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1. Introduction

Land tenure contracts in agriculture typically take three stylized forms - (1) a wage contract where the land is cultivated by the land owner with hired labor; this contract takes the form of a fixed payment from the landlord to the tenant on the basis of previously determined hourly or daily wage rate; and two types of land lease contracts namely (2) a rental contract where the landlord leases out the land to the tenant and in turn asks for a fixed rental payment; and (3) a share-cropping contract in which the landlord leases out the land to the tenant as well and instead of a fixed monetary amount, asks for a fraction of the output in payment. There are actually two separate questions that are raised in the context of rural land tenure contracts. First of all why do share-cropping contracts arise and persist over time? This question is interesting because while both a rental and a wage contract could ensure Pareto efficient resource allocation, a share-cropping contract, on the face of it, is analogous to a proportional tax, and therefore it should distort incentives to provide effort and other inputs into the production process. The second interesting question is the issue of co-existence of multiple contracts, not only in proximity to each other but sometimes in adjoining plots of land in the same village. Shaban (1987) in his study of 8 villages in India finds the co-existence of all three contractual forms within the same village.

Nor is interest in these issues confined to tenurial contracts in agriculture. Similar issues arise in other areas as well, such as licensing and franchising. In various types of franchising arrangements, most notably business format franchising, one observes the use of franchise fees which are similar to rental payments and/or royalty rates which are akin to sharing (which could refer to output, profit, revenue etc.) and often a mixture of the two

where the franchisor asks the franchisee for a up-front franchise fee as well as a royalty rate.

See for instance Mathewson and Winter (1985), Lal (1990), Lafontaine (1992, 1993), Bhattacharya and Lafontaine (1995) for discussions on the co-existence of multiple contracts as well as the frequent occurrence of revenue sharing arrangements in franchising.

In terms of agricultural contracts, there exists a large body of literature which tries to address the questions which arise in this context. Stiglitz (1974), Newbery (1977), Newbery and Stiglitz (1979), Hallagan, (1978), Allen (1982, 1985), Eswaran and Kotwal (1985) are some of the notable papers which try to explain the rise of share-cropping and the co-existence of multiple contracts in agriculture. One of the major strands in this literature are the “screening” models. It is argued that output depends on not only the amount of labor hours put in but on the intensity of effort. Many of these models combine moral hazard with adverse selection by assuming that the landlord is imperfectly informed about the true quality of the worker. Thus low quality workers can pose as high quality ones or vice versa. It has been argued that this problem can be solved by landlords through offering a menu of contracts. The workers will then choose the contract that is optimal for them and thereby reveal their true types through their choice of contracts. The story is similar to Spence’s (1973) paper on job market signaling.

However all of the existing literature suffers from the flaw that the models are all one-shot games and therefore many of the results that they develop fail to hold if we allow for the possibility of re-negotiation between the landlord and the tenant. As Holmstrom (1982b) points out “time should have a beneficial impact on policing moral hazard, because it permits a longer series of observations and thereby more accurate inferences about unobservable behavior.”

In this paper I model the interaction between the landlord and then tenant as a principal agent problem. I make the realistic assumption that the landlord possesses monopsonistic power and is interested in maximizing her own pay-off and wishes to choose a contract which will extract the maximum possible surplus from the tenant, driving him down to his reservation utility.

(In the rest of the paper, the landlord will be referred to as “she” and the tenant as “he” to avoid confusion) I assume that the landlord can observe the effort exerted by the tenant. The landlord does not know the true type of the tenant but has a prior distribution over the same. A contract will consist of a compensation scheme and an effort level that the landlord will offer to the tenant. I develop a dynamic model where I will show (1) how a share-cropping contract can arise and can in fact dominate the other two contracts in equilibrium; and (2) how multiple contracts can co-exist on land owned by the same land-owner.

Section 2 sets up the model. Section 3 discusses the static problem while I address the dynamic problem in Section 4. Section 5 concludes.

2 Model

We will set up the problem as a principal agent model. We will assume that the landlord (principal) is risk neutral while the tenant (agent) is risk averse. (In the rest of the paper, I will use the words landlord (tenant) and principal (agent) interchangeably).

Let there be a finite set Θ of productivity parameters such that the agent is characterized by an element $\theta \in \Theta$ and θ can take two values a high value θ_H and a low value θ_L . A higher value of θ signifies a higher productivity level.

The principal cannot observe θ but has prior beliefs over the distribution of the parameter - of the form $\Pr\{\theta=\theta_H\} = p$ and $\Pr\{\theta=\theta_L\} = 1-p$. We rationalize these priors by assuming that the principal knows that the proportion of the two types of the worker in the population are distributed in this manner.

Output “ f ” is a function of the effort exerted by the agent such that $f=f(e)$ with $f_e > 0$, $f_{ee} < 0$; $f(0) = 0$; $f_e(0) = \infty$ and $f_e(\infty) = 0$.

Effort has a disutility “ V ” associated with it and this disutility is a function of the effort level and the workers productivity such that $V=V(e,\theta)$. We make the following assumptions about the function V : $V_e > 0$; $V_{ee} > 0$ and for any e^* , $V(e^*,\theta_H) < V(e^*,\theta_L)$, i.e. if both types of the agent exert the same effort, then the high productivity type has a lower disutility than the low productivity type. So the disutility function for the high productivity agent lies below the disutility function of the low productivity everywhere except at zero. Also $V(0) = 0$, $V_e(0) = 0$ and $V_e(\infty) = \infty$.

A contract is a pair $[w(f(e^*)), e^*]$ such that $w(f(e^*))$ is an output sharing rule between the principal and the agent and e^* is the effort level that the principal specifies for the agent. In our model the landlord is interested in extracting the maximum possible surplus from the agent and therefore wishes to choose an effort level and a contract form which gives her the maximum monetary pay-off and drives the tenant down to his reservation utility level.

We normalize the agent’s reservation utility to zero.

Without loss of generality the optimal sharing rule can be represented by a linear contract of the form $\alpha + (1-\beta)*f(e)$ where α is a fixed payment from the agent to the principal and β is the share of the output that the tenant gets, leaving $(1-\beta)$ for the principal. Bhattacharya and Lafontaine (1995) provide an easy and intuitive proof of this proposition

in the appendix to their paper. Holmstrom and Milgrom (1987) provide a more general proof on the optimality of linear contracts. So one can substitute more complicated output sharing rules with simple linear contracts. Also most contracts observed in practice in tenurial contracts or franchise payments tend to take simple linear forms.

