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Moral Hazard, Financial Constraints and Sharecropping in El Oulja

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This paper develops a theory of sharecropping which emphasizes the dual role of moral hazard in the provision of effort and financial constraints. The model is compatible with a large variety of contracts as observed in the region of El Oulja in Tunisia. Using an original data set including financial data, various tests of the theory are undertaken. Production functions stressing the role of effort are estimated. The data support the theory which predicts lower efficiency when the tenant's share of output is lower. The role of financial constraints in explaining which type of contract is selected (as well as the implications that financial constraints have upon effort and therefore output) are supported by the data.

1. INTRODUCTION

Following Adam Smith, all economists until Johnson (1950) have considered sharecropping to be a "practice which is hurtful to the whole society", an unexplained failure of the invisible hand that should be either discouraged by taxation (A. Smith) or improved by appropriate sharing of variable factors (Schickele (1941), Heady (1947)). Johnson (1950) starts from the empirical observation that "the deviations from optimum (induced by sharecropping contracts) are not immediately obvious from a cursory examination of American farms operating under different types of tenure arrangements". He then argues that the landlord can approach the desired intensity of cultivation by detailed contracting and monitoring, by providing other inputs and keeping the size of the individual unit small, to decrease (by an income effect) the farmer's marginal disutility of effort, or by the use of short-term contracts. However, he admits that his theory does not quite explain why sharecropping contracts seem to do as well as rental contracts.

The next main step[1] in the understanding of sharecropping was achieved by stressing tenants' risk aversion. The rental contract does not provide an appropriate sharing of risk. Sharecropping results from the trade-off beween incentives and risk sharing (Stiglitz

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1. The solution proposed by Cheung (1968) amounts to assuming that labour intensity can be chosen by the landlord. Bardhan and Srinivasan (1971), in an otherwise unsatisfactory model, correctly stress that the landlord cannot decide how much labour the sharecropper puts in his land. Shaban (1987) provides empirical evidence against the idea that landlords can completely monitor effort.

(1974), Newbery (1977))[2]. A positive role for sharecropping is finally found as a second-best way of inducing effort by risk-averse tenants. Braverman and Stiglitz (1982) extend this insight by showing, as second-best theory suggests, that the landlord should intervene in all markets (credit market and input markets) in which the tenant transacts, in order to mitigate the inefficiency resulting from the above trade-off.

More recently, various papers (see Singh (1987) for a survey) focus on an asymmetry of information between tenants and landlords. Tenants are screened for their ability (or some other variable of private information) by the various contracts. However, the stability of the population in the village we study (El Oulja) makes these informational explanations quite unconvincing. Everybody seems to be aware of the abilities of every member of the village.

Other models stress the imperfections of some markets to explain various features of tenancy choices, for example missing markets for some inputs such as bullocks, technical know-how, family labour (Eswaran and Kotwal (1985), Bliss and Stern (1982), Pant (1983), Reid (1976)).

Our main emphasis will be on missing credit markets[3] when effort levels are not observable. We are not the first ones to stress these features. However, with one exception we became aware of after writing a first draft of this work, papers discussing credit constraints do not use these constraints as an explanation of sharecropping. Braverman and Srinivasan (1981) show that preventing either landlords from providing credit to tenants or the provision of credit by the government does not affect the welfare of tenants. This is due to the fact that in their model landlords can control effort levels by varying the size of the plot given to a tenant. The authors "take it as given that the only form of tenancy is sharecropping". Jaynes (1982) has also emphasized credit constraints but by assuming that landlords are more constrained than tenants[4].

In a contribution which is the closest to our paper Shetty (1988) develops a model where sharecropping is explained by an ex post liability constraint. In bad states of nature, the rent cannot be paid completely. Even with risk-neutral tenants limited liability introduces non-concavities in the landlord's and tenant's payoff functions. Sharecropping mitigates within the relationship the associated insurance problem. Shetty's assumption that tenants' assets can be appropriated costlessly by landlords is inadequate for the village we observe. We are led instead to write an ex ante financial constraint which, in the absence of moral hazard, explains the emergence of sharecropping, but not inefficient outcomes. An ex ante financial constraint *and* moral hazard will be the two main building blocks of our stylized model.

The data are briefly described in Section 2 (the Appendix gives summary statistics of the data). Section 3 describes the interaction of moral hazard in the tenant's effort level and of the financial constraint in the design of efficient contracts. The model of Section 3 is extended in Section 4 to account for the landlord's financial constraints, variable sizes of plots, risk aversion, repeated relationships, etc. Section 5 is devoted to the estimation of production functions including an effort variable. Strong empirical support is given to the need for considering incentives in the estimation of production or cost functions. Section 6 provides an empirical analysis for the choices of contracts and confirms the

2. Risk aversion alone is not enough. As shown by several authors a sharecropping contract can then be mimicked by an appropriate combination of rent and wage contracts.

3. See Braverman and Guasch (1986) for empirical evidence on the difficulties to provide rural credit in LDC's.

4. A referee pointed out a reference to Marx who stressed that sharecropping permits an "individual who is not himself a capitalist to have a capitalist for a partner" in Jaynes (1982).

important role played by financial variables in explaining the type of contract selected by a landlord and a tenant. Concluding comments are gathered in Section 7.

2. THE DATA

A survey carried out with the help of the Tunisian National Institute for Statistics has been conducted in 1986 in a rural area known as El Oulja, 40 miles west of Tunis. One hundred families have been concerned with this survey which includes three types of data.

(i) General information about the families with, in particular, the number of days worked in agriculture.
(ii) Information about each plot of land defined as a piece of land where only one type of crop is carried out each season. Data include size of plot, type of crop, type of labour contract used (either wage contract or fix rent contract or share-cropping contract), production levels, precise amounts of labour inputs as well as precise amounts of other inputs.
(iii) Wealth and income data for each family.

A similar survey was undertaken in 1988 with somewhat less care. We will use data from it only to test the robustness of our results (see the appendix for more on the data).

3. CONTRACTING WITH FINANCIAL CONSTRAINTS AND MORAL HAZARD

As recognized now in the literature (see Reid (1987), Singh (1987)), the theory of share-cropping is best viewed as a sub-field of the theory of the firm. One cannot expect "one particular explanation of managerial structure to be uniquely powerful over a long period of time and across many cases" (Reid (1987), p. 565). Any model of sharecropping must stress specific features of the data to be explored. The purpose of this section is to develop a simple model incorporating the basic ideas we found useful in explaining the character-istics of sharecropping in El Oulja. The model will then be enriched to account for a number of interesting but secondary aspects of the contracting problem we study and to relax some assumptions of the basic model.

