

Chaudhuri, Ananish; Maitra, Pushkar

Working Paper

Determinants of Land Tenure Contracts; Theory and Evidence from Rural India

Working Paper, No. 1997-10

Provided in Cooperation with:

Department of Economics, Rutgers University

Suggested Citation: Chaudhuri, Ananish; Maitra, Pushkar (1997) : Determinants of Land Tenure Contracts; Theory and Evidence from Rural India, Working Paper, No. 1997-10, Rutgers University, Department of Economics, New Brunswick, NJ

This Version is available at:

<https://hdl.handle.net/10419/94290>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Determinants of Land Tenure Contracts: Theory and Evidence from Rural India^{*}

Ananish Chaudhuri
Rutgers University

and

Pushkar Maitra
University of Southern California

JEL Classification: D82, O12, C35, C33.

Keywords: Tenurial contracts, Sharecropping, Principal-agent model, Qualitative dependent variable

This Version: June 1997

First Version: November 1996

Corresponding Author: Ananish Chaudhuri
Department of Economics, Rutgers University
PO Box 5055, New Brunswick, NJ 08903-5055
E-mail: ananish@rci.rutgers.edu
Fax: (908) 932-7416

^{*} We would like to thank without implicating Caroline Betts, Andy Neumeyer, Jeff Nugent, Jim Robinson, Lata Gangadharan, Shailen Swaminathan, Ira Gang, Barry Sopher, Thomas Prusa, Antu Murshid and seminar participants at University of Southern California for their comments and suggestions. We are grateful to the International Crops Research Institute for Semi Arid Tropics (ICRISAT) for providing us with the data set.

Determinants of Land Tenure Contracts: Theory and Evidence from Rural India

Abstract

In this paper we analyze the factors that affect the choice of land tenure contracts in the semi arid tropics of India. We develop a dynamic principal-agent model with one sided private information to explain the co-existence of wage, rent and share-cropping contracts. We develop sharp empirically testable hypotheses about how multiple contracts can co-exist and we identify household and plot-level characteristics that explain such co-existence. Using plot-level data from three Indian villages we find that the age of the head of the cultivating household and the value of the plot under cultivation increase the probability that the land is under tenant cultivation (i.e. cultivated under a share or rental contract).

1. Introduction

Land tenure contracts in agriculture take three stylized forms - (1) a *wage contract* where the land is cultivated by the land owner with hired labor, with 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 two questions which arise in this context. The first is the co-existence of multiple contracts not only in the same region, but often within the same village. In fact Shaban (1987) in his study of eight Indian villages finds different contractual arrangements on adjoining plots of land. The second question is regarding the appearance and persistence over time of a share-cropping contract. An output sharing contract resembles a proportional tax, and like a proportional tax, it should distort effort incentives. Since the tenant enjoys only a fraction of the output, an output sharing contract leads to sub-optimal resource usage not only in terms of labor or effort input into the production process, but also in terms of other material inputs as well as adoption of innovations. Hence on the face of it, an output sharing contract represents a Pareto inferior mode of production. The landlord can guarantee a Pareto efficient resource allocation by choosing a rental contract where the rent set is the maximum extractable surplus from the tenant (a fixed rent is analogous to a lump-sum tax and is therefore non-distortionary in its impact on effort incentives), or simply by cultivating the land himself, hiring labor at the going market rate. It has often been conjectured that share-

cropping, given its risk spreading attributes, makes its appearance in situations where markets for many inputs, especially credit or insurance, are not complete. However it seems to us that the need to share risks may be sufficient but hardly necessary given that share-cropping enjoys wide-spread currency not only in the impoverished rural countryside of south-east Asia, but also in the mid-western states of United States like Nebraska and South Dakota, where agriculture is a less risky proposition. For discussions of share-cropping in the US mid-west see Allen & Lueck (1992, 1996). Alston, Datta & Nugent (1984) discuss crop sharing in 19th century cotton production in the United States.

Interest in these issues is not confined to tenurial contracts in agriculture. Similar issues arise in other areas as well, such as licensing and franchising. In various types of franchising arrangement, most notably business format franchising, one observes the use of franchise fees which are similar to rental contracts or royalty rates which are akin to share-cropping contracts and often a mixture of the two where the franchiser asks the franchisee for a up-front franchise fee as well as a royalty rate. See for instance Lafontaine (1992), Bhattacharyya & Lafontaine (1995), Lal (1990) and Mathewson & Winter (1985) for discussions on the co-existence of multiple contracts as well as the frequent occurrence of revenue sharing arrangements in franchising. Hsiao, Nugent, Perrigne & Qiu (1996) examine output sharing contracts in the Chinese Township and Village Enterprises.

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 & Stiglitz (1979), Hallagan (1978), Allen (1982), Allen (1985), Eswaran & 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. See Singh (1989) for a survey of the literature. 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. However the problem with all the extant papers in this area is that they develop one-shot models to explain the co-existence of multiple contracts. All these static models give rise to separating equilibria where the information that was hidden at the beginning of the period becomes common knowledge at the end of the period. Thus these models cannot satisfactorily answer the question as to why all the contracts in a given region do not converge to one common contract over time.

In this paper we develop a dynamic principal agent model with one sided private information to show how all three contracts can arise and persist over time and how a share cropping contract can, under certain circumstances, actually dominate the other two contracts. This model assumes that the agent can be one of two types - high or low productivity and the principal only has a prior distribution over types (adverse selection). However we assume that the principal can monitor the tenant's effort. In our model the landlord is interested in extracting the maximum possible surplus from the tenant. The landlord has beliefs and/or information about the tenant and the plot of land that the tenant is cultivating and on the basis

of those beliefs will choose a contract that will maximize the pay-off to the landlord while ensuring that the tenant gets a reservation utility. So the landlord's strategy, given her beliefs, is to choose a suitable contract which will give her the maximum dynamic pay-off.¹ We develop sharp empirically testable hypothesis about the co-existence of various contracts. We use plot-level data from three Indian villages to test our hypotheses and find that an increase in the age of the head of the cultivating household and in the value of the plot of land under cultivation increases the probability that the plot is under tenant cultivation.

The rest of the paper is organized as follows. In Section 2 we develop the theoretical model to examine the choice of tenurial contracts. We present our empirical results in Sections 3.1 and 3.2. Section 3.1 considers a model where the three contracts are chosen simultaneously while section 3.2 presents a model where the contracts are chosen in a sequential fashion. We will explain the difference between the simultaneous and sequential choice models shortly. Section 4 concludes.

¹ For the rest of the paper we will denote the principal as *she* and the agent as *he*.

2. Choice of Tenurial Contract

We will set up the problem as a standard principal agent model. We will assume the landlord (principal) to be risk neutral and the tenant (agent) to be risk averse.² The agent can have one of two types (θ); $\theta = \theta_H$ (high skilled) with probability p and $\theta = \theta_L$ (low skilled) with probability $1-p$. We will impose suitable restrictions on p to ensure that the principal will hire both types of agents. The principal cannot observe θ but knows the true distribution of the agents in the population. Output (f) is a function of the effort exerted by the agent such that $f = \nu f(e)$, $f_e > 0$, $f_{ee} < 0$; $f(0) = 0$, $f_e(0) = \infty$, $f_e(\infty) = 0$. ν is a scale parameter. For the most part we normalize $\nu = 1$. The disutility of effort is $V = V(e, \theta)$, i.e., disutility is a function of the effort level of workers and the productivity of workers. Also assume, $V_e > 0$, $V_{ee} > 0$ and $V(e^*, \theta_H) < V(e^*, \theta_L)$, for any e^* , i.e., for any given level of effort, the higher productivity worker has lower disutility than the lower productivity worker. We also normalize the agent's reservation utility to zero.

We will focus on linear contracts such that the optimal sharing can be written in the form $\alpha + (1 - \beta) f(e)$ ³ (See Holmstrom & Milgrom (1987) and Bhattacharyya & Lafontaine (1995)). So

- A pure rental contract (R) is characterized by $\beta = 1$, $\alpha > 0$;
- A pure wage contract (W) is associated with $\beta = 0$, $\alpha < 0$;
- A pure sharecropping contract (S) is associated with $\beta \in (0, 1)$, $\alpha = 0$.

² This section is based on Chaudhuri (1997) which develops the theoretical model in detail.

³ We are assuming $\nu = 1$.

We will confine ourselves to these three pure contract forms and in particular ignore the case of both fixed payments and output sharing. The landlord's action consists of choosing a contract $C \in (W, R, S)$. We will assume that the landlord can observe all variables, including effort. The only unobservable in this model is the tenant type θ .

Assume that there are two periods. Contracts are written at the beginning of each period and the principal can take into account information revealed to him in the first period when rewriting the contract at the beginning of the second period. So a contract is specified by a sharing rule $w(f(e^*))$ and an effort level e^* , so that the landlord offers an effort level and a payment scheme to the tenant.

2.1 Wage Contracts

Under wage contracts we assume that the principal cultivates his land herself, using hired labor. So wage contracts and owner cultivation are equivalent terms in our analysis and we will use the terms interchangeably. The principal's problem at the beginning of the first period is

$$[2.1] \quad \text{Max}_e f(e) - w,$$

subject to

$$[2.2] \quad w - V(e, \theta_L) \geq 0$$

$$[2.3] \quad w - V(e, \theta_H) \geq 0$$

Equation [2.1] is the Individual Rationality (IR) constraint for the low type agent and [2.3] is the IR for the high type agent.⁴ This is the exact same problem as the agent choosing e to

⁴Since the principal can observe the level of effort there is no Incentive Compatibility constraint to be satisfied.

maximize $f(e) - V(e, \theta)$. Note that since $V(e, \theta_L) > V(e, \theta_H)$, for all e , we can get rid of equation [2.3] (IR for the high type). So rewrite the principal's problem as

$$\text{Max}_e f(e) - w,$$

subject to

$$w - V(e, \theta_L) \geq 0$$

Let $e_L^* = \text{Arg max } f(e) - V(e, \theta_L)$, since the principal will always choose w , so that $w = V(e, \theta_L)$, so that the participation constraint for the low type is binding. So the principal will choose

$$w = V(e_L^*, \theta_L)$$

so that he is able to extract the entire rent from the agent of the low type. The best that the principal can do is to choose w such that the low types exert the optimal effort, but he cannot do any better because then the high type might exert higher effort, but the low type will quit.