For our purposes then we will use linear contracts of the form $\alpha + (1-\beta)f(e)$ such that

- if $\beta = 1$, and $\alpha > 0$ we have a rental contract with a fixed payment from the tenant to the landlord; In this case the tenant is the residual claimant after making the fixed rental payment.
- if $\beta = 0$, and $\alpha < 0$ then we have a wage contract with a fixed payment from the landlord to the tenant. In this case the landlord is the residual claimant.
- if $\alpha = 0$ and $0 < \beta < 1$, then we have a share-cropping contract.

We will confine ourselves to these three pure contract forms in our present discussion and ignore cases with both fixed payments and output sharing.

The landlord's action consists of a choice of one contract "C" out a set of three contracts Wage (W), Rent (R), and Share (S) and a real number γ associated with each contract which specifies the monetary payment to be made under any given contract. A strategy for the landlord then is a 2-tuple $\{C, \gamma\} \in \{W, R, S\} \times \mathbf{R}^1$. Strategy for the tenant is the choice of an optimal effort level e_i^* where $i = H, L$.

3 The Static Model of Incomplete Information

The general version of the landlord's static maximization of the problem can be

written as

$$(1) \quad \text{Max}_{e, \alpha, \beta} E[\alpha + (1-\beta)f(e)] \text{ subject to}$$

$$(2) \quad -\alpha + \beta f(e) - V(e, \theta_L) \geq 0$$

$$(3) \quad -\alpha + \beta f(e) - V(e, \theta_H) \geq 0$$

(2) and (3) are the individual rationality conditions for the two types of the agent. Since we assume that the effort is observable, we do not need to write any incentive compatibility conditions. Now it is clear that we can get rid of constraint (3) because if (2) is satisfied then so is (3) given our assumptions about the function V . Thus the landlord can make the low productivity agent's participation constraint binding.

So we can rewrite the landlord's problem as

$$(5) \quad \text{Max}_{e, \alpha, \beta} E[\alpha + (1-\beta)f(e)] \text{ subject to}$$

$$(2) \quad -\alpha + \beta f(e) - V(e, \theta_L) \geq 0$$

such that (2) is now the individual rationality condition of the low productivity agent.

Let us define two critical values e_L^* and e_H^* such that

$$(5a) \quad e_i^* = \text{argmax}_e f(e) - V(e, \theta_i) \quad \text{where } i = H, L.$$

So the optimal effort level for the low (high) productivity agent is e_L^* (e_H^*). These two values will come in handy for our subsequent discussion.

Consider a wage contract first. The landlord cannot distinguish between the two types of the worker and therefore ex-ante announces the same wage rate for the two types.

The landlord's problem can be written as

$$(6) \quad \text{Max}_{e, \alpha} E(f(e)) - \alpha \text{ subject to}$$

$$(7) \quad \alpha - V(e, \theta_L) \geq 0;$$

Let e_L^* solve (6) such that $e_L^* = \text{argmax}_e f(e) - V(e, \theta_L)$ which is the optimal effort level for the

low productivity worker. Then the landlord will set the wage payment $\alpha^* = V(e_L^*, \theta_L)$, which makes the participation constraint for the low productivity agent binding. The low productivity agent exerts effort e_L^* and gets his reservation utility of zero because his pay-off is exactly equal to his disutility of effort. The high productivity worker also exerts low effort because since he gets the same wage payment $V(e_L^*, \theta_L)$, there is no incentive for him to provide high effort. However the high type agent incurs a lower disutility of effort equal to $V(e_L^*, \theta_H)$. So the output produced is $f(e_L^*)$ since both types of the worker produce the same effort e_L^* . The pay-off to the landlord is $\Pi_L = f(e_L^*) - V(e_L^*, \theta_L)$. The pay-off to the low type agent is $\Pi_{TL} = 0$ while the payoff to the high type agent is $\Pi_{TH}^W = V(e_L^*, \theta_L) - V(e_L^*, \theta_H)$.

Next let us look at rental contracts. Under a rental contract the agent is the residual claimant of the output. So the agent has an incentive to provide high effort because he gets to keep the rest of the output after making the rental payment. If the landlord could exactly identify the type of the worker then he would make each type exert their optimal effort e_i^* and extract the entire rent from each type by setting the rent for the each type at $\alpha_i = f(e_i^*) - V(e_i^*, \theta_i)$ where $i = H, L$.

However since the principal cannot ex-ante identify types, so the best she can do is to extract the entire rent for the low productivity type. Since the agent is the residual claimant, so the optimal effort level is chosen by solving the maximization problem for the low productivity agent;

$$(9) \text{Max}_e f(e) - V(e, \theta_L) - \alpha$$

So the answer to this problem is e_L^* again just as in a wage contract. Then the landlord will choose a rental payment of $\alpha = f(e_L^*) - V(e_L^*, \theta_L)$. So the pay-off to the landlord Π_L is the same again $f(e_L^*) - V(e_L^*, \theta_L)$, while the low productivity agent gets the reservation utility of

zero. However as we have noted the high productivity agent solves the problem

$$(10) \quad \text{Max}_e f(e) - V(e, \theta_H) - \alpha.$$

Obviously the solution to this problem is e_H^* which we have defined before. So the high productivity agent exerts a higher effort level than his low productivity counterpart. So the pay-off to the high productivity agent is

$$\Pi_{TH}^R = \{f(e_H^*) - V(e_H^*, \theta_H)\} - \{(f(e_L^*) - V(e_L^*, \theta_L))\}.$$

Finally let us turn to a share-cropping contract. The landlord's maximization problem under a share-cropping contract is

$$(11) \quad \text{Max}_{e, \beta} (1-\beta)*f(e) \quad \text{subject to (2)}$$

Once again it is clear that the solution to this problem is to set $e=e_L^*$ and then set β so as to extract the entire rent from the low productivity agent. So β is equal to $V(e_L^*, \theta_L)/f(e_L^*)$ so that the pay-off to the low productivity agent $\beta*f(e_L^*) - V(e_L^*, \theta_L)$ is equal to zero. However the high type agent's optimal solution is not so clear anymore. He can exert low effort e_L^* and pool with the low productivity agent. The landlord's pay-off then is $\Pi_L=f(e_L^*) - V(e_L^*, \theta_L)$ while the low productivity agent gets zero and the high productivity gets an informational rent which is given by $\Pi_{TH}^S=\{V(e_L^*, \theta_L)/f(e_L^*)\}*f(e_L^*) - V(e_L^*, \theta_H)$.