The production function of an elementary piece of land, called a plot, is written:

$$\tilde{y} = f(le, x) + \tilde{\varepsilon}, \qquad f \text{ increasing and concave}, \tag{1}$$

where $\tilde{y}$ is output, l is the amount of labour input, e is the average level of effort applied to these units of labour ($le = \hat{l}$ is labour in efficiency units), x is the amount of other material inputs, and $\tilde{\varepsilon}$ is a zero-mean random variable.

Land is owned by landlords who contract with tenants to organize production. A general contract is defined by three parameters (α, β, r) which are, respectively, the share of the product kept by the tenant, the share of material inputs paid by the tenant and the certain payment made by the tenant to the landlord. This general form of contract encom-passes all types of contracts used.

A pure rental contract (RC) is associated with $\alpha = 1$, $\beta = 1$, and $r > 0$.
A pure wage contract (WC) is associated with $\alpha = 0$, $\beta = 0$, and $r < 0$.
A sharecropping contract (SC, α; β) is associated with $\alpha \in (0, 1)$, $\beta \in (0, 1)$ and $r \geq 0$.
If we denote $\psi(le)$, with $\psi(0) = 0$, $\psi' > 0$, $\psi'' > 0$ the disutility of labour for the tenant his utility level for a contract (α, β, r) when he works le in efficiency units is, assuming

risk neutrality:

$$af(le, x) - \beta x - \psi(le) - r - w$$

where w denotes his living expenses at the subsistence level without working. Note also that, as we are going to use only a cross-section of data, all prices have been normalized to one.

First, assume that the landlord can observe all variables. If the landlord is risk neutral, the efficient contracts solve the following maximization programme:

$$\max_{(\alpha,\beta,r,\hat{l},x)} (1-\alpha)f(\hat{l}, x) - (1-\beta)x + r \qquad (2)$$

subject to

$$af(\hat{l}, x) - \beta x - \psi(\hat{l}) - r - w \geq \bar{u} \qquad (\lambda) \qquad (3)$$

where $\bar{u}$ is the alternative level of utility the tenant can achieve. The main interior first-order conditions of this programme are:

$$(1-\alpha)\frac{\partial f}{\partial \hat{l}}(\hat{l}, x) + \lambda\left[\alpha\frac{\partial f}{\partial \hat{l}}(\hat{l}, x) - \psi'(\hat{l})\right] = 0 \qquad (4)$$

$$(1-\alpha)\frac{\partial f}{\partial x}(\hat{l}, x) - (1-\beta) + \lambda\left[\alpha\frac{\partial f}{\partial x}(\hat{l}, x) - \beta\right] = 0 \qquad (5)$$

$$1 - \lambda = 0 \qquad (6)$$

or

$$\frac{\partial f}{\partial \hat{l}}(\hat{l}, x) = \psi'(\hat{l}) \quad \text{and} \quad \frac{\partial f}{\partial x}(\hat{l}, x) = 1 \qquad (7)$$

i.e. the efficient allocation of resources is achieved.

If $\hat{l}^*$, x^* denote the efficient allocation of resources, (α, β, r) are chosen so that:

$$af(\hat{l}^*, x^*) - \beta x^* - \psi(\hat{l}^*) - r - w = \bar{u} \qquad (8)$$

i.e.,

$$\alpha = 1, \beta = 1 \quad r = f(\hat{l}^*, x^*) - \beta x^* - \psi(\hat{l}^*) - \bar{u} - w \quad \text{for a RC,}$$
$$\alpha = 0, \beta = 0 \quad r = -\bar{u} - \psi(\hat{l}^*) - w \qquad\qquad\qquad \text{for a WC,}$$

any combination α, β, r satisfying (8) for a SC. In the observed share contracts we have $r = 0$.

Any type of contract can therefore fulfill the first-order conditions at the efficient allocation of resources.

Assume now that, because of imperfections in the credit market, the working capital R of the tenant is limited. In defining an optimal contract, we must add the constraint:

$$w + \beta x^* + r \leq R \qquad (9)$$

but there remain multiple optimal contracts implementing the efficient allocation of resources.

Remark. Constraint (9) is an ex ante financial constraint. It says that the tenant must pay for his living expenses (w), for his share of input (βx^*) and for an eventual rent

(r). The rent r may be negative and it is then interpreted as a wage. From the point of view of the sharecropper what matters is the aggregate amount of money $r + \beta x^*$ he must disburse. As β and x^* are observable β does not play any independent role in the theoretical analysis. Our way of writing the financial constraint implies that any delayed payment to the landlord takes place only in the form of a share of output $(1 - \alpha)(f + \varepsilon)$. An alternative (followed by Shetty (1988)) would be to ask for an ex post rent r and obtain min $(r, f + \varepsilon)$. Our unmodelled argument to exclude this possibility is that the transaction costs for monitoring output would then be as great as in sharecropping while at the same time inducing less effort of the landlord (who can give to the tenant all sorts of advices and helps). A complete investigation of this question would require introducing moral hazard in the insurance with limited liability model of Shetty. Also, this alternative way of sharing ex post output appears extremely conflictual in the cases of bad crops. The landlord then gets all of the production instead of sharing the consequences of bad states of nature with the tenant.

The logic of the behaviour we postulate for the landlord is to obtain as much cash advances from the tenant as possible in the form of rent or material inputs. He then picks the lowest α compatible with the tenant's individual rationality constraint.
From (8) and (9) we have:

$$\alpha \leqq \frac{\bar{u} + R + \psi(\hat{l}^*)}{f(\hat{l}^*, x^*)}. \tag{10}$$

Rental contracts and sharecropping contracts with a high share of the product given to the tenant may be excluded by financial constraints and the constraint (10) is tight. It predicts a positive correlation between α and R that is easy to observe in the data.
So far the model predicts efficient production, but we pursue the analysis by assuming that the tenants's effort levels are unobservable by the landlord (at least beyond some monitorable level). We continue to assume that material inputs, x, and labour, l, are observable and consequently can be chosen by the landlord. However, e is chosen by the tenant. Hence, the moral hazard constraint[5]:

$$\alpha \frac{\partial f}{\partial \hat{l}}(le, x) = \psi'(le). \tag{11}$$

If no financial constraint existed, then risk neutrality would enable the landlord to achieve an efficient allocation of resources by choosing a rental contract $(\alpha = 1)$. The tenant would then benefit from all his effort and would choose a socially optimal level of effort.
Consider now the landlord's optimization programme when both a financial constraint for the tenant and the moral hazard constraint (11) exist:

$$\max_{(\alpha, \beta, r, l, e, x)} (1 - \alpha)f(le, x) - (1 - \beta)x + r \tag{12}$$

subject to

$$\alpha f(le, x) - \beta x - r - \psi(le) - w \geqq \bar{u} \tag{13}$$

$$R - \beta x - r - w \geqq 0 \tag{14}$$

$$\alpha \frac{\partial f}{\partial \hat{l}}(le, x) - \psi'(le) = 0. \tag{15}$$

5. As f is concave in $\hat{l}$ and ψ convex, the first-order condition (11) is sufficient to characterize the choice of effort level.

