is not easy to assess the empirical relevance.¹² Often opting out of the contract involves a cost to the party that wants out, and it is reasonable to assume that the cost of opting out increases gradually with the progress of the production season. If the cost of using the escape clause is small directly after the signing of the contract, the high ability tenant will not accept a separating menu of contracts. The reason is that upon learning the ability of the tenant, the landlord will use the escape clause to tear up the contract, and negotiate another contract that pushes the tenant down to his reservation utility.¹³

A fifth argument considers the poor legal structures that typically exist in the village economies that we have in mind. In the extreme case, workers are completely unable to enforce contracts through a court system (which does not seem unreasonable in many village economies). In this case, the landlord will only honor the contract if it is self-enforcing. A landlord without a reputation to honor

¹¹Another solution, renegotiating the contract, might ex ante not be ideal when the unforeseen circumstances leave one of the parties in a weak bargaining situation.

¹²Even in the US many contracts are oral contracts. See Allen and Lueck (1992).

¹³Note that production uncertainty makes it necessary for any worker to commit to a single contract before the production season starts. If not, he would choose ex post a wage contract when production is poor and a rent contract when production is high.

contracts will only be able to attract wage labor where the wage is paid at the time that labor is being provided. Any contract that promises the laborer a share of output will be broken after the production season is completed. A landlord has thus a strong incentive to establish a reputation for honoring contracts. We do not attempt a full game theoretic analysis of reputation, but it seems clear that it is much easier for the landlord to establish such a reputation if everyone in the village has the same contract, than when everyone has a unique contract, particular when the ex post output and shares are easily observable within the community while contracts are not.

4. Policy implications

The implications of this model for public policy are strikingly different from almost all other theories of sharecropping. In this model the landlord and tenant are ‘bargaining’ over the surplus of the contract. The solution to this conflict leads to inefficiency because of the moral hazard problem. Suppose that the government makes share contracts illegal. The landlord has two choices: offer a wage contract or offer a fixed rent contract.

When moral hazard problems are small relative to the unobserved ability issue, the landlord will choose to offer a wage contract. As a consequence productive

efficiency and the social surplus decrease. The utility of all workers except those of the lowest ability will decrease because they will be pushed to their reservation utility. The landlord is necessarily worse off as well since he could have chosen the fixed wage contract in the first place and didn't do so.

However, in a situation where moral hazard problems are severe (for instance when the landlord is located outside the village) the fixed rent contract will be chosen. This has two consequences: productive efficiency is obtained and there is redistribution from the landlord to the tenant.¹⁴

Interestingly, this is exactly what several governments in the past have argued when they made share contracts illegal. These government policies have received great criticism from economists who argued, based on previous theoretical models (in particular the residual claimant models mentioned in the introduction), that share contracts are serving useful functions such as risk sharing even when productive efficiency was not reached. For instance, Brandão and Feder (1995) say that “prohibitions on sharecropping in agriculture should be completely eliminated since ... they ... may lead to reduced efficiency in agriculture because of

¹⁴This depends on the landlord being unable to commit to leave the land unused (that is, there is no renegotiation possible). If the landlord can leave some of the land unused, he will charge a monopoly rent so that some of the tenants that previously worked on shares would now not be able to obtain a contract. The policy might in this case be supplemented by an additional land distribution policy that takes unused land from the landowners and distributes it among potential tenants.

risk and supervision requirements.” (page 201). Indeed, in most other theories of sharecropping government interventions (and particularly prohibiting the use of share contracts) are detrimental to the welfare of society. Our model implies that this need not always be true.

5. Concluding remarks

In this paper we revisit the issue of unobserved ability in the context of land tenancy contracts and combine this with a problem of unobserved effort. In previous theoretical work signaling and screening took a prominent place when theorizing about the effects of unobserved ability. We argue that, at least in certain situations, separating solutions are impossible and only pooling will be observed. (This implies that our theory, unlike the screening and the residual claimant theories, can explain the stylized fact that share contracts are remarkably uniform within a region).

The central insight in this paper is that if ability is unobserved, a monopolistic landlord will offer the worker a wage contract. This is combined with a standard moral hazard problem which argues for a rent contract. The combination of both unobserved effort and ability makes it necessary for the landlord to compromise between the two issues and offer a share contract.