However given a share contract the high type agent can also exert his optimal effort e_H' , where e_H' is defined as

$$(12) \quad e_H' = \text{argmax}_e \beta*f(e) - V(e, \theta_H)$$

in which case the output produced is $f(e_H')$.

Now if it turns out to be the case that $e_H' < e_L^*$, then the high type has no option but to exert e_L^* as well; so the only interesting case is $e_L^* < e_H' < e_H^*$, which in turn implies that $f(e_L^*) < f(e_H') < f(e_H^*)$ and $V(e_L^*, \theta_H) < V(e_H', \theta_H) < V(e_H^*, \theta_H)$. In a static problem

the high type will choose his optimal effort only if the payoff $\beta^* f(e_H^*) - V(e_H^*, \theta_H)$ exceeds the pay-off from exerting the lower effort e_L^* .

If the high type does exert high effort then the landlord actually gets a much higher pay-off than $\Pi_L = f(e_L^*) - V(e_L^*, \theta_L)$, because given that β is equal to $V(e_L^*, \theta_L)/f(e_L^*)$, with the high type agent exerting high effort the landlord gets $(1-\beta)f(e_H^*)$ which works out to $\{f(e_L^*) - V(e_L^*, \theta_L)\}f(e_H^*)/f(e_L^*)$, which is bigger than $\Pi_L = f(e_L^*) - V(e_L^*, \theta_L)$ since $f(e_H^*) > f(e_L^*)$ because $e_H^* > e_L^*$.

I would like to point out that if the landlord could identify types then she would offer two different contracts to the two types - he would ask each type to exert his optimal effort e_i^* and adjust the share parameter β accordingly to extract the entire rent from both types by setting $\beta_i = V(e_i^*, \theta_i)$ where $i = H, L$. Now we are ready to state the main result that we have derived in this section.

Theorem 1: *So in the static model we can say the following: (1) if a share contract does not lead to the high type exerting his optimal effort then the landlord is indifferent between the three contracts because he gets the same pay-off Π_L and so is the low productivity worker because he gets only his reservation utility. However the high productivity worker gets a different pay-off from different contracts and so chooses a contract according to which of the three numbers Π_{TH}^i (where $i = W, R, S$) is bigger. (2) However if the high type chooses to exert his optimal effort under a share contract then a share contract actually yields the landlord a higher pay-off than the ones she can guarantee herself from the other two contract.*

Theorem 1 then states the same result obtained in Hallagan (1978) and is similar to

results derived in other papers like Allen (1982) where the landlord offers a menu of contracts in a static framework and the tenants self-select themselves through their choice of contracts.

So in a static model the equilibrium always results in separation of types under a rental contract whereas under the a wage contract the equilibrium leads to pooling by both types of the worker who each exert the same effort. Under a share contract the story is slightly more complicated in that the high type agent can either pool with the low type and exert e_L^* ; but on the other hand the high type can separate and exert his optimal effort e_H^* . If the static equilibrium leads to type separation then at the end of the first period the principal can identify the exact type of the agent, and the information that was private at the beginning of the period becomes common knowledge. Once the principal finds out the true type of the agent then in the next period the principal will write down the effort that is optimal for each type and also adjust the contract parameter to extract the entire informational rent from each type.

Now let us turn to the dynamic model. However for the sake of convenience, I would like to introduce some notation at this point.

Let $f(e_L^*)$ be f_L , $f(e_H^*)$ be f_H and $f(e_H^*)$ be f_H . Let $V(e_L^*, \theta_L)$ be V_L , $V(e_H^*, \theta_H)$ be V_H and $V(e_L^*, \theta_H)$ be V_{LH} . Denote by Π the standard one period pay-off that the landlord can guarantee for himself by making the participation constraint for the low type agent binding so that Π is equal to $f_L - V_L$. The high productivity agent gets a rent of $V_L - V_{LH}$ from a wage contract when he exerts effort e_L^* ; the rent $\{(f_H - V_H) - (f_L - V_L)\}$ from a rental contract when he exerts his optimal effort e_H^* , and $\{(V_L/f_L)*f_H - V_M\}$ from a share contract, once again when he exerts his optimal effort.

4 The Dynamic Model

Now suppose two periods exist.¹

Let $p_2(\theta)$ be the posterior belief of the principal regarding the type of the worker based on the tenant's choice of output in the first period. So at the beginning of period 2, the landlord believes that $\Pr\{\theta=\theta_H\} = p_2$ and $\Pr\{\theta=\theta_L\} = 1-p_2$; $p_2 \in [0,1]$. We allow for the possibility that the landlord learns the agent's true type at the end of the first period.

At the start of the first period the landlord chooses a contract and the corresponding payment depending on his prior beliefs p and $1-p$. The tenant responds by choosing an effort level $e_1 \in E$. Then at the beginning of the second period, the landlord updates his prior beliefs, on the basis of the tenant's output choice.

Now if the first period output choice results in a separation of types, in the sense that the two types reveal their true types, then in the second period the principal will choose the contract terms to extract the entire surplus from the agent.

The situation depicted is a two period dynamic game between the landlord and the tenant. Let C denote the contract that is chosen in a period and let γ be the generic symbol for the payment that is to be made under any contract C .

In the dynamic game the landlord's strategy is:

in period 1: pick a 2-tuple $(C, \gamma) \in \{W, R, S\} \times \mathbf{R}^1$;

in period 2: pick a function $\sigma(C, \gamma, e_i; p_2): \{W, R, S\} \times \mathbf{R}^1 \times \mathbf{R}^1 \rightarrow \{W, R, S\} \times \mathbf{R}^1$

The tenant's strategy in the dynamic game, on the other hand, is:

in period 1: pick a function $\xi_i(C, \gamma): \{W, R, S\} \times \mathbf{R}^1 \rightarrow \mathbf{R}^1$

in period 2: pick a function $\zeta_i(\cdot): \{W, R, S\} \times \mathbf{R}^1 \times \mathbf{R}^1 \times \{W, R, S\} \times \mathbf{R}^1 \rightarrow \mathbf{R}^1$

¹ In the two period model superscripts will denote time periods

where $I=H,L$.

An equilibrium outcome then is a 6-tuple $(C^1, \gamma^1, e_i^1, C^2, \gamma^2, e_i^2)$. The equilibrium concept involved is Perfect Bayesian.

