Moral Hazard, Land Fertility and Sharecropping in a Rural Area of the Philippines

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Abstract

Introducing concerns about land fertility for the landlords in a Principal-Agent model of sharecropping with moral hazard, we show that the optimal contract under limited commitment reflect a trade-off between production and land quality maintenance. Using Philippines data, a model where the leasing out and contract choices are simultaneous is estimated and avoids the selectivity bias of observed contracts. Landowners prefer to use more incentive contracts for more fertile plots and less incentive ones when crop choices induce land overuse. Empirical tests reject the model of pure risk sharing in production and show the interest of taking land quality maintenance into account.

Key Words: sharecropping, moral hazard, incentive contracts, land value, soil conservation, empirical contract theory.

JEL Classification: D23, D82, Q12, Q15, Q24.

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1. Introduction

The efficiency of share tenancy has mainly been studied in a static framework. Stiglitz (1974) points out that share contracts are second best choices because they result from a trade-off between incentives to work and risk sharing. In the transaction cost approach (Allen and Lueck, 1993), the type of agricultural contracts are determined by contracting costs. Yet, Johnson (1950) wrote: "When a man sells a bushel of wheat, he has no interest in the use to which the wheat is put and is consequently willing to sell to the highest bidder. However, when a man sells the use of land, he has a real interest in how the land will be used. Consequently, the choice of tenant is never made without considering what the impact of the tenancy will be upon the value of the asset." It seems relevant for the landlord to take into account the dynamics of land fertility. When this dynamics is explicitly formalized, it remains to be proven that static arguments about efficiency are still valid. In a dynamic model we might have to derive the way incentives are designed according to the management of land fertility.

In most share-tenancy models the landowner's objective is to maximize expected utility which depends on net benefit, labor supply and the contract shape (Stiglitz, 1974, Eswaran and Kotwal, 1985, Singh, 1989, or Otsuka, Chuma and Hayami, 1992). Among the papers adopting a dynamic framework, none allows for a dynamic dependence of land fertility on cultivating choice. Dutta, Ray, Sengupta (1989) analyze the efficiency problem when the relationship is infinitely repeated and the landowner uses threats of eviction. Bose (1993), shows how infinitely long fixed rent contracts interlinked with credit agreements between a landowner and a peasant bring a more efficient allocation of resources when investment is needed. Otsuka, Chuma and Hayami (1993) examine long term agrarian contracts to show that share tenancy is more efficient than fixed wage permanent labor. Other models take into account some aspects of land characteristics and land fertility with a transaction cost approach. Allen and Lueck (1992) analyze the choice between cash rent and crop share contracts; they argue that a share contract can curb the farmer's incentive to exploit land attributes. Bardhan (1984, ch. 7), Braverman and Stiglitz (1986) show how production sharing and cost sharing give more efficient incentives on a fertilizer input and a non observable labor effort. Bardhan (1984, ch. 8) shows with a two period model the trade-off between production incentives, enhanced in first period by a dismissal threat from the landowner, and land improvement incentives decreasing with a more powered contract.

An important issue modelled here is that agricultural activity during a crop season affects future production because land fertility is governed by an investment function depending on the past fertility level and the cultivator's effort. Agent's actions are not observable to the Principal and contracts are incomplete because they cannot be contingent on land fertility. The landowner's intertemporal utility is defined as a function of all future net benefits due to his property right. The long term - short term conflict of interest between parties in terms of incentives is at the heart of the argument. Considering a sequence of short term contracts, the shape of the utility of the Principal is markedly different from what results in standard moral hazard models, as it includes the value of land. The repeated moral hazard theory does not consider this case because in most of them Agent's actions don't modify future production technology (Rogerson, 1985, Lambert, 1983). Fudenberg, Holmstrom and Milgrom (1990) and Malcomson and Spinnewyn (1988) study the possibility in a repeated moral hazard relation to implement long term contracts, which are Pareto superior to short term agreements (Radner, 1985, Rubinstein and Yaari, 1983), by sequences of spot contracts. We know that short term renegotiable contracts achieve long run efficiency when there is no informational asymmetry at contracting dates (Rey and Salanié, 1990, 1996) but spot contracting may fail to optimally smooth agent's consumption. Here, we consider different informational conditions because contracts are incomplete and last for one period in an environment where long term full commitment is non credible.

We derive the optimal second best linear contract which is different from Stiglitz (1974). For example, if risk neutrality is assumed, the optimal contract is not a fixed rent contract but a sharecropping one. Low powered incentives (in the sense of Williamson, 1985) come from the presence of efforts leading to fertility damages though they are productive in the short term. As in Baker (1992), the gap between the Principal's objective and the Agent's performance measure leads to distortions in efforts in the second best case. We show how the optimal sharing rule depends on land fertility, production and land investment functions (and Agent's risk aversion).