Clearly, if R is large enough (14) is not binding and a rent contract is selected with the highest possible value of r which saturates the individual rationality constraint.

Let us now focus on the case where the financial constraint is binding; (14) can be used to substitute the value of $r + w + \beta x$ to give:

$$\max_{(\alpha, le, x)} (1 - \alpha) f(le, x) - x + R - w \tag{16}$$

subject to

$$\alpha f(le, x) - \psi(le) \geqq \bar{u} + R \quad (\lambda) \tag{17}$$

$$\alpha \frac{\partial f}{\partial \hat{l}}(le, x) - \psi'(le) = 0. \quad (\mu) \tag{18}$$

We obtain the first-order interior conditions[6]:

$$(1 - \alpha) \frac{\partial f}{\partial \hat{l}}(le, x) + \mu \left[\alpha \frac{\partial^2 f}{\partial \hat{l}^2}(le, x) - \psi''(le) \right] = 0 \tag{19}$$

$$(1 - \alpha) \frac{\partial f}{\partial x}(le, x) - 1 + \lambda \alpha \frac{\partial f}{\partial x}(le, x) + \mu \alpha \frac{\partial^2 f}{\partial \hat{l} \partial x}(le, x) = 0 \tag{20}$$

$$(\lambda - 1) f(le, x) + \mu \frac{\partial f}{\partial \hat{l}}(le, x) = 0. \tag{21}$$

Using (15) and (21) in (19) (20), we finally get, leaving out arguments in the functions:

$$\frac{\partial f}{\partial \hat{l}} = \psi' + \mu \left(\psi'' - \alpha \frac{\partial^2 f}{\partial \hat{l}^2} \right) \tag{22}$$

$$\frac{\partial f}{\partial x} = \frac{1 - \mu \alpha \frac{\partial^2 f}{\partial \hat{l} \partial x}}{1 - \mu \alpha \frac{\partial f}{\partial \hat{l}} \bigg/ f}. \tag{23}$$

The allocation is now inefficient, $\mu > 0$[7], the marginal productivity of labour in efficiency units is too high; the marginal productivity of inputs is also too low (if labour and material inputs are not complementary) with an ambiguous result if they are complementary. The complete comparative statics of this model is actually quite complex and will not be derived.

However, we can obtain the following proposition which summarizes the main predictions of the model.

Proposition 1.
  (i) *The landlord's utility level increases with the tenant's working capital R.*
  (ii) *Conditionally on the level of other inputs x, the level of effective labour le, and therefore the production level, y, are increasing in R.*

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6. We assume below that the individual rationality constraint is binding. For R small enough either there will be a switch to a wage contract (see below) or the landlord will prefer not to saturate the individual rationality constraint to induce some effort. For a fixed x it can easily be checked that $d\lambda/dR < 0$. Therefore depending on the production function either the constraint is always binding or it is not binding for R smaller than a threshold value. This helps explain why in practice the share of the product left to the worker is never less than $1/2$.
  7. Look at (19), and use the concavity of f and the convexity of ψ.
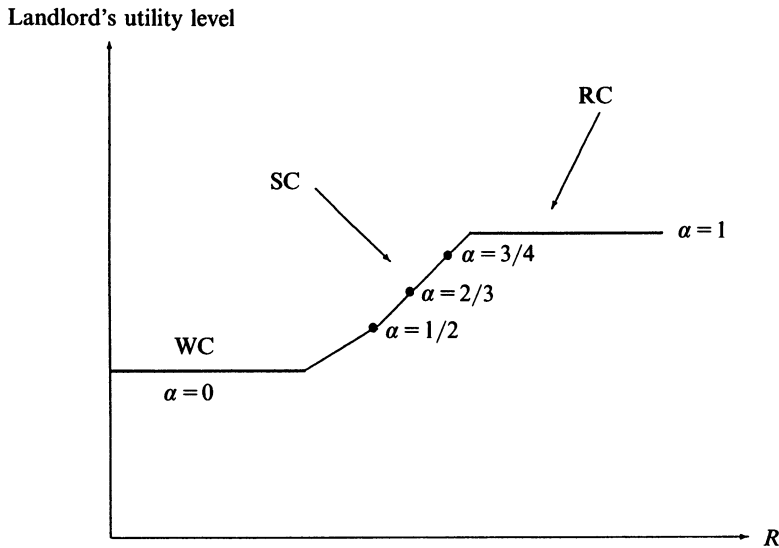
Landlord's utility level

FIGURE 1

(iii) *Conditionally on the level of other inputs x, the tenant's share of output α is increasing in R.*

Proof. (i) Follows from the envelope theorem and (ii) and (iii) from a straightforward differentiation of the first-order conditions for the landlord's programme. ‖

Since we have assumed that the tenant's individual rationality level of utility is independent[8] of his working capital, the level of utility for the landlord is decreasing when the tenant's working capital R decreases. Then comes a point at which the landlord prefers to incur some monitoring cost[9] to ensure a minimal effort level and switch to a wage contract. The model so obtained is then compatible with the co-existence of all types of contracts that we observe in El Oulja[10].

In Proposition 1, the monotonicity of y and α in R is obtained only conditionally on x. This will be enough for the empirical work. The prediction of Proposition 1 (ii) will be explored in Section 5 where we estimate production functions testing for a positive dependence of production on R or α conditionally on x. Proposition 1 (iii) will be used to test in Section 6 the positive dependence of the contract choice on R conditionally on x (and also unconditionally). Figure 1 summarizes the analysis. What has not been proved is the

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8. We may also expect (depending on the relative numbers of landlords and tenants) that the tenants with a lot of working capital will be able to extract more income than the others. In Figure 1 we have assumed that the bargaining power was in the hands of landlords, tenants being all kept at the $\bar{u}$ level. The other extreme situation would be the one where landlords would be kept at the same level and the increase of utility due to more effort (due to higher shares (due to higher working capital)) would benefit tenants. (see Bell (1989) for a bargaining model of sharecropping). In this paper we stay in the principal agent framework with $\bar{u}$ exogenous on the grounds that an excess supply of labour is endemic in El Oulja.

9. If $\partial f/\partial l$ is bounded above, and the tenant is very poor (α very small), sharecropping incentives for effort are very low.

10. Actually, we observe only the values of 1/2, 2/3 and 3/4 for the parameter α in the sharecropping contracts.

monotonicity of α in R unconditionally as we can expect in general and as illustrated in the figure.

4. EXTENDING THE BASIC FRAMEWORK

(i) Financial constraints of the landlords

If the tenant does not have any financial constraint, then the optimal contract is the rental contract. It remains the solution even if the landlord has financial constraints since this contract does not require any financial participation of the landlord.