The overall pay-off to the landlord is

$$(13) \quad \Pi_L = \Pi_L^1 + \delta \Pi_L^2$$

Similarly the overall pay-off to the tenant is

$$(14) \quad \Pi_{Ti} = \Pi_{Ti}^1 + \delta \Pi_{Ti}^2 \text{ where } i=H,L.$$

where δ is the one period discount factor.

A Perfect Bayesian Equilibrium is a set of (possibly mixed) strategies (C^1, γ^1) , e_i^1 , (C^2, γ^2) , e_i^2 and beliefs p_2 such that the following conditions hold:

1. $\forall \theta$, e_i^2 maximizes the tenant's second period pay-off.
2. (C^2, γ^2) maximizes the landlord's pay-off in period 2 given his beliefs $p_2(\theta, C^1, \gamma^1, e_i^1)$ and the tenant's second period strategy e_i^2 .
3. $\forall \theta$, e_i^1 maximizes Π_i given the second period strategies.
4. (C^1, γ^1) maximizes the expectation of Π_L , given the tenant's and the landlord's subsequent strategies.
5. $p_2(\theta, C^1, \gamma^1, e_i^1)$ is Bayes consistent with the prior probability p and the tenant's first period strategy e_i^1 and observed actions.

Notice from conditions (1) and (2) that the second period actions of the landlord and the tenant are the same as those in the static game of incomplete information, except with the new priors p_2 and $1-p_2$.

Lemma 1: *Under any contractual arrangement, for type θ_L , the effort level chosen is*

both periods is e_L^* .

Proof: As we have seen already the landlord can always make the participation constraint for the low type agent binding and can always get him to exert his optimal effort and ensure that this type always gets zero rent.

Theorem 2: *Under a wage contract the continuation equilibrium at the end of the first period leads to pooling by the two types of the agent.*

Proof: Under a wage contract both types of the agent choose effort level e_L^* . The low type agent has no option because e_L^* is his optimal response and his participation constraint is binding. The high type agent also chooses the same effort level because he gets a lower rent in period 1 if he exerts a higher level of effort and also reveals his true type to the landlord who can then extract his entire surplus in period 2 by designing a suitable contract. However by pooling with the low type agent, the high type agent ensures a rent of $(V_L - V_{LH})$ in period 1. In period 1 the landlord has no new information and therefore has no way of updating her prior beliefs. Thus the contract terms remain unchanged and the high type tenant can again get an informational rent. So a wage contract will lead to a pooling equilibrium.

Proposition 2: *The two-period pay-off to the landlord from a wage contracts is $\Pi + \delta\Pi$.*

Lemma 2: *Under a rental contract, for type θ_H , the first period strategy set has binary support $\{e_H^*, e_L^*\}$*

Proof: Faced with a fixed payment of Π in rent in period 1 the high type of the agent has two options. (1) He can exert high effort and produce output f_H in which case he gets a

first period rent of $[(f_H - V_H) - (f_L - V_L)]$ but at the same time his true type is revealed to the landlord who will extract the entire informational rent in the second period. (2) The high type agent can pool with the low type by exerting the same effort as the low type e_L^* , in which case he gets a lower first period rent $V(e_L^*, \theta_L) - V(e_L^*, \theta_H) = (V_L - V_{LH})$, but his type is not revealed to the landlord. So in the next period the rental payment will remain unchanged because the landlord has no new information and the tenant can get the full informational rent HR. The high productivity worker has no incentive to choose an \underline{e} such that $e_L^* < \underline{e} < e_H^*$, because that gives him a lower pay-off in period one but reveals his true type to the landlord and gets him zero pay-off in period two resulting in a lower inter-temporal pay-off.

Theorem 3: Define a discount factor $\delta_r = \{f_H - f_L - V_H + V_{LH}\} / \{f_H - f_L - V_H + V_L\}^2$ such that

(1) if $\delta < \delta_r$, then the continuation equilibrium is separating in the sense that the high type worker responds with e_H^* and the low type worker responds with e_L^* , in period 1 thereby revealing their types at the end of the period; (2) if $\delta > \delta_r$, then the continuation equilibrium is pooling in the sense that the high type pools with the low type worker by choosing e_L^* in period 1; (3) if $\delta = \delta_r$, then the continuation equilibrium is semi-separating, with the high type mixing between e_H^* and e_L^* in period 1.

Proof: Consider the high type agent - if he exerts his optimal effort then in period one he gets the full informational rent which is $\{(f_H - V_H) - (f_L - V_L)\}$. But his true type is revealed at the end of period one and so he does not get any rent in period two. On the other hand if the high type agent pools with the low type by exerting a first period effort of e_L^* then in

² Note that $V_L > V_{LH}$ since the disutility to the high type from the same effort e_L^* is less than the disutility to the low type; so $\delta_r < 1$.

period one he gets a lower rent of $(V_L - V_{LH})$, but at the same time his type is not revealed to the landlord. Then in period two the landlord has no new information with which to update her prior and therefore the rental payment remains unchanged in which case the agent can get the entire informational rent of $\{(f_H - V_H) - (f_L - V_L)\}$, albeit discounted so that the agent gets $\delta^*\{(f_H - V_H) - (f_L - V_L)\}$. In the event of a pooling equilibrium then the high type agent gets $(V_L - V_{LH}) + \delta^*\{(f_H - V_H) - (f_L - V_L)\}$. If the two pay-offs are equal then the high productivity agent is indifferent between revealing or not revealing his type in period 1. The result follows.

Proposition 3: *In a pooling equilibrium with $\delta > \delta_r$, the landlord fails to separate types and gets the same exact pay-off from rent as under a wage contract $\Pi + \delta\Pi$. However in a separating equilibrium the landlord gets a higher payment because he can set the second period contract terms to extract the entire surplus from both types of the agent. In a separating equilibrium the landlord's pay-off is $\Pi + \delta[p^*(f_H - V_H) + (1-p)^*(f_L - V_L)]$.*

Thus it is clear that in a separating equilibrium the landlord's pay-off from a rental contract will be higher than from a wage contract. So we have proved that if the continuation equilibrium with a rental contract leads to type separation then the principal is better off by choosing a rental contract with the same payment for both types in period one and then in second period offering a rental contract again but with differential rental payments designed to extract the entire surplus from the two types of the agent.