We note that both unobserved effort and unobserved ability by themselves do not give the worker power in the contract negotiations with the landlord, as the worker will be pushed down to his reservation utility in either case. However, the combination of unobserved ability and unobserved effort does give the worker bargaining power and the share contract will result in a utility above reservation utility for every worker except the least able one.

Many economists have criticised government intervention in land tenancy markets and especially the ban on share contracts, with the more ingenuous positions reminding one of the philosopher Pangloss in Voltaire's *Candide*: "for as all things have been created for some end, they must necessarily be created for the best end." In our model, the conflict between the landlord and the tenant over the surplus of the contract leads to productive inefficiency and banning the use of share contracts has, under certain conditions, beneficial social welfare effects.

Appendix A. A two-period game

In this section we show that if the game is repeated in two periods, pooling in the first period might dominate separation.

Consider the production function $f(e, a) = e + a$, the cost function $c(e) = \frac{1}{2}e^2$, and a reservation utility $r = 0$. Tenants can be of two types each with probability

equal to a half. High ability tenants have ability $a = 1$, while low ability tenants have ability $a = 0$. The game is a two period game, where each period game is identical to the game outlined in the text. That is, the landlord offers a contract or menu of contracts at the start of each period. The tenant can accept one of the contracts that is offered or reject to take any contract. If the landlord learns the type of the tenant in the first period, the contract that he offers in the second period can depend on the type of the tenant. We assume that the environment is so uncertain that the landlord does not learn anything about the ability of the tenant from observing output.

The landlord has two distinct options. He can offer a pooling contract in the first period and a menu of separating contracts in the second period. The other option is to offer a menu of separating contracts in the first period and a type-specific contract in the second period. We start with discussing the first option.

If the landlord offers a pooling contract in the first period and a menu of separating contract in the second period, it is clear that the pooling contract will be the same as the one period optimal pooling contract that is discussed in the text, while the menu of separating contracts will be the same as a one period optimal menu as discussed in Muthoo (1998). The pooling contract in the first

period closely follows the numerical example in the text and we just note here that the $\alpha = -\frac{1}{8}$, $\beta = \frac{1}{2}$, $e = \frac{1}{2}$. The utility of the low ability tenant is equal to 0 and the utility of the high ability tenant is equal to $\frac{1}{2}$. The landlord receives a utility of $\frac{3}{8}$ on a low ability tenant and a utility of $\frac{7}{8}$ on a high ability tenant, so that the expected value of his utility in the first period is $\frac{5}{8}$.

In the second period, the landlord offers a contract (α_l, β_l) designed for the low ability tenants, and a contract (α_h, β_h) designed for the high ability tenants. The moral hazard problem ensures that $e_l = \beta_l$, and $e_h = \beta_h$. Following standard arguments in the screening literature, the participation constraint will bind for the low ability tenants

$$\alpha_l + \beta_l e_l - \frac{1}{2} e_l^2 = 0 \tag{A.1}$$

so that $\alpha_l = -\frac{1}{2} \beta_l^2$. Similarly, for the high ability tenants the incentive compatibility constraint will be binding so that

$$\alpha_h + \beta_h (e_h + 1) - \frac{1}{2} e_h^2 = \alpha_l + \beta_l (e_l + 1) - \frac{1}{2} e_l^2 \tag{A.2}$$

and finally, it is straightforward to show that

$$\beta_h = 1 \tag{A.3}$$

The optimization problem for the landlord is

$$\max_{\alpha_h, \beta_h, e_h, \alpha_l, \beta_l, e_l} \frac{1}{2} \{ \alpha_h - (1 - \beta_h) (e_h + 1) \} + \frac{1}{2} \{ \alpha_l - (1 - \beta_l) (e_l) \} \tag{A.4}$$

which reduces to

$$\max_{\beta_l} \frac{3}{4} - \frac{1}{4}\beta_l^2 \tag{A.5}$$

The optimal menu of contractss in the second period is thus $(\alpha_l, \beta_l) = (0, 0)$ and $(\alpha_h, \beta_h) = (-\frac{3}{2}, 1)$. Both the low and high ability tenant receive a utility of 0. The landlord gets a utility of 0 and $\frac{3}{2}$ from respectively the low and high ability tenant. The expected value for the landlord in this period is equal to $\frac{3}{4}$ (which is a little more than what he got from the optimal pooling equilibrium). The total utility for the landlord over both periods (assuming no discounting) is $\frac{5}{8} + \frac{3}{4} = \frac{11}{8}$.