Consider now the case where the tenant's financial constraint is binding. If R^l denotes the available working capital of the landowner, indexing now by t, the tenant's working capital, his optimization programme is:

$$\max_{(\alpha,le,\beta,x,r)} (1-\alpha)f(le, x) - (1-\beta)x + r$$

subject to

$$\alpha f(le, x) - \beta x - r - \psi(le) \geqq \bar{u}$$

$$R^t - \beta x - r - w \geqq 0$$

$$\alpha \frac{\partial f}{\partial \hat{l}}(le, x) - \psi'(le) = 0$$

$$R^l - (1-\beta)x + r \geqq 0.$$

From the two tight financial constraints we derive:

$$x = R^t + R^l - w$$

$$r = (1-\beta)R^t - \beta R^l - (1-\beta)w.$$

The maximization programme is reduced to:

$$\max_{(\alpha,le)} (1-\alpha)f(le, R^t + R^l - w) - R^l$$

$$\alpha f(le, R^t + R^l - w) - R^t + w - \psi(le) \geqq \bar{u} \qquad (\lambda) \qquad\qquad (24)$$

$$\alpha \frac{\partial f}{\partial \hat{l}}(le, R^t + R^l - w) - \psi'(le) = 0. \qquad (\mu) \qquad\qquad (25)$$

Restricting the analysis to the case where both constraints are binding we obtain by straightforward differentiation

$$\frac{d\alpha}{dR^l} = -\frac{\partial f/\partial x}{f} < 0$$

$$\frac{d\alpha}{dR^t} = \frac{1 - \alpha \partial f/\partial x}{f} > 0$$

(if the marginal productivity of other inputs is not too far from the optimum) and

$$\frac{d\alpha}{dR^i} - \frac{d\alpha}{dR^l} > 0^{11}.$$

The effect of the landlord's wealth on effort or labour alloction in efficiency units depends on the sign of $\partial^2 f/\partial \hat{l} \partial x$. If labour and material inputs are not complementary ($\partial^2 f/\partial \hat{l} \partial x < 0$), labour is increased. The effect is ambiguous if they are complementary and null for a Cobb–Douglas production function.

We will use these results to test that the landlord's wealth has a negative effect on the tenant's share and that the landlord's working capital has no effect on production for a Cobb–Douglas specification.

(ii) Variable size of plots, hired labour

Let h be the size of the plot alloted to a given head of family who can use l_f units of familial work where l_f is first supposed to be observable. He can also hire an amount l of labour at a wage v with a normalized effort level of one enforced by the tenant's monitoring. Being essentially non-verifiable by the landlord this labour input is not usually shared. (We ignore the subsistence level in this next model).

The landlord's income is then:

$$(1 - \alpha) f(h, l_f e + l, x) - (1 - \beta)x + r.$$

Let $\psi(e)$ denote now the disutility of effort for each member of the family who has an outside opportunity equal to $\bar{u}$.

The utility level of the family is:

$$\alpha f(h, l_f e + l, x) - \beta x - vl - r - \psi(e)l_f.$$

The landlord's maximization programme becomes then:

$$\max_{(\alpha, \beta, h, e, l, x, r)} \{(1 - \alpha) f(h, l_f e, l, x) - (1 - \beta)x + r\}$$

$$\alpha f(h, l_f e, l, x) - \beta x - vl - r - \psi(e)l_f \geqq l_f \bar{u}$$

$$\alpha \frac{\partial f}{\partial \hat{l}} = \psi'(e) \text{ (if } l_f > 0)$$

$$\alpha \frac{\partial f}{\partial l} = v \text{ (if } l > 0)$$

$$R' - \beta x - vl - r \geqq 0.$$

By limiting the size or the plot, one might think that the landlord is able to obtain a high level of effort from the tenant (Braverman and Srinivasan (1981), Johnson (1950), Cheung (1969)). However, if l_f is unobservable because the family labour devoted to the plot is chosen by the tenant in an unverifiable way an additional moral hazard constraint of the choice of l_f must be added. We are then back to our previous model with a slight variation on the specification of the disutility of effort[12].

11. See Eswaran and Kotwal (1985) for alternative foundations of similar relationships.
12. The formulation $l\psi(e)$ would lead to the same conditional predictions in Section 3.

If there is no outside labour used and we have constant returns to scale the problem is reduced to our previous formulation if we reason per unit of land:

$$\max_{(\alpha,\beta,h,e,l_f/h,x,\tilde{r})} h\left\{(1-\alpha)g\left(e\frac{l_f}{h},\frac{x}{h}\right)-(1-\beta)\frac{x}{h}+\tilde{r}\right\}$$

$$\alpha g\left(e\frac{l_f}{h},\frac{x}{h}\right)-\beta\frac{x}{h}-\tilde{r}-\psi(e)\frac{l_f}{h}\geq\bar{u}\cdot\frac{l}{h}$$

$$\alpha\frac{\partial g}{\partial l}-\psi'(e)=0$$

$$\frac{R'}{h}-\beta\frac{x}{h}-w\frac{l_f}{h}-\tilde{r}\geq0.$$

A conclusion of this model is that if there are constant returns to scale, R' and h should appear only as the ratio R'/h in the explanation of the contract chosen. When a family works on several crops the working capital normalized by the total surface cultivated should be used.

(iii) Risk aversion

So far we have neglected risk aversion in our explanation of contracts. Clearly, risk aversion of the tenant may have a role in justifying a smaller share of output for him. As risk aversion is usually inversely related to wealth we will test this possibility by testing the significance of wealth in the explanation of the main features of the chosen contracts. This is certainly is a weak test given the relationship between wealth and working capital.

(iv) Repeated relationships

Game theory has familiarized us with the idea that repeated relationships may solve moral hazard problems by relying on appropriate threats such as here threat of non-renewal of the contract (Johnson (1950)). Financial considerations would explain the form of the contract and efficiency would be enforced by repeated relationships[13]. We will test this idea by introducing the length of the relationship in the productivity equations that we will estimate.

(v) Family labour constraints

The preceding analysis has assumed that sharecroppers and tenants are not constrained in their use of family labour. This is particularly doubtful for sharecroppers who may be financially constrained in the land they can rent and therefore have excessive family labour in a world where unemployment is widespread. To distinguish the inefficiency of family labour in sharecropping due to low effort levels and the inefficiency due to excessive labour inputs we will introduce a dummy variable which distinguishes "large size" families from "small size" families where the second effect should not appear.

13. See Dutta, Ray and Sengupta (1989).

5. ESTIMATION OF PRODUCTION FUNCTIONS

Our theoretical analysis suggests that the level of production depends on the level of the tenant's working capital. It is easy to exhibit a significant positive correlation between the level of working capital and production levels but the economic meaning of this dependence is difficult to ascertain given the high correlation between input levels and working capital. Instead we have chosen to estimate the effect of the contract type on the production levels[14]. For given input levels, the level of working capital affects the type of contract chosen, therefore the levels of effort and finally the production levels (see Proposition 1). This procedure does not raise econometric difficulties if contract types can be considered as exogeneous in the production function.