The problem is exactly the same in the second period. The principal continues to pay a wage $w = V(e_L^*, \theta_L)$ so that the participation constraint of the low type is binding. No new information regarding the type of the agent has been revealed in the first period. So the low type agent will choose e_L^* , since this is his optimal response and his participation constraint is binding. The high type agents also chooses e_L^* in both periods because if he exerts a higher level of effort he gets a lower rent in period 1 and also reveals his type to the landlord, who can then extract his entire surplus in period 2 by designing a suitable contract. However with pooling with the low type agent, the high type ensures a rent $V(e_L^*, \theta_L) - V(e_L^*, \theta_H)$ in period 1. Since there is no revelation of type, the agent can continue to earn this (same) rent in period 2. This can be summarized in the following proposition.

Proposition 1: *Under a wage contract the equilibrium is always pooling, in that both type of agents choose e_L^* as their first period response. So under a wage contract the principal cannot separate types and has to pay the same wage in both periods.*

Proof: Under a wage contract the low productivity type has no option other than to exert his optimal effort level e_L^* , if he wants a positive pay-off. The high type exerts effort e_L^* as well. The wage payment is fixed at $V(e_L^*, \theta_L)$. The disutility from high effort is $V(e_H^*, \theta_H)$ while that from low effort is $V(e_L^*, \theta_H)$. Given the fixed nature of the wage payment it makes sense to exert low effort since $V(e_L^*, \theta_H) < V(e_H^*, \theta_H)$.

Let us denote the discount factor of the landlord as ρ and the discount factor of the tenant as δ .

Proposition 2: *Under a wage contract, the two period pay-off to the principal is*

$$\Pi^p = \Pi + \rho\Pi$$

where

$$\Pi = f(e_L^*) - V(e_L^*, \theta_L)$$

We can write the two period pay-off to the two types of agents as

- Low Type agent gets: $\Pi_L^a = 0$
- High Type Agent gets: $\Pi_H^a = V(e_L^*, \theta_L) - V(e_L^*, \theta_H) + \delta\{V(e_L^*, \theta_L) - V(e_L^*, \theta_H)\}$

2.2 Fixed Rent Contracts

If the principal knows the type of the agent then he would choose rent $\alpha_L = f(e_L^*) - V(e_L^*, \theta_L)$ from the agent of low type and $\alpha_H = f(e_H^*) - V(e_H^*, \theta_H)$ from the agent of high type, where she makes each type exert optimal effort and then extracts all the rent, forcing them to their reservation utility level (of zero).

However if the principal does not know the true type of the agent, the maximum rent that she can ask for is

$$\alpha_L = f(e_L^*) - V(e_L^*, \theta_L)$$

So this is the maximum rent that the principal can charge in period 1. If the High type agent separates and reveals his type in period 1, then the principal can charge a higher rent from the high type agent in period 2 which is given by $\alpha_H = f(e_H^*) - V(e_H^*, \theta_H)$ (but she has to charge the same rent from the low type agent in the two periods).

The proportion of high productivity workers in the population is p . Now if it happens to be the case that $p\{f(e_H^*) - V(e_H^*, \theta_H)\} > f(e_L^*) - V(e_L^*, \theta_L)$, then a risk neutral principal is better off hiring only high productivity agents. We can now explicitly state the restriction p has to obey and that is given by

$$p < \frac{f(e_L^*) - V(e_L^*, \theta_L)}{f(e_H^*) - V(e_H^*, \theta_H)}$$

As long as the prior beliefs of the principal are such that p is less than the above mentioned value, the principal is better off hiring both types rather than hiring only the high productivity worker.

A rental contract may induce separation at the end of period 1. Note the high type worker has the following choice

- Exert e_H^* in period 1 and separate from the low type (who is exerting e_L^*). In period 2 the principal extracts the entire rent, because by choosing e_H^* in period 1 the agent of high type reveals himself and the principal can force him to his reservation utility. Then

$$\Pi_H^a = [\{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\}] + 0$$

- Exert e_L^* in period 1 and pool. So the principal cannot separate types and has to keep the rent unchanged. In period 2 the agent can choose e_H^* . Then

$$\Pi_H^a = [V(e_L^*, \theta_L) - V(e_L^*, \theta_H)] + \delta[\{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\}]$$

Proposition 3: Define a discount factor δ_r given by

$$\delta_r = 1 - \frac{V(e_L^*, \theta_L) - V(e_L^*, \theta_H)}{\{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\}}$$

such that

- if $\delta < \delta_r$, the high type separates by exerting e_H^* in period 1; and
- if $\delta > \delta_r$, the high type pools by choosing e_L^* in period 1.

The low type chooses e_L^* in each period.

Proof: Follows easily by comparing the two pay-offs to the agent - one from exerting low effort in the first period and the other from exerting high effort in the first period. If the high quality agent pools with the low type and exerts low effort in period 1, then he gets

$V(e_L^*, \theta_L) - V(e_L, \theta_H)$ in period 1. However since his type is not revealed, the principal has no new information at the beginning of the second period and hence will keep the rental pay-off unchanged in which case the high type agent can exert high effort in period two and extract the entire informational rent of $[\{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\}]$, although discounted by δ . So in this case the agent's two period pay-off is

$$\Pi_H^a = [V(e_L^*, \theta_L) - V(e_L^*, \theta_H)] + \delta[\{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\}]$$

On the other hand if the agent does choose to exert high effort in period 1, then he gets the full informational rent in the first period but since his type is revealed to the principal, so in the

second period she extracts the entire rent from the agent thereby leaving the agent with the reservation utility of zero. In this case then the agent's pay-off is

$$\Pi_H^a = [\{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\}] + 0$$

Comparing these two pay-offs gives us the value of the discount factor δ_r .

Proposition 4: *In a pooling equilibrium with $\delta > \delta_r$, the landlord gets the exact same pay-off from rent as under a wage contract $\Pi + \rho\Pi$. 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 agents. In a separating equilibrium the landlord's pay-off is*

$$\Pi + \rho[p(f(e_H^*) - V(e_H^*, \theta_H)) + (1 - p)(f(e_L^*) - V(e_L^*, \theta_L))]$$

Thus it is clear that in a separating equilibrium the landlord's pay-off is higher from a rental contract than from a pooling contract. So if $\delta < \delta_r$, both the high type agent and the principal is better off by separation. The low type agent is indifferent since in each case he earns the same pay-off.

2.3 Share Contracts

The principal chooses the share parameter β such that the participation constraint for the low type is binding. The first period problem for the principal in this case is to

$$\text{Max}_e (1 - \beta) f(e)$$

subject to

$$\beta f(e) - V(e, \theta_L) \geq 0$$

Let e_L^* solve this problem. Then set

$$\beta_L = V(e_L^*, \theta_L) / f(e_L^*)$$

so that the IR is binding. Should the high type agent choose to separate in the first period, the principal can charge a higher rent from the high type in the second period. This is given by

$$\beta_H = V(e_H^*, \theta_H) / f(e_H^*)$$

which is the maximum share that the principal can charge so that the participation constraint of the high type is binding. Remember that in the first period the maximum share the principal can get is given by β_L .

We can obtain the pay offs for the high type as

- Separate by exerting e_H^* in period 1, so that

$$\Pi_H^a = \beta_L f(e_H^*) - V(e_H^*, \theta_H) + 0$$

because as soon as the type is revealed, the principal adjusts β to extract all rent.

- Pool by exerting e_L^* in period 1, so that

$$\Pi_H^a = \beta_L f(e_L^*) - V(e_L^*, \theta_H) + \delta[\beta_H f(e_H^*) - V(e_H^*, \theta_H)]$$

Proposition 5: Define a discount factor δ_s , given by

$$\delta_s = 1 - \frac{\beta_L f(e_L^*) - V(e_L^*, \theta_H)}{\beta_L f(e_H^*) - V(e_H^*, \theta_H)}$$

such that

- if $\delta < \delta_s$, the high type agent separates by exerting e_H^* in period 1; and
- if $\delta > \delta_s$ the high type agent pools by choosing e_L^* in period 1

The low type chooses e_L^* in each period.

Proof: The proof follows along the same lines of Proposition 4. If the high type agent exerts high effort in period 1, then he gets the maximum informational rent $\beta_L f(e_H^*) - V(e_H^*, \theta_H)$,

but his true type is revealed to the landlord and so in the second period the landlord will extract the entire rent and the agent will get zero. On the other hand if the high type agent hides his true type and pools with the low type agent in period 1 by exerting effort e_L^* , then he gets a lower informational rent equal to $\beta_L f(e_L^*) - V(e_L^*, \theta_H)$ in period 1, but since his type is not revealed then the share parameter stays unchanged in period 2. So in period 2 the agent can get the full informational rent (discounted) which is equal to $\delta[\beta_L f(e_H^*) - V(e_H^*, \theta_H)]$. So the decision whether or not to reveal his type will depend on a comparison of these two pay-off streams and the result follows.