The semi-separating equilibrium is not too interesting for our purposes and so we will focus our attention only on the pooling and the separating equilibria.

Lemma 3: *Under a share-cropping contract, the set of actions available to the high productivity agent has binary support $\{e_H^*, e_L^*\}$.*

Proof: The proof is exactly along the lines of the proof of Lemma 2. The high productivity agent has the option of exerting his optimal effort in period 1 which yields him the full informational rent of $\beta^*f_M - V_M$, but at the same time reveals his type to the principal who then resets the share parameter in period 2, to extract the entire surplus leaving zero rents downstream. On the other hand, the high type worker can choose to pool with the low quality worker, and exert effort e_L^* , in which case he gets a lower rent of $V_L - V_{LH}$, but at the same time his type is not revealed and so he can get the entire informational rent of HS in period 2. Once again, we can exclude any other effort choice by the agent with a similar argument as in Lemma 2.

Theorem 4: Define a discount factor, $\delta_s = \{\beta^*f_M - V_M - V_L + V_{LH}\} / \{\beta^*f_M - V_M\}$, such that (1) if $\delta < \delta_s$, then the continuation equilibrium is separating in the sense that the high type worker responds with e_H' and the low type worker responds with e_L^* , in period 1 thereby revealing their types at the end of the period; (2) if $\delta > \delta_s$, then the continuation equilibrium is pooling in the sense that the high type pools with the low type worker by choosing e_L^* in period 1; (3) if $\delta = \delta_s$, then the continuation equilibrium is semi-separating, with the high type mixing between e_H' and e_L^* in period 1.

Proof: Consider the high type agent - if he exerts his optimal effort then in period one he gets the full informational rent which is $\{\beta^*f_M - V_M\}$. But his true type is revealed at the end of period one and so he does not get any rent in period two. On the other hand if the high type agent pools with the low type by exerting a first period effort of e_L^* then in period one he gets a lower rent of $(V_L - V_{LH})$, but at the same time his type is not revealed to the landlord. Then in period two the landlord has no new information with which to update her

prior and therefore the rental payment remains unchanged in which case the agent can get the entire informational rent albeit discounted so that the agent gets $\delta^*\{\beta^*f_M - V_M\}$. In the event of a pooling equilibrium then the high type agent gets $(V_L - V_{LH}) + \delta^*\{\beta^*f_M - V_M\}$. If the two pay-offs are equal then the high type agent is indifferent between pooling or separating in period 1. The result follows.

So both a rental and a share contract can give rise to a pooling or a separating equilibrium depending on the agent's discount factor δ . Now I am going to show that the discount factor will dictate contract choice under different situations. To do that we need to analyze the relationship between δ_s and δ_r . To better understand that relation between the two discount factors let us look at the expressions for $1 - \delta_s$ and $1 - \delta_r$. Notice that both of these expressions have the same numerator $V_L - V_{LH}$. So all we need to do is to compare the denominator of the two expressions.

The denominator for $1 - \delta_s$ is $\beta^*f_M - V_M$ while the denominator for $1 - \delta_r$ is $f_H - V_H - f_L + V_L$. Ex ante, without imposing other assumptions on the functional forms, it cannot be stated with certainty that one is bigger than the other. So three interesting cases arise:

Case A: $\beta^*f_M - V_M < f_H - V_H - f_L + V_L$ which implies $1 - \delta_s > 1 - \delta_r$ and hence $\delta_s < \delta_r$

Case B: $\beta^*f_M - V_M > f_H - V_H - f_L + V_L$ which implies $1 - \delta_s < 1 - \delta_r$ and hence $\delta_s > \delta_r$

Case C: $\beta^*f_M - V_M = f_H - V_H - f_L + V_L$ which implies $1 - \delta_s = 1 - \delta_r$ and hence $\delta_s = \delta_r$

I will show how these discount factors will act as the driving force in this model in order to explain the co-existence of various contracts. I will first discuss some points before stating the crucial propositions which will show the possibility of contractual co-existence.

Now I have already assumed that the choice of a contract is a strategy for the

principal and she always chooses the contract that will maximize her own pay-off and extract the entire surplus from the agent. I have also proved that while a wage contract leads to a pooling equilibrium, both a rental contract and a share-cropping contract can lead to either a pooling or a separating equilibrium. As I have mentioned before, I will ignore the semi-separating equilibrium for our purposes. This implies that the landlord's two-period pay-off from a rental or share-cropping contract depends on whether the continuation equilibrium is pooling or separating. This then implies that the value of the discount factor will dictate the choice of a contract in equilibrium. We will assume that the discount factor is common knowledge. The agent obviously knows his true discount factor but the principal can infer the discount factor correctly by observing agent characteristics. Such characteristics may include the agent's age, his family size, the length of the tenurial relationship and a host of other factors. I will address this issue again in my concluding remarks.

Under a wage contract the continuation equilibrium is pooling and so the pay-off to the landlord is always $\Pi + \delta\Pi$. This is the best pay-off that the landlord can ensure for herself. However even if the contract chosen in period 1 is a rental contract or a share-cropping contract, if the continuation equilibrium is pooling then the landlord has no new information at the end of period 1, and so has no reason to choose a new contracts or a new payment scheme under the same contract. In this case the pay-off to the principal is $\Pi + \delta\Pi$ as well. In a pooling equilibrium the landlord has no way of extracting the informational rent for the high productivity type in either of the two periods.

However if the equilibrium is separating then the story is different. Take a rental contract and assume that the equilibrium is separating in that the high type agent responds with e_H^* in period 1 thereby revealing his type. In that case the landlord gets the standard

first period rent of $\Pi = f_L - V_L$ but in the next period the principal will reset the terms of the contract so that he will set a rent of $f_i - V_i$ for type i where i is either H or L. So that with type separation the principal's two-period pay-off is