First, we consider Cobb–Douglas production functions with inputs, family labour FL, hired labour HL, and other inputs M, and shift variables $Z1$, $Z2$, $Z3$ defined as follows:

$Z1 = 1$ when the farmer is the owner or has a rental contract
$\quad = 0$ otherwise
$Z2 = 1$ when the farmer is a sharecropper
$\quad = 0$ otherwise
$Z3 = t \times Z2$ where t is the length of the relationship between the landlord and the
$\quad$ farmer for a sharecropping contract (t is measured in months).

In the following regressions, Y denotes production per hectare and inputs are evaluated per hectare. A two-stage least-squares procedure is used for inputs HL and M. Next an exogeneity test on $Z1$, $Z2$ and $Z3$ is carried out.

For the 1986 survey (170 observations) we obtain (t statistics in parenthesis):

$$\text{Log } Y = 4 \cdot 8 \; Z_1 + 4 \cdot 4 \; Z_2 + 0 \cdot 009 \; Z_3 + 0 \cdot 20 \; \text{Log FL} + 0 \cdot 15 \; \text{Log HL} + 0 \cdot 23 \; \log M$$
$$(8 \cdot 3) \quad (7 \cdot 7) \quad (5 \cdot 8) \quad (5 \cdot 6) \quad (4 \cdot 4) \quad (2 \cdot 5)$$

$$\bar{R}^2 = 0 \cdot 42$$

using as instruments dummy variables indicating the type of the crop (tomato, potato, melon, vegetable), the level of wealth, the number of active members in the family.

We test the exogeneity of Z_1, Z_2 and Z_3 as follows. By the probit technique we obtain

$$Z_1 = 2 \cdot 7 \; - \; 0 \cdot 5 \; \text{AGE} + \; 0 \cdot 006 \; (\text{AGE})^2 + \; 1 \cdot 01 \; \log \text{RICH}$$
$$(0 \cdot 8) \quad (2 \cdot 7) \quad (2 \cdot 8) \quad (5 \cdot 6)$$

$$Z_2 = 1 \cdot 09 \; - \; 0 \cdot 47 \; \text{ACT} - \; 0 \cdot 6 \; \text{OWL} - \; 0 \cdot 0007 \; R^l$$
$$(1 \cdot 8) \quad (2 \cdot 1) \quad (4 \cdot 8) \quad (5 \cdot 1)$$

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14. An alternative is to test the role of contracts in the allocation of resources by studying the dependence of input decisions on contracts. This approach was followed by Shaban (1987) who tested if differences in input intensities between rental and sharecropping contracts were significant. He considers that, with monitoring, marginal productivities of inputs are equated to prices, while, with no monotoring and sharecropping, prices are equated to marginal productivities multiplied by the farmer's share. We believe that the structural form representing sharecropping is more complex. We can only rely on input data when those inputs are included in the contract and presumed observable. For those (as family labour in efficiency units) that are not observable it must be taken into account that they are chosen by the farmer, but they cannot be used in the estimation. Indeed, if they were observable, they could be monitored.

and by the least-squares method we obtain:

$$Z_3 = 18 \cdot 2 - 5 \cdot 2 \log \text{ACT} - 0 \cdot 0009 \ R' + 0 \cdot 0012 \ R'$$
$$(5 \cdot 5) \quad (-1 \cdot 6) \qquad (-3 \cdot 6) \qquad (5 \cdot 4)$$

where AGE is age, RICH wealth, ACT the number of working members in the family OWL owned land, R' the landlord's working capital. Then the residuals μ_1, μ_2 and μ_3 of these regressions are introduced in the following regression:

$$\text{Log } Y = 4 \cdot 7 \ Z_1 + \ 4 \cdot 3 \ Z_2 + 0 \cdot 009 \ Z_3 + 0 \cdot 20 \ \log \text{FL} + 0 \cdot 15 \ \log \text{HL}$$
$$(8) \qquad (7 \cdot 3) \qquad (2 \cdot 2) \qquad (5 \cdot 4) \qquad (3 \cdot 8)$$

$$+ 0 \cdot 25 \log M - 0 \cdot 02 \ \mu_1 + 0 \cdot 11 \ \mu_2 + 0 \cdot 00013 \ \mu_3$$
$$(2 \cdot 6) \qquad (-0 \cdot 14) \ (0 \cdot 9) \qquad (0 \cdot 04)$$

$$\bar{R}^2 = 0 \cdot 42$$

As the coefficients of μ_1, μ_2, μ_3 are not statistically different from zero we can accept the exogeneity of Z_1, Z_2 and Z_3.

These results are confirmed[15] using the data set from 1988 (136 observations)

$$\text{Log } Y = \ 5 \cdot 7 \ Z_1 + \ 5 \cdot 1 \ Z_2 + 0 \cdot 009 \ Z_3 + \ 0 \cdot 26 \ \log \text{FL} + \ 0 \cdot 15 \ \log \text{HL} + \ 0 \cdot 09 \ \log M$$
$$(8 \cdot 7) \qquad (8 \cdot 1) \qquad (5 \cdot 2) \qquad (4 \cdot 4) \qquad (3 \cdot 8) \qquad (1 \cdot 5)$$

$$\bar{R}^2 = 0 \cdot 53$$

We have also explored an alternative explanation of these results suggested by a referee. More able tenants have earned more in the past, have now more working capital and therefore are likely to be given rental contracts. To eliminate this effect we restrict the analysis to young tenants (less than 35 years old) and obtain similar results.

In 1986 (67 observations)

$$\text{Log } Y = \ 4 \cdot 6 \ Z_1 + \ 4 \cdot 3 \ Z_2 + 0 \cdot 006 \ Z_3 + \ 0 \cdot 21 \ \log \text{FL} + \ 0 \cdot 14 \ \log \text{HL} + \ 0 \cdot 25 \ \log M$$
$$(4 \cdot 6) \qquad (4 \cdot 4) \qquad (2 \cdot 8) \qquad (3 \cdot 3) \qquad (2 \cdot 5) \qquad (1 \cdot 6)$$

$$\bar{R}^2 = 0 \cdot 38$$

In 1988 (54 observations)

$$\text{Log } Y = \ 4 \cdot 7 \ Z_1 + \ 4 \cdot 3 \ Z_2 + 0 \cdot 005 \ Z_3 + \ 0 \cdot 26 \ \log \text{FL} + \ 0 \cdot 10 \ \log \text{HL} + \ 0 \cdot 28 \ \log M$$
$$(4 \cdot 7) \qquad (4 \cdot 6) \qquad (1 \cdot 4) \qquad (2 \cdot 3) \qquad (1 \cdot 4) \qquad (3 \cdot 0)$$

$$\bar{R}^2 = 0 \cdot 43$$

The significance of contracts in the explanation of production is very stable across these different regressions. In all the above regressions we rejected at the 1% significance level the hypothesis that the coefficients of Z_1 and Z_2 are equal. The type of contract matters in the explanation of production levels as predicted by the theory. Using for reference the results from 1986 we see that moving from a sharecropping contract to a rental contract increases production by 50% (compare $e^{4 \cdot 8}$ and $e^{4 \cdot 4}$). The effect of the length of the relationship between the landlord and the sharecropper is positive and significant. A three-year contract of sharecropping increases production by 38%. Independently of the

15. The exogeneity of the contract variables was also tested positively.

type of contract the coefficient of hired labour is 50% less than the coefficient of family labour.