Proposition 6: *The discount rate which yields type separation under a rental contract exceed in value the discount factor which yields type separation under a share contract i.e.*

$$\delta_r > \delta_s$$

Proof: To prove this notice that

$$1 - \delta_r = \frac{V(e_L^*, \theta_L) - V(e_L^*, \theta_H)}{\{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\}}$$

and

$$1 - \delta_s = \frac{\beta^* f(e_L^*) - V(e_L^*, \theta_H)}{\beta^* f(e_L^*) - V(e_H^*, \theta_H)}$$

$$\text{and } \beta = \frac{V(e_L^*, \theta_L)}{f(e_L^*)}$$

Let us suppose that $1 - \delta_r > 1 - \delta_s$ which in turn implies that $\delta_r < \delta_s$. The numerator is the same in both expressions, therefore

$$\begin{aligned}
& 1 - \delta_r > 1 - \delta_s \\
& \Rightarrow \{f(e_H^*) - V(e_H^*, \theta_H)\} - \{f(e_L^*) - V(e_L^*, \theta_L)\} < \beta * f(e_H^*) - V(e_H^*, \theta_H) \\
& \Rightarrow \beta * f(e_H^*) > f(e_H^*) - f(e_L^*) + V(e_L^*, \theta_L) \\
& \Rightarrow \left\{ \frac{f(e_H^*)}{f(e_L^*)} - 1 \right\} * V(e_L^*, \theta_L) > f(e_H^*) - f(e_L^*) \\
& \Rightarrow V(e_L^*, \theta_L) > f(e_L^*)
\end{aligned}$$

But this is a contradiction since $V(e_L^*, \theta_L)$ is less than $f(e_L^*)$ and hence it must be the case that δ_r is greater than δ_s .

Proposition 7: *We can separate the range of δ into three regions.*

(1) $\delta > \delta_r$: *In this range we have pooling from all three contracts. In this case the principal is indifferent between the three since he gets the same payoff*

$$(1 + \rho)\{f(e_L^*) - V(e_L^*, \theta_L)\}$$

from all three contracts. In this case we assume that the principal offers the wage contract.

(2) $\delta_s < \delta < \delta_r$: *For any value of $\delta < \delta_r$, wage is strictly dominated and the principal chooses to lease out land because either a share contract or a rental contract yields higher pay off. In this range share leads to pooling but rent leads to separation. Further Rent yields higher pay off. So if $\delta_s < \delta < \delta_r$, choose rental contract.*

(3) $\delta < \delta_s < \delta_r$: *both share and rent leads to separation but the pay off to the principal is higher under share tenancy.*

Proof: If $\delta < \delta_r$, a rental contract will yield separation of types with the high type exerting effort e_H^* in period 1. In this case then the two period pay-off to the principal is

$$\Pi^P(\text{rent}) = \{f(e_L^*) - V(e_L^*, \theta_L)\} + \rho[p\{f(e_H^*) - V(e_H^*, \theta_H)\} + (1-p)\{f(e_L^*) - V(e_L^*, \theta_L)\}]$$

Notice that if the principal offers a wage contract the agents will never separate. So the two period pay-off to the principal from a wage contract is $\Pi^P(\text{wage}) = (1+\rho)\{f(e_L^*) - V(e_L^*, \theta_L)\}$. Clearly $\Pi^P(\text{rent})$ is greater than $\Pi^P(\text{wage})$ and hence any time the principal gets type separation at the end of the first period, and hence prefers a rental contract.

If $\delta < \delta_s < \delta_r$, then both a rental contract and a share contract will yield separation of types. The two period pay-off to the principal from a share contract is

$$\Pi^P(\text{share}) = \{p(1-\beta_L)f(e_H^*) + (1-p)(1-\beta_L)f(e_L^*)\} + \rho\{p(1-\beta_H)f(e_H^*) + (1-p)(1-\beta_L)f(e_L^*)\}$$

where $\beta_t = V(e_t^*, \theta_t)/f(e_t^*)$ where $t = L, H$.

Substituting for β_t , we find that the two period pay-off from a share contract is equal to $p[\{f(e_L^*) - V(e_L^*, \theta_L)\}/f(e_L^*)]f(e_H^*) + (1-p)\{f(e_L^*) - V(e_L^*, \theta_L)\} + \rho^*[p\{f(e_H^*) - V(e_H^*, \theta_H)\} + (1-p)\{f(e_L^*) - V(e_L^*, \theta_L)\}]$. If we compare the expressions for $\Pi^P(\text{share})$ and $\Pi^P(\text{rent})$ then it is easy to see that the pay-off to the principal is the same in period 2 but in period the principal actually gets a higher pay-off from a share contract than from a rental contract. From a rental contract the principal can get a maximum first period pay-off of $\{f(e_L^*) - V(e_L^*, \theta_L)\}$ while from a share contract she gets $\{f(e_L^*) - V(e_L^*, \theta_L)\}[f(e_H^*)/f(e_L^*)]$. Therefore in situations where both share and rental contracts yield type separation, the principal is better off choosing a share contract.

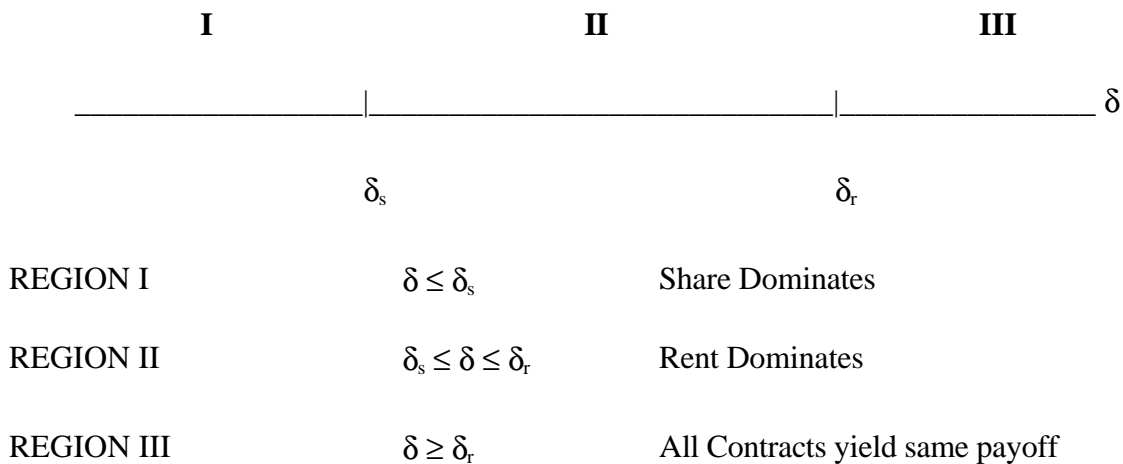
Now in the range $\delta_s < \delta < \delta_r$, a share contract will not yield type separation while a rental contract will. So the principal's maximum pay-off from a share contract is

$(1+\rho)(1-\beta_L)f(e_L^*)$ which is $(1+\rho)\{f(e_L^*) - V(e_L^*, \theta_L)\}$. On the other hand if the principal offers a rental contract then she gets type separation and then as we stated before her two period pay-off is $\{f(e_L^*) - V(e_L^*, \theta_L)\} + \rho[p^*\{f(e_H^*) - V(e_H^*, \theta_H)\} + (1-p)^*\{f(e_L^*) - V(e_L^*, \theta_L)\}]$

It is clear that the first period pay-off from either a rental contract or a share contract are equal but the rental contract yields a higher second period pay-off and so in this situation the principal should choose a rental contract.

The main conclusion of proposition 7 is clear from Figure 1 It proves that all three contracts can co-exist and the fact that there are circumstances when share tenancy actually dominates the other contractual forms.

Figure 1



We will assume that this discount factor is common knowledge. The agents obviously knows his true discount factor but the principal can infer the discount factor correctly by observing agent characteristics. We claim that the choice of a contract is dictated by the agent's discount factor. In the next section we are going to test this conjecture using our data set. Before we can do so, we need to come up with a suitable proxy for the discount factor. We use the agent's age as a proxy for his discount factor. We can make two arguments. First, an older agent has less of an incentive to pool than a younger agent, because the future

payment stream is shorter for the older agent than the latter and so the latter has more of an incentive to hide his type. The second argument has to do with observability. An older agent has obviously been in a tenancy relationship longer than a younger agent. Therefore the principal has had more of an opportunity to observe the older agent than the younger agent. Higher age then should be a signal of lower discount factor.

If the agent is older implying a lower discount factor then the principal should offer the older agents a land-lease contract, i.e. either a share or a rental contract. And among all land-lease contract we expect to see share contracts for the oldest tenants and rental contracts for the rest. To summarize, depending on the value of the tenant's discount factor, we expect to see the following - youngest agents working for wage, those in the intermediate range, working for rent and the oldest tenants working for share. This then is our empirical strategy - to determine how age affects the choice of the contract offered to the agent.

Before proceeding to the empirical section, we will augment our theoretical arguments by explicitly considering the effect of land quality on contract choice. Let us redefine the production function as $f = v f(e)$ where v is a multiplicative scale parameter which is a proxy for the quality of the plot of land under cultivation. Output then depends on effort and as well as the quality of the land, except that land quality enters into the production function as a multiplicative term. A higher value of v implies higher output. So far we have normalized v to 1. However now we can carry out some comparative statics which will enable us to see how land quality affects contractual choice.

Proposition 8: *An increase in v increases δ_r , but has no effect on δ_s . In other words*

$$\frac{\partial \delta_r}{\partial v} > 0 \text{ and } \frac{\partial \delta_s}{\partial v} = 0$$

Proof: Both results follow quite easily if we look at the expression of the two discount factors and write $v f(e)$ in place of $f(e)$. Taking the derivative of δ_r with respect to v , using the quotient rule, we get a squared term in the denominator. So all we need to show is that the numerator is positive. The numerator for this expression is

$\{f(e_H^*) - f(e_L^*)\} * \{V(e_L^*, \theta_L) - V(e_L^*, \theta_H)\}$. This expression is positive since $f(e_H^*) > f(e_L^*)$ and $V(e_L^*, \theta_L) > V(e_L^*, \theta_H)$, by the assumptions of the model. Turning to the expression for δ_s , we find that all terms containing v cancel out and hence δ_s does not depend on v . The implication of this proposition is that an increase in v increases the range of δ for which the principal chooses to offer a fixed rent contract but has no effect on the range of δ for which the principal chooses to offer a share contract.