$$\Pi_L = [(f_L - V_L) + \delta \{p^*(f_H - V_H) + (1-p)^*(f_L - V_L)\}].$$

Turning to a share-cropping contract now, in period 1 the landlord sets the share parameter at $\beta = V_L/f_L$ such that she once again ensures herself at least a minimum first period pay-off of $\Pi = f_L - V_L$. However if the two types separate then the landlord sets a different share parameter for the two types in period two by choosing $\beta_i = V_i/f_i$ where i is H or L. So in the second period the landlord can guarantee herself the maximum pay-off of $\{p^*(f_H - V_H) + (1-p)^*(f_L - V_L)\}$ by extracting the surplus from each type of the agent. But there is one important difference; if the high productivity agent does exert his optimal effort e_H , then the actual output produced in period 1 is f_M and so the landlord's share is $(1-\beta)^*f_M$ which is equal to $\{(f_L - V_L)^*f_M\}/f_L$ which is clearly bigger than $f_L - V_L$ since $f_M/f_L > 1$. So from this we can conclude that if the landlord gets type separation from either a rental contract or a share-cropping contract then the landlord is actually better off choosing a share-cropping contract because the latter yields a bigger period 1 pay-off to the landlord and the same period 2 pay-off as the former. We can also think of the case where a rental contract leads to type separation while a share contract does not. In this case, however a rental contract yields a higher pay-off because while the landlord gets the same pay-off $(f_L - V_L)$ from either contract, rent or share in period 1, but since the rental contract yields type separation the landlord gets a higher second period pay-off from rent than from share, which yields $f_L - V_L$ in period 2 as well.

Now we are in a position to sum up the main insight obtained from this section.

Irrespective of whether δ_s is greater than, equal to or less than δ_t , there will always exist a

discount factor δ^* , such that either a rental contract or a share contract or both will lead to separation of types. In that case I can write the following proposition.

Proposition 4A: *If the continuation equilibrium is pooling then the landlord is indifferent between all three contracts. However if the value of the agent's discount factor is less than δ^* , which means either a share contract or a rental contract or both will yield type separation, then the landlord will not offer a wage contract in equilibrium and will offer a land lease contract with either rent or share.*

So if we make a distinction between owner cultivation with wage payments, and land lease arrangements on a rental or share payment basis, then I have shown that in a pooling equilibrium all three contracts are efficient and the principal is indifferent between all three. In this case the principal is willing to offer a menu of contracts. The low productivity agent is also indifferent between the three because he gets zero rent in any case. The high productivity agent will then choose the contract in accordance with the one which gives him the highest pay-off as we pointed out in Theorem 1. Whichever contract is chosen in period 1 will persist in period 2 and with the same payment scheme because the landlord, at the beginning of period 2, has no new information and therefore has no incentive to change either the contract or the terms thereof. The equilibrium concept I have relied on is the Perfect Bayesian Equilibrium which merely puts values on information sets that are reached.

I do not make any claims about unreached information sets. So the point is that if the landlord continues to believe in period 2, that with probability “p” the agent is of the high type and with probability “1-p”, he is of the low type then the principal has no reason to shift in period 2. However if the equilibrium is separating, then a wage contract is clearly

dominated because a rental or a share contract yields the principal a bigger pay-off in period

2. This brings me to the next set of propositions;

Proposition 4B: *If the discount factor δ is such that $\delta_s < \delta < \delta_r$ (which corresponds to Case A stated above) i.e. a rental contract separates types while a share contract does not, then in equilibrium the principal chooses a rental contract; however if $\delta < \delta_s < \delta_r$, then the principal chooses a share contract.*

Proof: Consider the situation where only a rental contract yields separation of types, but a share contract does not. In this case the landlord gets the static rent of $f_L - V_L$ in period 1 but can extract the full rent from both types in period 2. However from a share contract the maximum rent that the landlord can get is $(1+\delta)(f_L - V_L)$, thus the landlord is better off choosing a rental contract since that yields the highest dynamic pay-off. However consider the scenario where both contracts yield separation. So no matter what contract is chosen in period 1, the landlord obtains type separation. What happens in this case? Think about a rental contract. In period 1 the landlord gets $f_L - V_L$ and then in period 2 he can extract the entire rent and therefore stands to make $\{p(f_H - V_H) + (1-p)(f_L - V_L)\}$. However think about the share contract now. A share contract will yield type separation as well. So in period 2 the landlord can extract the entire rent from both types and so stands to get the same exact pay-off as from a rental contract $\{p(f_H - V_H) + (1-p)(f_L - V_L)\}$. But what about the first period? In the first period, in a separating equilibrium both types exert their optimal effort and so the landlord's expected first period pay-off is then $\{p(1-\beta)f_M + (1-p)(1-\beta)f_L\}$. Now β we know is equal to V_L/f_L which implies that we can rewrite the landlord's first period pay-off as $\{p(1-V_L/f_L)f_M + (1-p)(f_L - V_L)\}$. It should be clear that this term is bigger than $(f_L -$

V_L) (which is what the landlord will get from a rental contract in period 1), because this is a convex combination of two terms - one of them is $(f_L - V_L)$ and the other one is bigger than $(f_L - V_L)$. Since “ p ” is by definition different from 0 or 1, it has to be the case that the landlord’s first period pay-off from a share contract is bigger than the first period pay-off from a rental contract. The second period pay-offs are the same from both. Therefore in all those situations where both share and rental contracts yield separation the landlord is better off choosing a share contract.

The intuition which emerges from this is that any time both a rental contract and a share contract yield type separation, the landlord should choose a share contract. This is because with type separation the landlord can extract the entire informational rent in the second period, but in period 1, the landlord can get only $(f_L - V_L)$ in period 1, whereas when a share contract yields type separation the landlord actually gets a higher first period pay-off equal to $\{(f_L - V_L)/f_L\} * f_M$ which is bigger than $(f_L - V_L)$ since $f_M/f_L > 1$. Then I can state the following proposition:

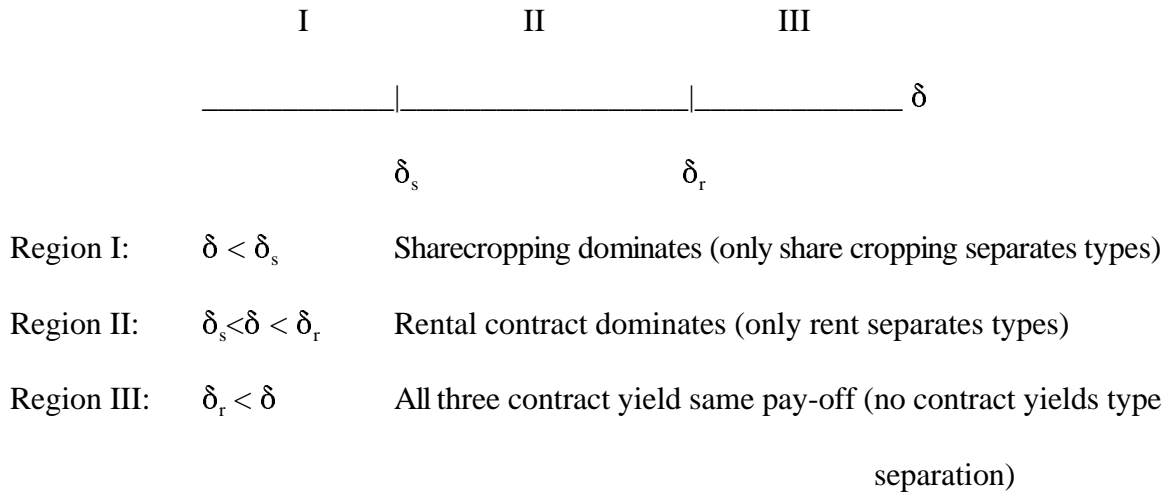
Proposition 4C: *If we are in a world where both a rental contract and a share contract will yield type separation, i.e. Cases B and C, where δ_s is greater than or equal to δ_r , such that anytime a rental contract yields type separation, so does a share contract the landlord should choose a share contract since that gives the landlord a higher first period pay-off and the same second period pay-off.*

Proof: The proof of this proposition follows easily from our prior discussion.

So depending on the agent’s discount factor the principal will choose a different contract for each agent. If the discount factor is such that the continuation equilibrium is

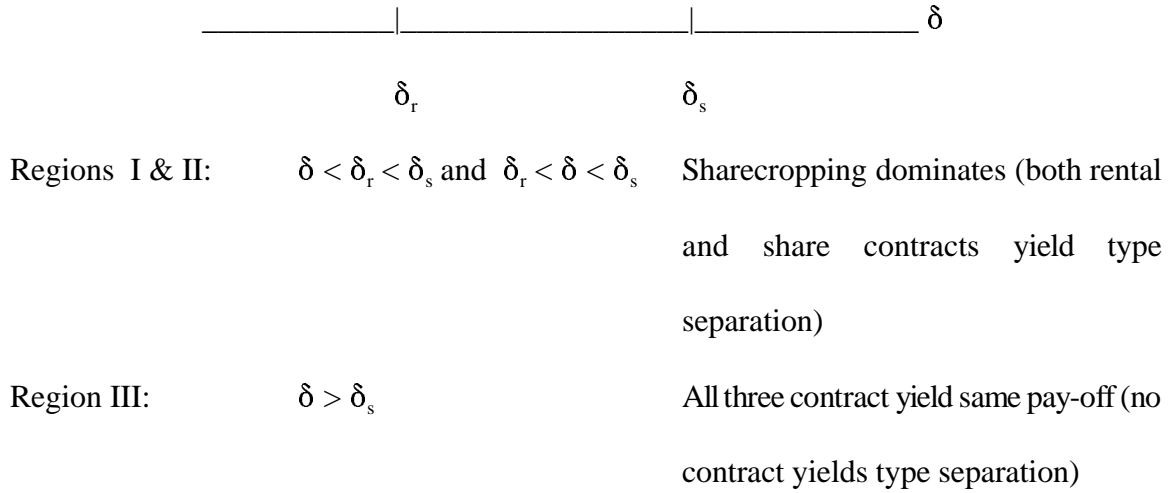
pooling, then the landlord can offer any of the three since they are all efficient. However if the situation is such that the landlord can get type separation by offering a land-lease contract, then the landlord always offers a land lease contract namely share or rent. Under land lease arrangements, if there is separation with rent but not with share, then the landlord will offer a rental contract whereas if there is type separation with both (if a share contract leads to type separation, then so will a rental contract, from Theorem 4), then the landlord will offer a share contract. Propositions 4A, 4b and c provide necessary and sufficient conditions for the co-existence of multiple contracts as well as the persistence of share contracts. The intuition behind the three propositions 4A, 4B and 4C can be summed up in the following diagrams.

Case A

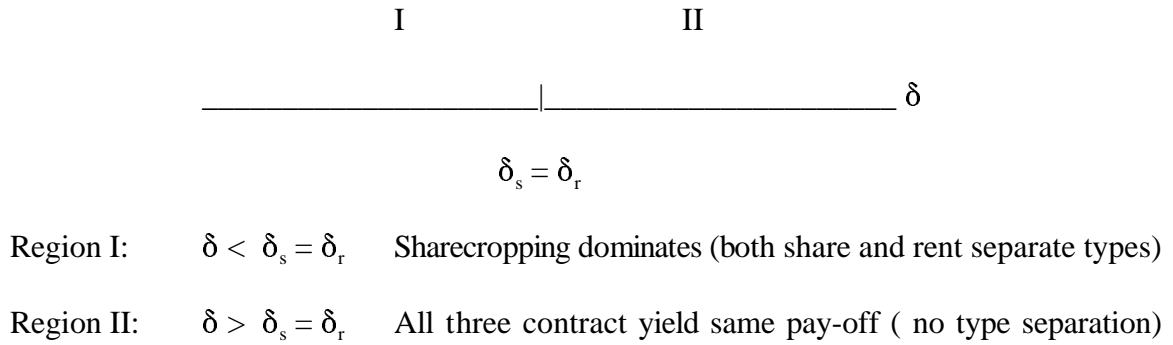


Case B

I	II	III
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Case C



Thus we have shown how depending on the value of the discount factor the landlord may offer a different contract to agents which would then easily explain contractual co-existence in adjoining plots as long as they are cultivated by different tenants.

2.5 Concluding Remarks

This paper fills an important gap in the extant literature on tenurial contracts. The literature abounds with static models which can explain the co-existence of multiple contracts in a static context but the results obtained in these models is not proof to re-negotiation.

The information that is private at the beginning of the contracting period is common knowledge at the end of the period and once the informational asymmetry is removed the results cannot be sustained in a dynamic framework. This paper on the other hand derives necessary and sufficient conditions which can explain (1) the co-existence of multiple contracts in a static as well as a dynamic context; as well as (2) how a share-cropping contract can arise and persist over time. As I have shown, there may be circumstances where a share-cropping contract dominates the other contracts. Also in proving my results I have relied only on one sided private information. Bhattacharya and Lafontaine (1995) develop a model of two sided moral hazard to explain the existence of share contracts in a franchising context.

In this model both the principal and the agent, each provide an input into the production process and each has private information about the same. They also suggest that one needs two sided moral hazard to explain the existence of share contracts (which can refer to output sharing, revenue sharing, profit sharing etc.). However as I have shown here, two sided moral hazard may be sufficient but is definitely not necessary to prove the existence of share contracts.