The combination of a Cobb–Douglas production function and the modelling of labour in efficiency units lead to a specification where the effect of the contract is similar to a Hicks-neutral technical efficiency effect. To test the robustness of our results we change the specification by assuming that there may be a different elasticity of production for the amount of family labour in the case of rent contracts and in the case of sharecropping contracts[16]. We obtain:

In 1986 (170 observations)

$$\text{Log } Y = 4 \cdot 2 + 0 \cdot 222 \ Z_1 \log FL + 0 \cdot 197 \ Z_2 \log FL + 0 \cdot 19 \ \log HL + 0 \cdot 28 \ \log M$$
$$(6 \cdot 8) \quad (5 \cdot 7) \qquad\qquad (5 \cdot 0) \qquad\qquad\quad (5 \cdot 0) \qquad\qquad (2 \cdot 8)$$

$$\bar{R}^2 = 0 \cdot 31$$

In 1988 ($n = 136$)

$$\text{Log } Y = 4 \cdot 5 + 0 \cdot 39 \ Z_1 \log FL + 0 \cdot 32 \ Z_2 \log FL + 0 \cdot 20 \ \log HL + 0 \cdot 16 \ \log M$$
$$(6 \cdot 4) \quad (6 \cdot 1) \qquad\qquad (5 \cdot 0) \qquad\qquad\quad (5 \cdot 0) \qquad\qquad (2 \cdot 3)$$

$$\bar{R}^2 = 0 \cdot 40$$

In 1986 (young tenants $n = 67$)

$$\text{Log } Y = 3 \cdot 8 + 0 \cdot 25 \ Z_1 \log FL + 0 \cdot 22 \ Z_2 \log FL + 0 \cdot 16 \ \log HL + 0 \cdot 34 \ \log M$$
$$(3 \cdot 6) \quad (3 \cdot 9) \qquad\qquad (3 \cdot 5) \qquad\qquad\quad (2 \cdot 8) \qquad\qquad (2 \cdot 0)$$

$$\bar{R}^2 = 0 \cdot 31$$

In 1988 (young tenants $n = 54$)

$$\text{Log } Y = 3 \cdot 8 + 0 \cdot 36 \ Z_1 \log FL + 0 \cdot 31 \ Z_2 \log FL + 0 \cdot 14 \ \log HL + 0 \cdot 32 \ \log M$$
$$(4 \cdot 3) \quad (3 \cdot 3) \qquad\qquad (2 \cdot 8) \qquad\qquad\quad (1 \cdot 9) \qquad\qquad (3 \cdot 4)$$

$$\bar{R}^2 = 0 \cdot 30$$

With this new specification we also find that the coefficients of family labour in rent contracts and sharecropping contracts are significantly different at the 1% significance level.

It may be argued that pervasive unemployment leads to low efficiency of sharecropping due to excessive use of family labour. We then introduce a dummy variable Z_5 which equals 1 if the number of family workers per hectare is larger than $2 \cdot 5$ and zero otherwise. The following result suggests the existence of this excessive labour effect ($0 \cdot 17$ significantly different from $0 \cdot 19$ at the 5% level) but also confirms, for families of small size, the lower efficiency of family labour in sharecropping contracts compared to rent contracts ($0 \cdot 19$

16. Because of the very high correlation between Z_1 and $Z_1 \log FL$ (which is $0 \cdot 96$) and the very high correlation between Z_2 and $Z_2 \log FL$ (which is $0 \cdot 98$) it is not possible to imbed meaningfully the two models obtained within a single model and test the retrictions to which they correspond. We could engage in non-nested tests but the purpose here is not to choose the best model, but to check the robustness of our result according to which contract variables affect productivity.

significantly different from 0·21 at the 5% level)[17]. Using the method of 2SLS we obtain:

In 1986 ($n = 170$)

$$\text{Log } Y = \ 4·2 \ + \ 0·21 \ Z_1 \log \text{FL} + \ 0·17 \ Z_2 Z_5 \log \text{FL} + \ 0·19 \ Z_2 (1 - Z_5) \log \text{FL}$$
$$\quad\quad (6·8) \quad (5·1) \quad\quad\quad\quad (3·7) \quad\quad\quad\quad\quad (4·8)$$
$$+ 0·19 \ \log \text{HL} + 0·28 \ \log M$$
$$(5·0) \quad\quad\quad\quad (2·8)$$
$$\bar{R}^2 = 0·31$$

In 1988 ($n = 136$) we obtain similar results with a 1% significance level.

$$\text{Log } Y = \ 4·5 \ + \ 0·37 \ Z_1 \log \text{FL} + \ 0·30 \ Z_2 Z_5 \log \text{FL} + \ 0·33 \ Z_2 (1 - Z_5) \log \text{FL} +$$
$$\quad\quad (6·5) \quad (5·8) \quad\quad\quad\quad (4·5) \quad\quad\quad\quad\quad (4·9)$$
$$+ 0·21 \ \log \text{HL} + 0·16 \ \log M$$
$$(4·9) \quad\quad\quad\quad (2·3)$$
$$\bar{R}^2 = 0·40$$

Similarly for the sub-sample of young tenants we still get significant differences in the coefficients of family labour in rent contracts and sharecropping contracts. However the excessive labour effect disappears for young tenants.