We will use the monetary value of a plot (value per-acre in Rs. 100 (VALUE)) as a proxy for land quality. Per-acre estimated value of the plot in Rs. 100 are recorded, based on information obtained from either patwari or some knowledgeable person in the village. While recording the values of the plot, potential sale value of the plot, location of the plot, irrigation, topography are considered. See Singh, Binswanger & Jodha (1985) for details.

3. Estimation and Results

The data set for this study comes from the International Crops Research Institute for Semi Arid Tropics (ICRISAT) and was collected as part of ICRISAT's longitudinal Village Level Surveys in the semi arid tropics of India. We have complete labor market participation data for three villages Aurepalle in the state of Andhra Pradesh and Shirapur and Kanzara in the state of Maharashtra, between the years of 1979 and 1984. The data is a stratified sample of 40 randomly chosen households in each village; 10 in each of four categories - (1) large

farmers, owning more than 3.2 acres in Aurepalle, and more than 5.3 acres in Shirapur and Kanzara; (2) medium farmers, those owning between 1.2 and 3.2 acres in Aurepalle, between 2 and 5.3 acres in Shirapur and between 1.8 and 5.3 acres in Kanzara; (3) small farmers, who own between 0.2 and 1.2 acres in Aurepalle, between 0.2 and 2 acres in Shirapur and between 0.2 and 1.8 acres in Kanzara and finally (4) landless laborers who own less than 0.2 acres. The richness of the data from these surveys, both in terms of the breadth of information conveyed and the level of detail pertaining to each aspect of household decision making is amply illustrated by the numerous studies that have been conducted by economists around the world using this data set.

The three villages of Aurepalle, Shirapur and Kanzara are situated in south-central India and are predominantly agricultural with more than 94% of the population (942) households dependent on agriculture as the main source of income (either as cultivators or as farm laborers). Even by Indian standards the villages are poor with a monthly per capita income of Rs. 700 (averaged over the survey period in 1977 prices) compared to the all-India per capita monthly income of Rs. 1080 using the same base year. One can refer to Walker & Ryan (1990) and Singh, Binswanger & Jodha (1985) for more details of the survey.

Our interest in investigating the nature of the contract under which each plot is cultivated and to this end we examine data from each plot of land under cultivation. We have data for 310 plots of land in Aurepalle, 414 plots in Shirapur, and 396 plots in Kanzara, giving us data on a total of 1120 plots of land.

Table 1 presents the distribution of ownership status across villages. As is clear from Table 1, more than 76% of plots are under owner cultivation, and only 8 out of the total 1120

plots are under fixed rent cultivation. The rest are under share-cropping. Except in Shirapur where 60% of the plots are owner cultivated and the remaining 40% are under share-cropping, there is a preponderance of owner cultivation in the other two villages of Aurepalle and Shirapur.

Tables 2 and 3 present data on distribution of soil types and irrigation source. As far as irrigation is concerned, the principal source is village wells, though we do see some electric pump-sets. All the villages are characterized by an absence of canal irrigation (see Table 3). All the villages are characterized by absence of canal irrigation (See Table 3). Soil type varies across villages. For example in Aurepalle, 223 out of 310 plots are shallow red. On the other hand in Kanzara, 344 out of 396 plots are medium black. In Shirapur though Medium Black and Medium to Shallow black soils are almost equally common (See Table 2).

Let us now turn to the question of tenurial choice. We can think of this choice in two ways. First, it could be a simultaneous decision where the landlord chooses one contract out of a set of three {Wage, Rent, Share}⁵ and offers it to the tenant with a corresponding payment scheme stipulated along with it. The existing theoretical literature on contract choice has almost exclusively focused on this type of simultaneous choice where the landlord, given a choice of three different contracts, chooses the one which she believes will yield her the maximum pay-off. However, we can think of this choice being made differently - which to us is an equally intuitive way of thinking about the choice of a contract. We can think of this as a sequential decision-making process where in the first stage the landlord decides whether to cultivate the land on her own with hired labor or to lease it out on a tenancy basis. Once she

⁵We would like to point out that owner cultivation with hired labor on a fixed wage basis is synonymous with a wage contract. In the rest of our discussion, we will use the terms “owner cultivation” and “wage contract” to imply the same contractual form.

does decide to lease it out, then the question is whether to use a fixed rental contract or a share-cropping contract. In this case the decision is made in two stages. We will examine each case separately.

3.1 The Simultaneous Choice Model

We first consider a case where the choice is a simultaneous decision. What we observe in this case is the type of the contract under which each plot is cultivated and we are interested in isolating factors which are significant determinants of that contract. This is a problem with a polychotomous dependent variable which can take three discrete values. A variety of qualitative response models have been devised to deal with such cases. These fall into two types - models designed to deal with ordered responses and models designed to deal with unordered responses. Based on the theoretical discussion in the previous section, we have shown that there is a natural way in which the various contracts can be ordered, and therefore we posit that the correct way to analyze the present problem is to set it up as an ordered qualitative response model. We use an ordered probit model.⁶

Define a variable CONTRACT, such that

$$\begin{aligned} \text{CONTRACT} &= 0, \text{ if land is under a wage contract} \\ \text{CONTRACT} &= 1, \text{ if land is under fixed rent} \\ \text{CONTRACT} &= 2, \text{ if land is under share-cropping} \end{aligned}$$

We wish to examine the choice of contract for each plot. The usual approach in cases like this is to assume that there is an underlying response variable CONTRACT*, defined by the regression relation

⁶ Sadoulet, DeJanvry & Benjamin (1996) and Gangadharan (1997) use a similar framework to analyze different typologies which separate their variable of interest into classes obtained from theoretical predictions.

$$\text{CONTRACT}^* = \beta^*x + u$$

where the error term u is distributed normally with mean zero and variance 1. In practice CONTRACT^* is unobservable and what we do observe is the binary variable CONTRACT such that

$$\begin{aligned} \text{CONTRACT} &= 0, && \text{if } \text{CONTRACT}^* \leq 0 \\ &= 1, && \text{if } 0 \leq \text{CONTRACT}^* < \mu \\ &= 2, && \text{if } \text{CONTRACT}^* \geq \mu \end{aligned}$$

The probability that the land is under owner cultivation (wage contract) is given by $\Pr(\text{CONTRACT}=0)$ which is equal to $\Phi(-\beta x)$; that it is under fixed rent is given by $\Pr(\text{CONTRACT}=1)$ which is $\{\Phi(\mu-\beta x) - \Phi(-\beta x)\}$ and finally the probability that the plot is share-cropped is given by $\Pr(\text{CONTRACT}=2)$ is $\Phi(\beta x - \mu)$. Then the log likelihood function is

$$\begin{aligned} [3.1] \quad L(\beta, \mu) &= \sum_{\text{CONTRACT}=0} \log (\Phi(-\beta x)) + \sum_{\text{CONTRACT}=2} \log (\Phi(\beta x - \mu)) \\ &+ \sum_{\text{CONTRACT}=1} \log (\Phi(\mu - \beta x) - \Phi(-\beta x)) \end{aligned}$$

We obtain maximum likelihood estimates of the parameter of the model by maximizing this log likelihood function. In obtaining parameter estimates, we use two different specifications

Specification 3.1A: We include only household-level characteristics among the explanatory variables

Specification 3.1B: We include both plot-level and household-level characteristics on the right hand side

Household characteristics include age of the head of the cultivating household (AGE); experience of the household head (AGE²)⁷; total number of working males in the family, i.e. all males between the ages of 15 and 60 (TOTMAL); total number of working females in the family, once again between the ages of 15 and 60 (TOTFEM); a dummy for the disability status of the adult members in the household (DISABIL), such that DISABIL is set equal to 1 if any adult member of the household is unable to work and zero otherwise; a dummy for the sex of the household head (SEX), where SEX is equal to 1, if the household head is a female and zero if male; the amount of outstanding debt of the family (CRED), and two other dummies LMWD and LFWD. LMWD is 1 if any adult male member of the family worked in the village labor market in the previous year, while LFWD is 1 if any adult female member of the family worked in the village labor market in the previous year. In Table 4 we present some relevant summary statistics. As can be seen from Table 4, the average age of the household head is 37.5 years. On an average, each family consists of 2 males and 2 females.

Plot characteristics include value of the plot in Rs. (VALUE), dummies for different sources of irrigation (IRRD1, IRRD3, IRRD4), and for alternative soil types (SOILD1, SOILD3, SOILD5, SOILD6, SOILD8) and the fraction of total cultivated area that is irrigated (IRR). Table 5 contains a detailed description of all the dummy variables.

Table 6 presents the maximum likelihood results from this regression. The corresponding marginal results are presented in Tables 7 and 8. A positive sign on the estimated coefficient indicates that the variable increases the probability that the plot is under share-cropping while a negative sign indicates that the variable increases the probability that the

⁷ Since it is difficult to obtain a measure for experience of the household head, we use square of the age of the household head as a proxy. This is a common proxy in both the Development and the Labor literature. See Mincer (1970) for a discussion.

plot is under owner cultivation. In Column 2 of Table 6, we present the results from Specification 3.1A (i.e. when we use only household characteristics as explanatory variables) and Column 3 presents the corresponding standard errors. Notice that age of the household head (AGE), disability status of the adult members of the household (DISABIL), whether adult members of the family worked in the labor market in the previous year (LMWD and LFWD) are significant at 95% confidence level. Column 4 presents the estimated coefficients from Specification 3.1B, where we use both household and plot-level characteristics as right hand side variables, with the corresponding standard errors in column 5. Age of the household head (AGE), disability status (DISABIL), value of the plot of land under cultivation (VALUE), some of the dummies for soil type (SOILD1, SOILD3, SOILD5 and SOILD6) and one of the irrigation dummies (IRR4) is significant at 95% level.