I would like to end with a few words on my assumptions about the discount factor. In this paper I have made the assumption that the contract choice is dependent on the agent's discount factor and that the principal can infer this discount factor correctly by observing characteristics about the agent. I have also argued that the agent's age or other characteristics can serve as a reliable signal of this discount factor. Consider the issue of age. We can make two arguments; first, an older agent has less of an incentive to pool than an younger agent because the future payment stream is shorter for the former than the latter and so the latter has more of an incentive to hide his type; the second argument has to do with

observability (Holmstrom, 1982b). An older agent has obviously been in a tenancy relationship for a longer period and therefore has been observed for a longer period of time than a younger agent. So the principal has had more of an opportunity to infer the true type of the agent for older agents than for younger agents. So higher age then should be a signal of a lower discount factor. I have proved in this paper that if the discount factor is less than a critical value δ^* , then the principal chooses land-lease whether if it is bigger then she chooses wage. And among all land lease arrangements, we expect to see share contracts for a lower value of the discount factor and rental contracts if $\delta_s < \delta_r$ and the opposite if $\delta_s > \delta_r$. So if age is indeed related inversely to the discount factor, then we would expect to see wage contracts for younger tenants and land lease contracts for older tenants. And among those lease contracts again we expect to see one type of land lease contract for older tenants and a different type of land lease contract for younger tenants. In a separate paper, written with a co-author (I will omit the reference in the interests of anonymity) we provide empirical support for this conjecture. In that paper we set up the land tenure choice as a two step process where in the first step the principal chooses whether to have owner cultivation with wage payments or to lease the land out. And in the second step if the landlord does decide to lease out the land, then the question is whether to use share or rental contracts. We find that age tends to increase the probability that the land is leased out rather than owner cultivated with wage; and among all land lease contracts, age once again increases the probability that a share cropping contract is chosen over a rental contract.

Thus I believe this paper provides a fresh look at the question of why do all these three different type of contract co-exist in adjoining plots of land and tend to persist over time. The answer to the query though, I think, is still in need of more theoretical and

empirical analysis.

REFERENCES:

- Ai, C., Arcand, J. & Ethier, F. (1996), 'Moral Hazard and Marshallian Inefficiency: Evidence from Tunisia', *Mimeo, University of Montreal*.
- Allen, D. W. & Lueck, D. (1992), 'Contract Choice in Modern Agriculture: Cash Rent versus Cropshare', *Journal of Law and Economics* **XXXV**, pp. 397--426.
- Allen, F. (1982), 'On Share Contracts and Screening', *Bell Journal of Economics* **13**(2), pp. 541--547.
- Allen, F. (1985), 'On the Fixed Nature of Sharecropping Contracts', *Economic Journal* **95**(377), pp. 30--48.
- Alston, L. J., Datta, S. K. & Nugent, J. B. (1984), 'Tenancy Choice in a Competitive Framework with Transactions Costs', *Journal of Political Economy* **92**(6), pp. 1121--1133.
- Banerjee, A. V. & Ghatak, M. (1996), 'Empowerment and Efficiency: The Economics of Tenancy Reform', *Mimeo, Harvard University*.
- Bhalla, S. S. (1988), 'Does Land Quality Matter?', *Journal of Development Economics* **29**, pp. 45--62.
- Bhattacharyya, S. & Lafontaine, F. (1995), 'Double-sided Moral Hazard and the Nature of Share Contracts', *Rand Journal of Economics* **26** (4), pp. 761--781.
- Datta, S. K., O'Hara, D. J. & Nugent, J. B. (1986), 'Choice of Agricultural Tenancy in the Presence of Transaction Costs', *Land Economics* **62**(2), pp. 145--158.
- Eswaran, M. & Kotwal, A. (1985), 'A Theory of Contractual Structure in Agriculture', *American Economic Review* **75**(3), pp. 352--367.

- Ghosh, P. (1995), 'On the Coexistence of Share, Rent and Wage Contracts in a Rural Economy', *IED Working Paper, Boston University*.
- Hallagan, W. (1978), 'Self Selection By Contractual Choice and the Theory of Share Cropping', *Bell Journal of Economics* **9**, pp. 344--354.
- Hanchate, A. (1996), 'Timeliness of Farm Operations, Allocation of Labor and Yield Differences', *Mimeo, Case Western Reserve University*.
- Hsiao, C., Nugent, J., Perrigne, I. & Qiu, J. C. (1996), 'Shares vs. Residual Claimant Contracts: The Case of Chinese TVEs', *Mimeo, University of Southern California*.
- Laffont, J. J. & Matoussi, M. S. (1995), 'Moral Hazard, Financial Constraints and Sharecropping in El Oulja', *Review of Economic Studies* **62**, pp. 381--399.
- Lafontaine, F. (1992), 'Agency Theory and Franchising: Some Emperical Results', *Rand Journal of Economics* **23**(2), pp. 263--283.
- Morduch, J. (1990), 'Risk Production and Saving: Theory and Evidence From Indian Households', *Mimeo, Harvard University*.
- Newbery, D. M. & Stiglitz, J. (1979), Share Cropping, Risk Sharing and the Importance of Imperfect Information, in J. A. Roumasset, J. M. Boussard & I. Singh, eds, 'Risk, Uncertainty and Agricultural Development', SEARCA-ADC Publication.
- Newbery, D. M. G. (1977), 'Risk Sharing, Share Cropping and Uncertain Labor Markets', *Review of Economic Studies* **44**, pp. 585--594.
- Rai, A. S. (1996), 'Sharecropping, Inequality and Production Efficiency in Bangladesh', *Mimeo, University of Chicago*.

- Shaban, R. A. (1987), 'Testing Between Competing Models of Sharecropping', *Journal of Political Economy* **95** (5), pp. 893--920.
- Shetty, S. (1988), 'Limited Liability, Wealth Differences and Tenancy Contracts in Agrarian Economies', *Journal of Development Economics* **29**, pp.1--22.
- Singh, N. (1989), Theories of Sharecropping, in P. Bardhan, ed., 'The Economic Theory of Agrarian Institutions', Clarendon Press, Oxford, pp. 33--72.
- Stiglitz, J. (1974), 'Incentives and Risk Sharing in Share Cropping', *Review of Economic Studies* **41**, pp. 219--255.