In 1986 ($n = 67$)

$$\text{Log } Y = \ 3·7 \ + \ 0·25 \ Z_1 \log \text{FL} + 0·21 \ Z_2 Z_5 \log \text{FL} +$$
$$\quad\quad (3·5) \quad (3·8) \quad\quad\quad\quad (3·4)$$
$$+ 0·23 \ Z_2 (1 - Z_5) \log \text{FL} + 0·16 \log \text{HL} + 0·35 \log M$$
$$(3·3) \quad\quad\quad\quad\quad (2·6) \quad\quad\quad (2·0)$$
$$\bar{R}^2 = 0·30$$

In 1988 ($n = 54$)

$$\text{Log } Y = \ 3·8 \ + \ 0·36 \ Z_1 \log \text{FL} + 0·31 \ Z_2 Z_5 \log \text{FL} +$$
$$\quad\quad (4·3) \quad (3·2) \quad\quad\quad\quad (2·8)$$
$$+ 0·31 \ (1 - Z_5) Z_2 \log \text{FL} + 0·14 \ \log \text{HL} + (0·32) \log M$$
$$(2·7) \quad\quad\quad\quad\quad (1·9) \quad\quad\quad (3·3)$$
$$\bar{R}^2 = 0·38$$

Finally, we look at an alternative specification of the incentive effects due to the length of the relationship t in sharecropping labour and to the share of input β paid by the tenant by introducing a parameter of sharecropping labour which depends on both t and β (for a given α a high β means a high productivity plot which can support a high funding of inputs; the motivation of introducing β is the discrete nature of α).

17. There is no reason to test for an excessive labour effect in rental contracts because tenants with rent contracts are not financially constrained and therefore should be able to rent enough land for all their family labour. Furthermore we are not interested in the pervasive unemployment effect per se, but rather in the difference in the efficiency of family labour, stemming from differences in effort, between rental and sharecropping contracts. Given that 0·21 is significantly greater than 0·19 we can expect the coefficient of $Z_1(1 - Z_5) \log \text{FL}$ to be even more different from 0·19. So allowing for the excessive labour effect in rental contracts would only strengthen the findings.

In 1986 (170 observations)

$$\text{Log } Y = 4.8 + 0.21 \ Z_1 \log \text{FL} + (0.10 + 0.002t + 0.0005\beta \ Z_2 \log \text{FL}$$
$$(8.5) \quad (5.8) \qquad\qquad (1.3) \quad (4.8) \quad (0.5)$$
$$+ 0.15 \ \log \text{HL} + 0.23 \ \log M$$
$$(3.9) \qquad\qquad (2.5)$$
$$\bar{R}^2 = 0.24$$

In 1988 ($n = 136$)

$$\text{Log } Y = 5.5 + 0.29 \ Z_1 \log \text{FL} + (0.07 + 0.002t + 0.0016\beta \ Z_2 \log \text{FL} +$$
$$(8.2) \quad (4.7) \qquad\qquad (0.82) \quad (3.3) \quad (1.6)$$
$$+ 0.15 \ \log \text{HL} + 0.12 \ \log M$$
$$(3.8) \qquad\qquad (1.7)$$
$$\bar{R}^2 = 0.50$$

In 1986 (young tenants $n = 67$)

$$\text{Log } Y = 4.5 + 0.24 \ Z_1 \log \text{FL} + (0.16 + 0.0012t + 0.0003\beta) \ Z_2 \log \text{FL}$$
$$(4.4) \quad (3.9) \qquad\qquad (1.4) \quad (2.5) \quad (0.2)$$
$$+ 0.13 \ \log \text{HL} + 0.26 \ \log M$$
$$(2.2) \qquad\qquad (2.2)$$
$$\bar{R}^2 = 0.38$$

In 1988 (young tenants $n = 54$)

$$\text{Log } Y = 4.3 + 0.30 \ Z_1 \log \text{FL} + (0.05 + 0.002t + 0.004\beta \ Z_2 \log \text{FL}$$
$$(4.3) \quad (2.6) \qquad\qquad (0.3) \quad (0.2) \quad (1.6)$$
$$+ 0.12 \ \log \text{HL} + 0.31 \ \log M$$
$$(1.6) \qquad\qquad (3.2)$$
$$\bar{R}^2 = 0.42$$

Again the coefficient of family labour in rent contracts is significantly different at the 1% level (5% level only for young tenants in 1988) from the coefficient in the sharecropping case (actually the sum of three coefficients computed at the average sample values). Furthermore, with this new specification we again find that the length of the contract significantly affects positively the productivity of sharecropping labour.

6. CHOICE OF CONTRACTS

The previous section has shown the effect of contract type on production. In this section we test the role of financial constraints and risk aversion in the selection of contracts.

The structural form obtained in Sections 3 and 4 is summarized as an ordered probit model where the contract type variable, CT takes the values

$$0 \quad \text{if } \alpha = 1/2$$
$$1 \quad \text{if } \alpha = 2/3$$
$$2 \quad \text{if } \alpha = 3/4$$
$$3 \quad \text{if } \alpha = 1$$

The underlying model is then $Z = \beta_1 + \beta_2 R^t + \beta_3 R^l + \beta_4 W^t + \varepsilon$ with $\varepsilon \to \mathcal{N}(0, \sigma)$ where R^t (resp. R^l) is the tenant's (resp. landlord's) working capital and W^t is the tenant's wealth

$$CT = 0 \quad \text{if } z_t \leq \mu_0$$
$$1 \quad \text{if } \mu_0 < z_t \leq \mu_1$$
$$2 \quad \text{if } \mu_1 < z_t \leq \mu_2$$
$$3 \quad \text{if } z_t > \mu_2$$

The maximum likelihood estimators of this model are obtained by the Davidson (1959), Fletcher and Powell (1963) algorithm and the variance covariance matrix for the estimates is the Berndt *et al.* (1974) estimator using the first derivatives.

For the 1986 survey we obtain:

$$Z = -0.36 + 0.0003\,R^t - 0.0001\,R^l + 0.000045\,W^t$$
$$\quad (2.2) \quad (5.1) \qquad (9.5) \qquad (1.49)$$

with $\mu_0 = 0$ (normalization).

$$\mu_1 = 0.30 \qquad \mu_2 = 0.63$$
$$(3.3) \qquad\quad (4.1)$$

In 1988, we get:

$$Z = -0.19 + 0.0005\,R^t - 0.0004\,R^l + 0.0001\,W^t$$
$$\quad (0.5) \quad (3.5) \qquad (-4.4) \qquad (2.5)$$

with

$$\mu_1 = 0.8 \qquad \mu_2 = 0.3$$
$$(3.0) \qquad\quad (4.1)$$

As predicted by the theory the higher the tenant's working capital, the closest to a rent contract we are. On the contrary the higher the landlord's working capital the higher his share in the sharecropping contract. The wealth effect is of the right sign but not very significant, suggesting that financial constraints play a more important role than risk aversion in explaining the selection of contracts[18].

The ordered probit model assumes here that the discrete choice between rental and sharecropping is governed by the same model that determines whether $\alpha = 1/2$, $2/3$ or $\alpha = 3/4$. To test this hypothesis we run a probit of rental versus sharecropping. Since the variance of the error term is not identified in such a probit model we re-scale the parameters of the ordered probit with the estimate of the standard error obtained above ($\hat{\sigma} = 0.384$).