The model has substantial explanatory power (see Table 6A). The value of the log likelihood function from Specification 3.1A (with only household characteristics on the right hand side) is -607.59. The value of the restricted log likelihood is -649.87 and the corresponding chi-squared is 84.567. If the null hypothesis is that *all the parameter of the model are not significantly different from zero*, then given the value of the chi-squared statistic we can reject the null hypothesis. Again if we look at Specification 3.1B, where we include both household and plot characteristics on the right hand side, the value of the log likelihood function is -558.70. The corresponding chi-squared is 182.34, showing that we can reject the null hypothesis that the parameters are not significantly different from zero. Also for Specification 3.1A we get a pseudo-R² ⁸ of 0.0163 while for Specification 3.1B the pseudo-R²

⁸ The measure of pseudo-R² we use is $1 - (\log L_U / \log L_R)$ where L_U is the maximum of the likelihood function when maximized with respect to all the parameters and L_R is the maximum of the likelihood function when maximized with respect to the constant only. See Maddala (1983), pages 37-40.

is 0.1423. We find that with only household characteristics as explanatory variable the model predicts correctly 76% of the time while including plot data increases the percentage of correct predictions to 80.

Notice that as AGE increases, the probability that a plot of land is under share tenancy increases. We know that higher age is a signal of lower discount factor and we expect to see tenancy contracts for agents with higher age (and therefore lower discount factors). Thus the positive and significant coefficient of AGE is a clear validation of our theoretical claim that agents should be working as tenants. This result is re-confirmed by the marginal results in Tables 7 and 8. The marginal effects in the ordered probit model show how the change in the covariates affect the cell probabilities of the plot being under owner cultivation, under a rental contract and under share-cropping. In particular, notice in Column 2 and 4 that when AGE increases (implying δ decreases) the probability of the land being under owner cultivation declines and the probability of the plot being under share-cropping increases. AGE is positive and significant in both specifications, leading us to the conclusion that the tenant's age is a significant determinant of the contract offered to him.

One could ask at this point about how a change in age affects the choice of a contract. For instance, how does the probability of $\text{CONTRACT} = 0$ (i.e. the probability of the plot being under a wage contract) change when there is a change in age? The marginal results of Tables 7 and 8 do not give us the answer to this question because a change in age affects the probability of $\text{CONTRACT} = 0$ via a change in the square of age as well. For this purpose we calculate the cumulative probability of $\text{CONTRACT} = 0$, for four different values of age, AGE = 20, 30, 40 and 50. The cumulative probability of $\text{CONTRACT} = 0$ is given by $\Phi(-\beta x)$.

To calculate the cumulative probability, we multiplied the mean values of the all the explanatory variables (both household and plot variables) *except age and the square of age*, by the corresponding coefficients and then inserted the relevant values for age and its square for AGE = 20, 30 40 and 50. We find that at AGE = 20, the cumulative probability of CONTRACT = 0 is 0.3824; at AGE = 30, the probability decreases to 0.3412. So increasing the tenant's age by 10 years reduces the probability of his working under a wage contract by 4%. Similarly increasing the tenant's age to 40 reduces the cumulative probability further to 0.3145 and finally for AGE = 50, it is 0.2977. We can carry out a similar exercise for the cumulative probability of CONTRACT = 2, i.e. the probability of the plot being under share-cropping, with the cumulative probability being $\Phi(\beta x - \mu)$. Changing AGE from 20 to 50 increases the cumulative probability of CONTRACT = 2 from 0.606 to 0.688. See Table 6B, for these marginal results.

One other point needs to be noted here. In discussing the implications of age on contract choice, we have assumed that the only way this variable affects the cultivation status is through its impact on the discount factor. However the coefficients will be biased in an upward direction if age affects cultivation status in some other way, even if in an indirect manner. For example it might be argued that age might affect productivity which in turn might impact upon contract choice. We therefore regressed output on the same set of household and plot-level characteristics, which gave us the following regression equation of the form

$$y_{ih} = \beta_0 + \beta_1 H_h + \beta_2 PLOT_{ih} + \varepsilon_{ih}$$

where y is the output per acre on the i -th plot, HH stands for the household-level data and $PLOT$ for the plot-level characteristics. We do not present these results, but we find that age

does not have a significant impact on output. Hence we can go on to argue that the only way age affects the choice of a contract is through its effect on the discount factor.

Like the age of the household head, *DISABIL* is negative and significant. This implies that if an adult member of the household is unable to work then the probability of that family working as tenants goes down. If an adult member of the family is unable to work, landowners will be less willing to lease out land to that family. Hence if an adult member of a family is disabled, it reduces the probability that the plot is under share tenancy.

Consider the issue of *VALUE* next. As shown in Section 2 that an increase in *VALUE* (which we approximate by v) increases the probability of the land lease contracts. We find that *VALUE* is positive and significant at the 95% level showing that an increase in the value of the plot under cultivation tends to increase the probability that the plot is under sharecropping, though we cannot conclude much about the probability of rental contracts from this simultaneous choice model. We will have more to say on this issue when we consider the sequential choice model.

We also find that four of the soil dummies, namely *SOILD1*, *SOILD3*, *SOILD5* and *SOILD6* are significant - meaning that soil characteristics definitely have an impact on the choice of a contract. *SOILD1*, *SOILD3* and *SOILD6* are positive and significant while *SOILD5* is negative and significant. Thus if a plot is characterized by black soil then it seems that the probability of the plot being under tenant cultivation increases, while for red soil, the probability of that plot being tenant cultivated decreases. There is no great mystery to this finding - black soil tends to be more fertile than red soil and hence it would be harder for a landowner to find tenants for a plot characterized by red soil.

At this point one could conjecture that VALUE is picking up some of the impact of soil type, i.e., the value of the plot of land under cultivation is determined by the soil type of that plot and hence it is meaningless to include both soil dummies as well as the value of the plot. We decided to look at an alternative specification - one where we included only VALUE and excluded all the soil dummies. We do not report the results from that specification separately but we find that VALUE is still positive and significant - showing that an increase in plot value will increase the probability of tenant cultivation. The upshot of this is that we feel justified in treating VALUE as an exogenous variable - which is captured only in part by soil type but not entirely. The only difference in this specification is that IRR, i.e. the percent of land irrigated, also becomes negative and significant. Which in turn implies that with an increase in the percentage of land irrigated, the probability of that land being cultivated by the owner increases. Also note from Table 6, that IRRD4 is negative and significant. This reinforces our finding that in some specifications IRR is negative and significant. IRRD4 is a dummy which stands for well with oil engine. So it would appear that with better irrigation facilities on a certain plot of land, the probability of that plot of land being under owner cultivation increases. However it appears that the impact of irrigation is not very strong and affects contract choice only indirectly through increasing the productivity of the soil.

Finally, the lagged work dummies, LMWD and LFWD are negative significant. So if an adult male member or an adult female member of the family worked in the village labor market the previous year then the probability that they would be leasing land would decline. This is hardly surprising. If the adult members are working either as hired labor or in an alternative employment then they themselves are less inclined to lease in land and landlords

too would be disinclined to lease out land to families where the adult members have alternative employment implying less effort intensity on the leased land.

3.2 The Model with Sequential Choice

The alternative specification of tenurial choice that we consider is a sequential decision problem. In the first stage we examine what determines whether a particular plot of land is cultivated by the owner or is leased out to be cultivated by a tenant. In the second stage, *conditional on the plot being cultivated by a tenant*, we examine what determines whether the plot is under fixed rent or under share-cropping.

As we have already mentioned, the first stage is to examine whether a particular plot of land is under owner cultivation or under tenant cultivation. Note that the tenant in this case can be either a fixed rent tenant or a share tenant. Define a variable TENANT such that

$$\begin{aligned} \text{TENANT} &= 0, \text{ if the plot is under owner cultivation} \\ &= 1, \text{ if the plot is under tenant cultivation} \end{aligned}$$

As before let us assume that there is an underlying response variable TENANT* which is unobservable and has a linear specification of the form

$$[3.2] \quad \text{TENANT}^* = \beta x + u, \quad u \sim \text{IN}(0, \sigma_u^2)$$

While TENANT* is not observable what we do observe is a dummy variable TENANT such that

$$\begin{aligned} \text{TENANT} &= 0, \text{ if } \text{TENANT}^* \leq 0 \\ &= 1, \text{ otherwise} \end{aligned}$$

So in the first stage we run a binary probit to consider the choice between owner cultivation and land lease. The probability that $TENANT = 0$ is $\Phi(-\beta x)$ while the probability that $TENANT = 1$ is $\Phi(\beta x)$ giving us the log likelihood function

$$[3.3] \quad L(\beta) = \sum_{TENANT=0} \ln \Phi(-\beta x) + \sum_{TENANT=1} \ln \Phi(\beta x)$$

As before we run two specifications [3.3A] where we include only household data and another [3.3B] where we include both household and plot data.