Now consider the option of offering a separating menu of contracts in the first period. Given that the landlord learns the type of the tenant, the second period is straightforward: $\beta_l = \beta_h = 1$, $\alpha_l = -\frac{1}{2}$, $\alpha_h = -\frac{3}{2}$. Both low and high ability types receive a utility of 0 in the second period. The landlord receives a utility of $\frac{1}{2}$ and $\frac{3}{2}$ from respectively the low and high ability types. Expected value for the landlord in this period is equal to 1.

In the first period the optimal separating equilibrium is similar to the one analyzed above with the exception that the incentive compatability constraints must take into account that the tenant will receive a contract in the second period based on the type that he signals in the first period. That is, for the low ability tenant accepting contract (α_l, β_l) results in second period utility $\alpha_l + \beta_l e_l - \frac{1}{2}e_l^2 =$

$-\frac{1}{2} + 1 - \frac{1}{2} = 0$ and accepting contract (α_h, β_h) results in second period utility $\alpha_h + \beta_h e_h - \frac{1}{2}e_h^2 = -\frac{3}{2} + 1 - \frac{1}{2} = -1$. Similarly, for the high ability tenant accepting contract (α_l, β_l) results in second period utility $\alpha_l + \beta_l (e_l + 1) - \frac{1}{2}e_l^2 = -\frac{1}{2} + 2 - \frac{1}{2} = 1$ and accepting contract (α_h, β_h) results in second period utility $\alpha_h + \beta_h (e_h + 1) - \frac{1}{2}e_h^2 = -\frac{3}{2} + 2 - \frac{1}{2} = 0$.

The maximization problem for the landlord is then

$$\max_{\alpha_h, \beta_h, e_h, \alpha_l, \beta_l, e_l} \frac{1}{2} \{-\alpha_h + (1 - \beta_h)(e_h + 1)\} + \frac{1}{2} \{-\alpha_l + (1 - \beta_l)(e_l)\}$$

subject to the participation constraints

$$\alpha_h + \beta_h (e_h + 1) - \frac{1}{2}e_h^2 \geq 0 \tag{A.6}$$

$$\alpha_l + \beta_l (e_l + 0) - \frac{1}{2}e_l^2 \geq 0 \tag{A.7}$$

the two incentive compatibility constraints

$$\alpha_h + \beta_h (e_h + 1) - \frac{1}{2}e_h^2 + 0 \geq \alpha_l + \beta_l (e_l + 1) - \frac{1}{2}e_l^2 + 1 \tag{A.8}$$

$$\alpha_l + \beta_l (e_l + 0) - \frac{1}{2}e_l^2 + 0 \geq \alpha_h + \beta_h (e_h + 0) - \frac{1}{2}e_h^2 - 1 \tag{A.9}$$

and finally the other incentive constraints

$$e_h = \beta_h \tag{A.10}$$

$$e_l = \beta_l \tag{A.11}$$

As usual (A.7), and (A.8) are binding and $\beta_h = 1$. The maximization problem for the landlord reduces to

$$\max_{\beta_l} -\frac{1}{4}\beta_l^2 + \frac{1}{4} \tag{A.12}$$

so that $\beta_l = 0$. The menu of contract is $(\alpha_l, \beta_l) = (0, 0)$ and $(\alpha_h, \beta_h) = (-\frac{1}{2}, 1)$.

The low and high ability tenants get utilities of 0 and 1 respectively. The landlord gets a utility of 0 and $\frac{1}{2}$ from respectively the low and high ability tenant, so that his expected utility in this period is $\frac{1}{4}$. The total expected utility of the landlord in the two periods is $\frac{1}{4} + 1 = \frac{5}{4} = \frac{10}{8}$ which is $\frac{1}{8}$ less than what he receives if he first uses a pooling equilibrium.

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