Then we obtain empirically testable implications of the model relating the choice of contract and land value when the production effort can reduce the land fertility because of land overuse. Allen and Lueck (1993, 1996) show on American data how transaction cost considerations could explain the determinants of choices between cash rent and crop share contracts. The idea of the transaction cost approach telling that the tenant and the landowner have different interests in the exploitation of land attributes endogenously arises in our model. In the present paper, we implement empirical tests between predictions of the pure risk sharing model (Stiglitz 1974) and the dynamic model of this paper using Philippines data. The empirical study shows that fixed rent contracts are chosen against sharecropping for most fertile plots and that sharecropping is preferred when crops inciting to land overuse such as corn are grown. We show how this effect on contracting modes is specific to the main crop cultivated. We also try to evaluate the validity and limits of these empirical tests. Our results seem to be robust to various specification tests, in particular with respect to the presence of heterogeneity between landowners. A main econometric contribution of the paper is also that unlike empirical studies on share tenancy, we avoid the selection bias that arises, because the sample of observed contracts selects participations, by estimating the simultaneous choice of landlords to lease out land and a type of contract.

Section 2 presents the micro-economic model. In section 3, the empirical study implements tests of some predictions of the model. Section 4 concludes by emphasizing the main theoretical and empirical points of the paper. The appendix is in section 5.

2. A dynamic model of contracting

In this section, we present the microeconomic model allowing to take into account the endogenous evolution of land fertility in a Principal-Agent model with moral hazard modelling share-tenancy.

2.1. Production, information and preferences

The agricultural production function is assumed to be linear homogenous with respect to land area (as is generally admitted, see Otsuka, Chuma and Hayami, 1992). For a fixed amount of land, denote y_t the agricultural output in period t, e_t an index of peasant's work effort defined as the efficient labor time, x_{t-1} an index of land fertility at the end of period $t-1$. Therefore e_t is the decision variable of the model and x_{t-1} is a state variable. Define an agricultural production function f such that $y_t = \nu_t f(x_{t-1}, e_t)$ where ν_t is a multiplicative positive random variable with mean one representing weather uncertainty. Dynamics of land fertility are described by an investment function $x_t = \varepsilon_t g(x_{t-1}, e_t)$ where ε_t is a positive random variable with mean one which represents weather shocks. The general form of g includes cases where x_t has a time invariant component related to a particular land characteristic. We hereafter do the following assumption:

Basic Assumption $f(.,.)$ is increasing in both arguments and globally concave. $g(.,.)$ is increasing in x, non-increasing in e and globally concave.

In this framework, we study the relationship between a landowner (Principal) and a peasant (Agent), who rents land under a contractual arrangement. The production is observable and verifiable. Agent's actions are unobservable by the Principal, the source of moral hazard because monitoring costs are prohibitively high (Otsuka, Chuma and Hayami, 1992). We assume that land fertility has no contractible value because it is observable but not verifiable. Hence, we consider incomplete contracts i.e. contracts which cannot be contingent to all states of nature. It is equivalent to say that all contract terms cannot be computed by a third party. Casual observation shows that contracts are never complete and do not include conditions on land fertility. Murrell (1983) puts forward that, given the complexity of specifying agricultural tasks and the difficulty to observe and measure land quality, the contract cannot be complete. Allen and Lueck (1992, 1993, 1996) also consider incomplete contracts. We could also say that the cost of completing contracts would be too large with respect to expected inefficiency loss resulting from incompleteness.

At each crop season, the landowner can contract with a tenant for the current period but cannot commit himself to more than one period. Contracts are signed for one season only. The landlord can sign again a contract with the same tenant but he cannot commit to a long term agreement[1]. Actually, in a situation of land scarcity and surplus of labor, it is very likely that the landlord will not respect the contract with its coming end. The landowner could enforce a more efficient allocation of effort promising a larger share of future production to the tenant. However, in the last periods the landowner can benefit from firing the tenant without honoring his promise. The trust in the commitment of the landlord to respect the contract is doubtful for the tenant. We could also consider that courts enforce only one period contracts. This impossibility to commit being known by both parties, spot contracts are used.

According to the contract signed in period t, the Principal pays the Agent $\tau_t(y_t)$ at the end of crop season t. Let $U(\tau_t(y_t)) - C(e_t)$ and $y_t - \tau_t(y_t)$ denote the Agent's and Principal's instantaneous utility functions. $C(.)$ (increasing, convex and twice differentiable) is the cost of effort or its disutility and $U(.)$ a Von Neumann Morgenstern utility function is increasing and concave. Agent's utility is separable between income and leisure. The Principal is risk neutral. The exogenous reservation utility of the Agent is supposed to be $\overline{U}$.

[1]Though Pareto superior, a long term contract where parties can commit would require the tenant's payment to be contingent to current and past performances ("memory effect" shown by Rogerson (1985), Chiappori, Macho, Rey, Salanié (1994)). These contracts require that past productions be recorded and verifiable in the future.