In the second stage we consider only those plots which are under tenant cultivation. Such plots are either under fixed rent or under share-cropping. Define a variable $TENANT2$, such that

$$\begin{aligned} TENANT2 &= 0, \text{ if plot is under fixed rent} \\ &= 1, \text{ if plot is under share-cropping} \end{aligned}$$

Let us say that the underlying response variable for $TENANT2$ is $TENANT2^*$ which has the form

$$[3.4] \quad TENANT2^* = \gamma x + e, \quad e \sim IN(0, \sigma_e^2)$$

Now the problem is that $TENANT2$ is observed only when $TENANT = 1$, and hence when we look at the second stage of the we have a censored sample. Now $TENANT$ and $TENANT2$ are defined by underlying response variables $TENANT^*$ and $TENANT2^*$ respectively. Let $\rho_{u,e}$ be the correlation coefficient between the two error terms u and e as defined in equation [3.2] and [3.4] respectively. Moreover, the structure exposed to the potential sample selection bias has a qualitative dependent variable, so that the standard Heckman's two step procedure is not applicable. The equations [3.2] and [3.4] together

constitute a bivariate qualitative dependent variable model that exhibits a form of partial observability. The set-up of this problem is the following:

$$\begin{aligned} \text{TENANT}^* = \beta x + u, \text{ TENANT} &= 0, \text{ if plot is under owner cultivation} \\ &= 1, \text{ if plot is leased out on a share or rent basis} \\ \text{TENANT2}^* = \gamma x + e, \text{ TENANT2} &= 0, \text{ if plot is under fixed rent} \\ &= 1, \text{ if plot is under share} \end{aligned}$$

The model is one of partial observability, because we only observe three possible outcomes (1) $\text{TENANT} = 0$; (2) $\text{TENANT} = 1, \text{ TENANT2} = 0$; (3) $\text{TENANT} = 1, \text{ TENANT2} = 1$.

Recognizing that TENANT2 is only observed when TENANT is 1, the log likelihood function for the sample of I plots and H households can be written as (as specified in Meng & Schmidt (1985, equation 6), and Boyes, Hoffman and Low (1989))

$$\begin{aligned} [3.5] \quad L(\beta, \gamma; \rho) &= \sum_H \sum_I \{ \text{TENANT}_{ih} \text{TENANT2}_{ih} \ln F(\beta x_{ih}, \gamma x_{ih}; \rho) \\ &\quad + \text{TENANT}_{ih} (1 - \text{TENANT2}_{ih}) \ln [\Phi(\beta x_{ih}) - F(\beta x_{ih}, \gamma x_{ih}; \rho)] \\ &\quad + (1 - \text{TENANT}_{ih}) \ln [1 - \Phi(\beta x_{ih})] \} \end{aligned}$$

where $F(\cdot)$ and $\Phi(\cdot)$ denote the bivariate standard normal cumulative distribution function and the univariate standard normal cumulative distribution respectively. Estimates of the parameters are obtained by maximizing the log likelihood function. These estimates offer efficiency gains over those obtained via separate estimation of the two equations. More importantly the joint approach accounts for the potential correlation between the two equations ρ and thereby corrects for potential sample selection bias that could be incurred in separate estimation of the two equations. Once again we run two sets of regressions - one

with only household data (specification [3.5A]) and one with both household and plot level characteristics (specification [3.5B]).

However in running these regressions we found that the correlation coefficient between the two error terms u and e ($\rho_{u,e}$) is not significant in either of the specifications. This suggested that the error terms from equations [3.2] and [3.4] are not correlated and hence we could estimate the equation for TENANT2 separately by running a binary probit. So we run a binary probit to consider the choice between fixed rent tenancy and share tenancy. The probability that TENANT2 = 0 is $\Phi(-\gamma x)$ while the probability that TENANT = 1 is $\Phi(\gamma x)$ giving us the log likelihood function

$$[3.6] \quad L(\gamma) = \sum_{\text{TENANT2}=0} \ln \Phi(-\gamma x) + \sum_{\text{TENANT}=1} \ln \Phi(\gamma x)$$

As before we run two specifications [3.6A] where we include only household data and another [3.6B] where we include both household and plot data. This simple binary probit is a fairly good benchmark given the absence of correlation between the two error terms u and e .

In Table 9 we present the results from the first stage binary probit for TENANT using equation [3.3]. However for the second stage estimation for TENANT2, where sample selection is a potential problem, we present two sets of results. In Table 10 we present the coefficient estimates for TENANT2 from the joint estimation using equation [3.5]. while in Table 11 we present the results from the ordinary binary probit estimation of TENANT2 using equation [3.6].

Let us turn to these results now. The parameter estimates from the first stage probit (see Table 9) reinforce the results that we obtained in the simultaneous choice model. Once

again, the age of the household head (AGE) is positive and significant. So with an increase in the age of the household head the probability of that plot being tenant cultivated increases.

Disability, as before, is still negative and significant, showing that families with a disabled adult member tend to be owner operators and are seldom chosen as tenants.

We now get strong empirical support for Proposition 8 from the sequential choice model. VALUE is positive and significant at the 95% level showing that the probability of the plot to being tenant cultivated increases with an increase in the value of the land. In the simultaneous choice model we could only conclude that an increase in the value of the plot increases the probability of the share-cropping. Now based on the sequential choice model we can say that an increase in value increases the probability of all land lease contracts - both rent and share-cropping. This, in fact, is quite an intriguing finding because the existing literature argues that plots of higher value are cultivated by the owner using hired labor on a wage basis. Ghosh (1995) predicts a sharp testable relationship between land quality and contractual form. He argues that the best quality land will be cultivated by the owner, the medium grade land will be share-cropped and the poorest quality land will be rented out on a fixed rent basis. Our empirical results go against this prediction. In both simultaneous and sequential choice models, the sign of VALUE is positive and significant showing that increasing land quality tends to increase the probability that the land is tenant cultivated.

We also find that both LMWD and LFWD is negative and significant implying that is an adult family member worked in the village labor market in the previous year then the probability of the tenant having a land lease contract decreases. This again is intuitive. If an

adult member of the family has an alternative source of employment then the incentive for that family to lease in land declines.

Next, we turn to the second stage where we try to identify factors which affect the choice between fixed rent and share-cropping. As we mentioned already, we present two sets of results. In Table 10, we present the FIML results from the joint estimation of TENANT and TENANT2 where we correct for sample selection. In Table 11, we present the results from the simple binary probit for TENANT2, where we do not correct for sample selection.

Looking at Table 10, we find that none of the household-level or plot-level variables are significant in affecting the choice between fixed rent and share-cropping. However we do find that the correlation coefficient between the error terms e and u is not significant. When we run a simple binary probit in the second stage (see Table 11), we find that CRED and LFWD is significant at the 95% level.

CRED is defined as the outstanding debt of the household. In terms of the ICRISAT data we find that there is a positive correlation between the size of the farm and the amount of outstanding debt. We interpret the amount of outstanding debt of a household as its capacity to borrow as well, i.e., a high amount of debt for the family also implies a higher borrowing capacity. For similar arguments, see Hanchate (1996) and Morduch (1990). We find that CRED is negative and significant implying that if the tenant's borrowing capacity increases then the probability of being a share-cropper decreases. The fact that CRED is significant is of interest. It has long been held that one of the reasons one does not observe more rental contracts in less developed countries is the fact that they tend to put the entire production risk on the tenant. In a country like India where agriculture is still dependent largely on the

vagaries of nature and markets for credit or insurance are incomplete if not non-existent, tenants are leery of accepting fixed rental contracts because then they have to bear the entire risk. Very often defaulting on the rental payment means having to take a loan from the landowner and these loans typically come with exorbitantly high rates of interest (often 100% or more), with the tenant gradually getting caught up in a never-ending cycle of debt. It has been suggested that one observes a preponderance of share contracts in third world countries is due to its valuable risk sharing attributes. Shetty (1988) among others suggests that one would observe a shift towards more rental contracts if the tenant had access to credit, because in that case he would be more willing to bear the risk since the penalty from defaulting is not as high. We find empirical validation of this claim that an increase in the availability of credit leads to a shift towards more rental contracts.

As we have mentioned already a rental contract is Pareto efficient and preserves incentives to provide effort and other inputs into the production process. On the other hand share-cropping, it is believed, leads to sub-optimal resource usage. In fact there has been quite a bit of work on the Marshallian inefficiency of share-cropping (see Bell (1985) and Shaban (1987)) which suggests that output is lower on share-cropped plots as opposed to plots under rental contracts. If we concede this argument for the time being then we find that an increase in credit availability will lead to a move towards rental contracts.

Finally the lagged female work dummy is negative and significant, showing that if an adult female member of the family worked in the village labor market the previous year then the probability of that family having a rental contract increases. If an adult member has an alternative source of income, then that income provides an insurance against income shocks

which may result from, say, bad weather. So long as the alternative income is not subject to the same shocks as the income from agricultural production, it can serve as a means of smoothing consumption and hence might increase the family's willingness to bear the extra risk of a rental contract. It is somewhat surprising that LMWD, the lagged male work dummy is not significant as well.

We do have to point out that out of 266 plots of land under tenancy, only 8 are being cultivated on a fixed rent basis while the rest are all share-cropped and hence the power of the test in the second stage is suspect.

4. Concluding Remarks

We conclude with some general remarks based on the findings of the previous sections. We find that the contract offered to a tenant is determined to a large extent by the tenant's discount factor and the value of the plot of land under cultivation. Using age as a proxy for the discount factor of the agent, we find that an increase in age tends to increase the probability that the agent will be offered a land-lease contract. Overall, we find that the youngest tenants will be working for wage, while the intermediate ones work for rent and the oldest tenants will work as share-croppers. We also find that higher quality of land will be offered on a tenancy basis.

We also find that with an increase in the tenant's capacity to borrow, the tenant will most likely be working for a rental contract. This is an important finding because it has been suggested that providing rural credit at affordable rates of interest would lead to a shift towards rental contracts. To the best of our knowledge this is the first time that anyone has provided empirical validation of this proposition. Moreover this should also lead to higher output

because output on rental plots exceeds that from share-cropped plots. However given the vary small number of rental plots in our sample, we do not wish to emphasize this result too much, but we feel it is interesting enough to report.