The rental/sharecropping choice is then made with the model

$$\text{Rental if } \tilde{\beta}_1 + \tilde{\beta}_2 R^t + \tilde{\beta}_3 R^l + \tilde{\beta}_4 W^t + \tilde{\varepsilon} > 0$$

where ε is now $\mathcal{N}(0, 1)$, instead of the previous model

$$\text{Rental if } \frac{\beta_1 - \mu_2}{\hat{\sigma}} + \frac{\beta_2}{\hat{\sigma}} R^t + \frac{\beta_3}{\hat{\sigma}} R^l + \frac{\beta_4}{\hat{\sigma}} W^t + \frac{\varepsilon}{\hat{\sigma}} > 0$$

18. An alternative explanation given by a referee uses risk aversion. The more working capital a tenant has, the more crops he plants. The more crops a tenant plants, the more diversified he is, so the less risk he bears for a given sharing parameter in the contract. However, we did not find any correlation between the number of crops (*NP*) and the size of working capital.

$$NP = \quad 2.8 \quad -0.000084\,R^t \quad R^2 = 0.004$$
$$(13.3) \quad (-0.44)$$

where re-scaling is made to have $\varepsilon/\hat{\sigma}$ as a $\mathcal{N}(0, 1)$ random variable so that the estimators $\tilde{\beta}_i$ and $\hat{\beta}_i/\hat{\sigma}$, $i=2, 3, 4$ are two estimators of the same value under the null hypothesis of no difference between the choice models.

Noting that $\hat{\beta}_i/\hat{\sigma}$ is the most efficient estimator we can run Hausman tests.

As is often the case in small samples the difference in the covariance matrices between probit and the re-scaled ordered probit parameters did not turn out to be positive semi-definite. Thus to compare the results we simply test that the coefficients of R^I and W^I are the same. For the coefficients R^I and W^I we obtain χ^2-statistics which are 5·66 and 0·43 respectively which are below the 1% significance level which is 6·63.

We can safely conclude that our assumption of the same choice model for the four regimes is not rejected.

Since the theory only obtained the predictions concerning the effect of working capital on contract choices conditionally on the level of inputs we also obtained the maximum likelihood estimators for an enlarged model with similar results.

In 1988 ($n = 136$)

$$Z = -1\cdot2 + 0\cdot00058 R^I - 0\cdot00032 R^I + 0\cdot00008 W^I$$
$$\quad (-1\cdot6) \quad (2\cdot7) \qquad (2\cdot9) \qquad (2\cdot0)$$
$$+ 0\cdot0055 \text{ FL} + 0\cdot0020 \text{ HL} + 0\cdot00026 \text{ M}$$
$$\quad (2\cdot4) \qquad (0\cdot42) \qquad (0\cdot40)$$
$$\mu_0 = 0 \qquad \mu_1 = 0\cdot86 \qquad \mu_2 = 1\cdot35$$
$$\qquad\qquad (3\cdot0) \qquad\quad (4\cdot0)$$

In 1986 ($n = 170$)

$$Z = -1\cdot09 + 0\cdot0003 \ R^I - 0\cdot00011 R^I + 0\cdot00003 W^I$$
$$\quad (2\cdot5) \quad (5\cdot3) \qquad (9\cdot01) \qquad (1\cdot0)$$
$$+ 0\cdot00024 \text{ FL} + 0\cdot00047 \text{ HL} + 0\cdot001 \ M$$
$$\quad (1\cdot11) \qquad (0\cdot3) \qquad\quad (2\cdot3)$$
$$\mu_0 = 0 \qquad \mu_1 = 0\cdot42 \qquad \mu_2 = 0\cdot67$$
$$\qquad\qquad (3\cdot3) \qquad\quad (4\cdot1)$$

7. CONCLUSION

We have developed a theory of sharecropping which emphasizes the dual role of moral hazard and financial constraints. The unobservability of effort requires the use of incentive contracts to induce good effort levels. This can easily be achieved with rental-contracts which leave to tenants all the proceeds of their effort. However, the tenant's financial constraints make these contracts often impossible. The poorer the tenant, the smaller the share of the crop he will retain and therefore the less effort he will provide.

Production functions stressing the role of effort have been estimated. They support the theory which predicts lower efficiency when the tenant's share of output is lower. However, this inefficiency is somewhat mitigated by the length of the relationship between the landlord and the tenant. The working capital of the tenant (and of the landlord) appear as significant explanations of the type of contract chosen by a tenant. Little empirical evidence was found for the alternative explanation related to risk aversion (assumed to be decreasing with wealth). However, the close link between wealth and working capital should qualify this last statement.

APPENDIX

The Data

V	Value of production on the plot. (in Tunisian Dinars (T.D.))
S	Surface of the plot (in hectares)
FL	Family labour in days (per plot)
HL	Hired labour in days (per plot)
M	Cost of inputs other than labour in T.D.
CT	Type of contract CT = 3, 2, 1, 0, for $\alpha = 1$; 3/4, 2/3, 1/2
R^t	Tenant's working capital (available monetary liquidities, rented value of various owned equipments)
R^l	Landlord's working capital (the same)
t	Length of the relationship in months
β	Percentage of cost of inputs paid by the farmer
W^t	Tenant's wealth (value of owned animals, equipment, and land)
M	Cost of seeds, ploughing, transportation, water, other inputs
L	in front of a variable indicates the logarithm of the variable.

TABLE 1

Descriptive statistics (1986)

Variable	Mean	Std. Dev.	Minimum	Maximum
V	5785·0	7404·7	280·0	0·4914E + 05
S	2·1538	2·4450	0·2000	12·50
FL	168·21	156·17	22·00	1160·0
HL	406·06	643·87	1·000	3600·0
M	1404·0	1761·2	82·00	0·1149E + 05
R^t	5510·3	5792·3	50·00	0·3500E + 05
R^l	2534·3	6027·6	1·000	0·2950E + 05
t	68·565	39·314	6·000	100·0
β	83·229	20·324	50·00	100·0
W^t	39274·0	70659·0	501·0	0·4050E + 06
CT	1·8824	1·3667	0·0000	3·000

TABLE 2

Descriptive statistics (1988)

Variable	Mean	Std. Dev.	Minimum	Maximum
V	6913·0	7988·4	600·0	0·5915E + 05
S	2·0188	2·1696	0·1600	14·50
FL	185·88	192·75	17·00	1715·0
HL	287·21	403·39	1·0	2571·0
M	1640·7	2183·4	109·0	0·1709E + 05
R^t	4748·2	3996·2	700·0	0·2500E + 05
R^l	1455·1	3437·3	1·000	0·1650E + 05
t	78·824	33·423	6·000	100·0
β	87·228	19·861	50·00	100·0
W^t	41537·0	85324·0	601·0	0·4780E + 06
CT	2·1985	1·2221	0·0000	3·000

TABLE 3

Types of contract

	CT	1986	1988
$\alpha =$	1/2	52	26
	2/3	13	12
	3/4	8	7
	1	97	91
Total		170	136

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