While there has been quite a bit of work on the Marshallian inefficiency of share-cropping (Shaban (1987)), there has been a conspicuous void in empirical work analyzing factors affecting the choice of contracts. The only paper which does this prior to our study is Laffont & Matoussi (1995). However our paper is very different in spirit. We do not claim to have provided all the answers, but we do believe that our paper constitutes an important step in analyzing contractual choice and factors which affect that choice. In that sense this paper provides a good foundation for future research in this area.

References

- Ai, C., Arcand, J-L. & 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**, 397--426.
- Allen, F. (1982), 'On Share Contracts and Screening', *Bell Journal of Economics* **13**(2), 541--547.
- Allen, F. (1985), 'On the Fixed Nature of Sharecropping Contracts', *Economic Journal* **95**(377), 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), 1121--1133.
- Banerjee, A. V. & Ghatak, M. (1996), 'Empowerment and Efficiency: The Economics of Tenancy Reform', *Mimeo, Harvard University*.
- Bell, C. (1977), 'Alternative Theories of Sharecropping: Some Tests Using Evidence from Northeast India', *Journal of Development Studies*, 13(4), 317--346.
- Bell, C. & Zusman, P. (1976), 'A Bargaining Theoretic Approach to Sharecropping Contracts', *American Economic Review*, 66, 578--588.
- Bhaduri, A. (1972), 'On the Formation of Usurious Interest Rates in Backward Agriculture', *Cambridge Journal of Economics*, 1(4), 341--352.
- Bhalla, S. S. (1988), 'Does Land Quality Matter?', *Journal of Development Economics* **29**, 45--62.
- Bhattacharyya, S. & Lafontaine, F. (1995), 'Double-sided Moral Hazard and the Nature of Share Contracts', *Rand Journal of Economics* **26** (4), 761--781.
- Boyes, W.J., Hoffman, D. & Low, S. (1989), 'An Econometric Analysis of the Bank Credit Card Scoring Problem', *Journal of Econometrics*, 40, 3--14.
- Chaudhuri, A. (1997), 'A Dynamic Model of Contract Choice in Tenancy', *Mimeo, Rutgers University*.
- Cheung, S.N.S. (1969), 'The Theory of Share Tenancy', *Cambridge University Press*.
- 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), 145--158.

Eswaran, M. & Kotwal, A. (1985), 'A Theory of Contractual Structure in Agriculture', *American Economic Review* **75**(3), 352--367.

Gangadharan, L. (1997), 'Transactions Costs in Tradeable Emissions Markets: An Empirical Study of the Regional Clean Air Incentives Market in Los Angeles', *Mimeo, University of Southern California*.

Gangopadhyay, S. & Sengupta K. (1987), 'Small Farmers, Money Lending and Trading Activity', *Oxford Economic Papers*, 39, 333--342.

Ghosh, P. (1995), 'On the Coexistence of Share, Rent and Wage Contracts in a Rural Economy', *IED Working Paper, Boston University*.

Greene, W. H. (1991), LIMDEP: User's Manual and Reference Guide, Technical report, Econometric Software Inc.

Hallagan, W. (1978), 'Self Selection By Contractual Choice and the Theory of Share Cropping', *Bell Journal of Economics* **9**, 344--354.

Hanchate, A. (1996), 'Timeliness of Farm Operations, Allocation of Labor and Yield Differences', *Mimeo, Case Western Reserve University*.

Holmstrom, B. (1982b), 'Managerial Incentive Problems - A Dynamic Perspective', *Essays in Economics and Management in Honor of Lars Wahlbeck*, Helsinki, Stockholm School of Economics.

Holmstrom, B. & Milgrom, P. (1987), 'Aggregation and Linearity in the Provision of Intertemporal Incentives', *Econometrica*, 55(2), 303--328.

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**, 381--399.

Lafontaine, F. (1992), 'Agency Theory and Franchising: Some Empirical Results', *Rand Journal of Economics* **23**(2), 263--283.

Lal, R. (1990), 'Improving Channel Coordination through Franchising', *Marketing Science*, 9, 299--318.

Maddala, G.S. (1983), 'Limited Dependent and Qualitative Variables in Economics', *Econometric Society Monographs No. 3*, Cambridge University Press.

Maitra, P. (1996), 'A Quantitative Analysis of Employment Guarantee Programs with an Application to Rural India', *Mimeo University of Southern California*.

Mathewson, G.F. & Winter, R.A. (1985), 'The Economics of Franchise Contracts', *Journal of Law and Economics*, 28, 503--526.

Meng, C. & Schmidt, P. (1985), 'On the Cost of Partial Observability in the Bivariate Probit Model', *International Economic Review*, 26(1), 71--85.

Mincer, J. (1970), 'The Distribution of Labor Incomes: A Survey with Special Reference to the Human Capital Approach', *Journal of Economic Literature*, 8(1), March, pp. 1--26.

Morduch, J. (1990), 'Risk Production and Saving: Theory and Evidence From Indian Households', *Mimeo, Harvard University*.

Newbery, D. M. G. (1977), 'Risk Sharing, Share Cropping and Uncertain Labor Markets', *Review of Economic Studies* 44, 585--594.

Newbery, D. M.G. & 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.

Otsuka, K., Chuma, H. & Hayami, Y. (1992), 'Land and Labor Contracts in Agrarian Economies: Theories and Facts', *Journal of Economic Literature*, 30, 1965--2018.

Poirier, D. J. (1980), 'Partial Observability in Bivariate Probit Models', *Journal of Econometrics*, 12, 210--217.

Rai, A. S. (1996), 'Sharecropping, Inequality and Production Efficiency in Bangladesh', *Mimeo, University of Chicago*.

Sadoulet, E., de Janvry, A. & Benjamin, C. (1996), 'Labor Market Imperfections and Selective Separability in Household Models', *Mimeo, University of California, Berkeley*.

Shaban, R. A. (1987), 'Testing Between Competing Models of Sharecropping', *Journal of Political Economy* 95 (5), 893--920.

Shetty, S. (1988), 'Limited Liability, Wealth Differences and Tenancy Contracts in Agrarian Economies', *Journal of Development Economics* 29, 1--22.

Singh, N. (1989), Theories of Sharecropping, in P. Bardhan, ed., 'The Economic Theory of Agrarian Institutions', Clarendon Press, Oxford, pp. 33--72.

Singh, R. P., Binswanger, H. P. & Jodha, N. S. (1985), Manual of Instructions For Economic Investigators in ICRISAT's Village Level Studies, Technical report, ICRISAT, Patancheru, Andhra Pradesh 502324, India.

Stiglitz, J. (1974), 'Incentives and Risk Sharing in Share Cropping', *Review of Economic Studies* **41**, 219--255.

Walker, T. S. & Ryan, J. G. (1990), Village and Household Economies in India's Semi-arid Tropics, The Johns Hopkins University Press, Baltimore and London.

TABLE 1: Number of Plots Classified by Ownership Status

<u>Ownership</u>	<u>Aurepalle</u>	<u>Shirapur</u>	<u>Kanzara</u>
Owner-operated (Wage)	288 (93%)	249 (60%)	317 (80%)
Fixed-rent	1 (0.3%)	0 (0%)	7 (2%)
Share-cropping	21 (6.7%)	165 (40%)	72 (18%)
Total	310	414	396

TABLE 2: Number of Plots, Classified by Soil Type

<u>Soil Type</u>	<u>Aurepalle</u>	<u>Shirapur</u>	<u>Kanzara</u>
Deep Black	0	40	36
Medium Black	45	128	344
Medium to Shallow Black	29	139	16
Shallow Red	223	0	0
Gravelly	0	96	0
Saline	13	9	0
Others	0	2	0

TABLE 3: Number of Plots, Classified by Irrigation Source

<u>Irrigation Source</u>	<u>Aurepalle</u>	<u>Shirapur</u>	<u>Kanzara</u>
Tank	3	1	1
Canal	0	0	0
Well with electric motor	65	31	36
Well with oil engine	0	24	0
Well with traditional device	242	357	359

TABLE 4: Selective Descriptive Statistics

Variable	Number of Observations	Mean
AGE	1120	37.437
AGE ²	1120	1920
TOTMAL	1120	2.098
TOTFEM	1120	1.90
CRED	464	7457.89
VALUE	1120	2375
IRR	1120	0.1236
DISABIL	1120	
= 0	470 (42%)	
= 1	650 (58%)	
SEX	1120	
= 0	1004 (89.6%)	
= 1	116 (10.4%)	

TABLE 5: Definition of Dummies Used

DISABIL	= 1, if any adult member of the family is unable to work
SEX	= 1, if household head is a female
IRRD1	= 1, if source of irrigation is tank
IRRD3	= 1, if source of irrigation is well with electric motor
IRRD4	= 1, if source of irrigation is well with oil engine
SOILD1	= 1, if soil type is deep black
SOILD3	= 1, if soil type is medium to shallow black
SOILD5	= 1, if soil type is shallow red
SOILD6	= 1, if soil type is gravelly
SOILD8	= 1, any other soil type
LMWD	= 1, if an adult male member of the family worked in the village labor market in the previous year
LFWD	= 1, if adult female member of the family worked in the village labor market in the previous year

**TABLE 6: Ordered Probit Results for Cultivation Status (from Equation [3.1])
Dependent Variable CONTRACT**

CONTRACT	=	0, if plot is under owner cultivation (wage contract)		
	=	1, if plot is under fixed rent		
	=	2, if plot in under share-cropping		
Variable	Coefficient Results Specification 3.1A (Household data)	Standard Error	Coefficient Results Specification 3.1B (Household and Plot data)	Standard Error
CONSTANT	0.77*	0.12	1.24*	0.17
<i>Household Characteristics</i>				
AGE	0.19E-01*	0.80E-02	.20E-01	0.88E-02
AGE ²	-0.17E-03	0.14E-03	-0.18E-03	0.16E-03
TOTMAL	0.63E-02	0.50E-01	0.56E-01	0.56E-01
TOTFEM	0.87E-02	0.47E-01	0.90E-02	0.53E-01
DISABIL	-0.42*	0.12	-0.47*	0.13
SEX	-0.42E-01	0.14	0.87E-01	0.16
CRED	-0.108E-04	0.81E-05	-0.15E-04	0.8E-05
LMWD	-0.62*	0.20	-0.39	0.21
LFWD	-0.39*	0.15	-0.80E-01	0.22
<i>Plot Characteristics</i>				
IRRD1			0.97	0.89
IRRD3			-0.54	0.48
IRRD4			-1.24*	0.58
SOILD1			0.37*	0.18
SOILD3			0.46*	0.13
SOILD5			-0.65*	0.27
SOILD6			0.74*	0.17
SOILD8			5.13	11605
VALUE			0.96E-04*	0.37E-04
IRR			0.25	0.48
μ	0.25E-01	0.90E-02	0.28E-01	0.11E-01

Number of Observations: 1120

*: H_0 significant at 95%

TABLE 6A: (For Data Presented in Table 6)

	Specification 3.1A (Household Data)	Specification 3.1B (Household & Plot Data)
log likelihood function	-607.59	-558.70
Restricted log likelihood	-649.87	-649.87
chi-squared	84.567	182.34
degrees of freedom	9	19
pseudo-R ²	0.065	0.14029
percentage of correct predictions	76	80

TABLE 6B: Effect of Changing AGE on the Cumulative Probability

	<u>AGE = 20</u>	<u>AGE = 30</u>	<u>AGE = 40</u>	<u>AGE = 50</u>
CONTRACT = 0 (Wage Contract)	0.382	0.341	0.314	0.298
CONTRACT = 2 (Share Contract)	0.606	0.648	0.675	0.688

**TABLE 7: Marginal Results from Ordered Probit Estimation - Specification 3.1A
(Dependent Variable CONTRACT)**

CONTRACT = 0, if plot is under owner cultivation
 = 1, if plot is under fixed rent
 = 2, if plot is under share-cropping

Variable	CONTRACT=0	CONTRACT=1	CONTRACT=2
CONSTANT	0.2277	-0.0045	-0.2233
<i>Household Characteristics</i>			
AGE	-0.0057	0.0001	0.0056
AGE ²	0.0001	0.0000	0.0000
TOTMAL	-0.0020	0.0000	0.0020
TOTFEM	-0.0020	0.0000	0.0020
DISABIL	0.1255	-0.0025	-0.1230
SEX	0.0123	-0.0002	-0.0121
CRED	0.0000	0.0000	0.0000
LMWD	0.1836	-0.0036	-0.1800
LFWD	0.1153	-0.0023	-0.1130

**TABLE 8: Marginal Results from Ordered Probit Estimation - Specification - 3.1B
(Dependent Variable CONTRACT)**

CONTRACT =	0, if plot is under owner cultivation		
=	1, if plot is under fixed rent		
=	2, if plot is under share-cropping		

Variable	CONTRACT=0	CONTRACT=1	CONTRACT=2
CONSTANT	0.3463	-0.0081	-0.3382
<i>Household Characteristics</i>			
AGE	-0.0055	0.0001	0.0054
AGE ²	0.0000	0.0000	0.0000
TOTMAL	-0.0161	0.0004	0.0157
TOTFEM	-0.0022	0.0001	0.0022
DISABIL	0.1306	-0.0030	-0.1276
SEX	-0.0243	0.0006	0.0237
CRED	0.0000	0.0000	0.0000
LMWD	0.1089	-0.0025	-0.1064
LFWD	0.0215	-0.0005	-0.0210
<i>Plot Characteristics</i>			
IRRD1	-0.2756	0.0064	0.2692
IRRD3	0.1499	-0.0035	-0.1464
IRRD4	0.3472	-0.0081	-0.3392
SOILD1	-0.1026	0.0024	0.1002
SOILD3	-0.1267	0.0029	0.1237
SOILD5	0.1833	-0.0043	-0.1790
SOILD6	-0.2083	0.0048	0.2034
SOILD8	-1.4664	0.0341	1.4323
VALUE	0.0000	0.0000	0.0000
IRR	-0.0688	0.0016	0.0672

**TABLE 9: Binary Probit Results for the First Stage - Equation 3.5
(Dependent Variable TENANT)**

Variable	Coefficient Results (Household data)	Standard Error	Coefficient Results (Household & Plot data)	Standard Error
TENANT	=	0, if plot is under woner cultivation	=	1, if plot is leased out on a rent or share basis
CONSTANT	-0.78*	0.11548	-1.22*	0.16
<i>Household Characteristics</i>				
AGE	0.19E-01*	0.70569E-02	0.19E-01*	0.79E-02
AGE ²	-0.17E-03	0.11744E-03	-0.16E-03	0.13E-03
TOTMAL	0.62E-02	0.42705E-01	0.56E-01	0.47E-01
TOTFEM	0.40E-02	0.44119E-01	0.28E-02	0.48E-01
DISABIL	-0.41*	0.10763	-0.46*	0.13
SEX	-0.48E-01	0.14556	0.68E-01	0.16
CRED	-0.86E-05	0.70755E-05	-0.13E-04	0.78E-05
LMWD	-0.63*	0.20576	-0.39	0.22
LFWD	-0.38*	0.15467	-0.68E-01	0.18
<i>Plot Characteristics</i>				
SOILD1			0.34	0.18
SOILD3			0.45*	0.13
SOILD5			-0.67*	0.19
SOILD6			0.70*	0.16
SOILD8			5.29	77.95
IRRD1			4.47	49.03
IRRD3			-0.63	0.50
IRRD4			-1.34*	0.58
VALUE			0.91E-04*	0.36E-04
IRR			0.36	0.51

Number of observations: 1120 *: H₀ significant at 5%
log likelihood function (Specification A - household data) -572.44
log likelihood function (Specification B - household & plot data) -522.52
Restricted log likelihood function -613.96
Chi-squared (9 degrees of freedom) = 83.04 Chi-squared (19 degrees of freedom)=182.88
Pseudo-R² = 0.067 for model with household data only;
Pseudo-R² = 0.1489 for model with household and plot data

**TABLE 10: Coefficient Results for TENANT2 from Joint Estimation of
TENANT and TENANT2 - Equation 3.4**

Variable	Coefficient Results (Household data)	Standard Error	Coefficient Results (Household & Plot data)	Standard Error
TENANT2	=		0, if plot is under fixed rent	
	=		1, if plot is under share tenancy	
CONSTANT	1.02	19.70	0.96	36.52
<i>Household Characteristics</i>				
AGE	0.61E-03	0.16	0.12E-02	0.20
AGE ²	0.31E-03	0.76E-02	0.14E-03	0.62E-02
TOTMAL	-0.36E-02	0.56	0.16E-02	1.18
TOTFEM	0.20E-01	0.44	0.21E-01	1.02
DISABIL	-0.17E-01	2.31	-0.23E-01	5.11
SEX	0.81E-02	1.44	0.37E-01	2.58
CRED	-0.56E-04	0.62E-03	-0.59E-04	0.53E-03
LMWD	0.34E-01	2.94	0.19E-01	4.34
LFWD	-0.60E-01	2.29	-0.54E-01	4.03
<i>Plot Characteristics</i>				
SOILD1			0.12	4.76
SOILD3			0.45E-01	5.41
SOILD5			0.82E-01	5.93
SOILD6			0.72E-01	8.21
SOILD8			0.75E-01	39.44
IRRD1			-0.70E-01	18.21
IRRD3			0.58E-01	9.33
IRRD4			0.46E-01	594.42
VALUE			0.23E-03	0.66E-02
IRR			-0.11	6.62
$\rho_{u,e}$	0.31E-04	30.29	0.30E-03	52.03

Number of observations: 266

*: H_0 significant at 5%

log likelihood function (with household data only) -745.33

log likelihood function (with household and plot data) -677.56

TABLE 11: Coefficient Results for TENANT2 from Ordinary Probit in Second Stage

Variable	Coefficient Results (household data)	Standard Error	Coefficient Results (household & plot data)	Standard Error
TENANT2	= 0, if plot is under fixed rent = 1, if plot is under share tenancy			
CONSTANT	-4.78*	0.12	-1.23*	0.16
<i>Household Characteristics</i>				
AGE	-0.16E-01	0.82E-01	0.14	0.19
AGE ²	-0.46E-03	0.12E-02	-0.32E-02	0.31E-02
TOTMAL	0.26	0.35	2.47	1.85
TOTFEM	0.18	0.21	-1.72	1.49
DISABIL	-1.18	075	-7.90	59.99
SEX	1.03	10.94	6.54	239.77
CRED	-0.50E-04*	0.25E-04	0.15E-03	0.95E-04
LMWD	3.43	47.76	0.29	7688.3
LFWD	-1.31*	0.67	1.61	68.03
<i>Plot Characteristics</i>				
SOILD1			21.79	168.35
SOILD3			3.44	62.91
SOILD5			3.35	7684.4
SOILD6			10.86	160.48
SOILD8			7.76	806.83
IRRD1			-10.97	110.52
IRRD3			-4.38	8.32
IRRD4			-11.92	7724.1
VALUE			0.14E-02	0.15E-02
IRR			-2.92	6.43
Number of Observations		1120	*: H ₀ significant at 5%	
log likelihood function (household data)		-24.09		
log likelihood function (household and plot data)		-10.69		
Restricted log likelihood function		-35.91		
Chi-squared (9 degrees of freedom)		23.6	Chi-squared (19degrees of freedom) 50.435	
pseudo-R ² = 0.329 for household data only;			pseudo-R ² = 0.702 for household and plot data	