2.2. Intertemporal optimization and land value

The Principal designs and proposes a contract at each period that is optimal under the Agent's incentive compatibility (IC_t) and individual rationality (IR_t) constraints. He has an infinite time horizon and his intertemporal utility is additively separable. Let $\rho \in [0,1[$ be the discount factor. The Principal's maximization program at the beginning of the period can be written:

$$w_0(x) = \underset{\tau_t(.)}{Max}\; E_{\nu_t,\varepsilon_t} \sum_{t=0}^{\infty} \rho^t \left[y_t - \tau_t(y_t)\right] \tag{1}$$
$$s.t.\ \forall t \geq 0, \begin{cases} EU(\tau_t(y_t)) - C(e_t) \geq \overline{U} & (IR_t) \\ e_t \in \arg\max\limits_{e} EU(\tau_t(y_t)) - C(e) & (IC_t) \end{cases}$$

The landowner's alternative to sell the land instead of continuing to lease out can be ruled out if we assume that the land sales market is almost completely inactive because of liquidity constraints of potential buyers and imperfect financial markets[2].

As (IR_t) and (IC_t) are period specific, and if random terms and reservation utility are stationary, the value function is a solution to the "Bellman equation":

$$w(x) = \underset{\tau(.)\ s.t.\ (IC),(IR)}{Max} \{E[y - \tau(y)] + \rho E w(z)\} \tag{2}$$

where $z = \varepsilon g(x,e)$ and $w(z)$ represents the optimal value that the Principal can get at the beginning of next period when land quality is equal to z. As the tools of contract theory (see Hart and Holmstrom, 1987) do not provide enough characterization of the optimal contracts in order to derive formal properties of $w(.)$ (in particular concerning its monotonicity), we will restrict (as usually done in this literature) the analysis to linear contracts[3] of the form $\tau(y) = ay + b$ with $a \geq 0$ being the share of production promised to the tenant. A benchmark (called the first best) is obtained when there is perfect information (i.e. without the incentive constraint):

Proposition 2.1. *In the case of perfect information, the land value is an increasing and concave function of fertility x.*

The proof is straightforward and consists in defining an operator T relating the expected value at the end of the period and the expected value at the beginning of the period. The value

[2] The Principal's objective will not be modified if land prices are functions of land fertility and equal exactly the long term value provided to the owner by agricultural contracts. Feder and Fenny (1993, p.249) show that if there is no risk of land loss and the interest rate equals the rate of time preference, the price of land will equal the discounted value of the stream of net benefits.

[3] We could call upon bounded rationality to justify this behavior. But, simple incentive schemes like sharing rules are generally prevalent in the economy. Hart and Holmstrom (1987) argue that it can be caused by prohibitive costs of writing intricate contracts but also by a need for robustness with respect to other possible Agent's choices. Holmstrom and Milgrom (1987) show that linear contracts are optimal in a continuous time framework when errors are normal and the Agent has constant absolute risk aversion.

function is the fixed point of T. It is increasing and concave because T is a contraction mapping which maps the space of increasing concave functions onto itself. When information is imperfect, we have (proof in appendix 5.1):

Proposition 2.2. *When the Agent is risk neutral, the land value function is increasing and concave.*

When the Agent is risk neutral, the land value endogenously derived in this model is equal to that of the first best where the Agent's effort is enforceable. When he is risk averse, comparative statics are more complicated. The aim of this paper is not to derive the largest set of necessary conditions for predictions that are being tested in the empirical application. Therefore, simple and plausible sufficient assumptions only are given to derive interesting testable implications.

Assumption 1a The ratio f_e/f is weakly increasing with fertility ($\frac{\partial}{\partial x}(f_e/f) \geq 0$).

Assumption 1b The ratio f_e/f is constant with fertility ($\frac{\partial}{\partial x}(f_e/f) = 0$).

Assumption 2 The land fertility and effort are complementary in production ($f_{ex} \geq 0$).

The production functions of the Cobb-Douglas form satisfy the assumptions $1a$, $1b$ and 2.

Assumption 3 The marginal negative impact of effort on fertility decreases with the fertility level ($g_{ex} \geq 0$).

This assumption says that the marginal negative effect of effort on fertility is constant or decreasing with the fertility level. Less fertile plots are also more fragile.

Assumption 4 Third order effects compared to second order ones are negligible in comparative statics.

This approximation assumption is not always needed in the following of the paper but sometimes helps exhibiting simple cases. The proof of the proposition is in appendix 5.2.

Proposition 2.3. *If the Agent is risk averse, under assumptions* $1a$, 2, 3, 4 *or* $1b$, 2, 3 *the land value function is increasing and concave.*

2.3. Optimal incentives

The Principal's objective at the beginning of the period is to maximize the expected sum of the current period utility and the future discounted land value. Consequently, the Principal's utility is $(1-a)\,y - b + v\,(z)$ where $v\,(.)$ is the solution of the Bellman equation $(v\,(.) \equiv \rho w\,(.))$.
In the case of perfect information, the endogenous value function is increasing and concave for any initial fertility level. The Principal's maximization program is $\underset{a,b,e}{Max}\; E[(1-a)\,y - b + v\,(z)]$ subject to the Agent's participation constraint:

$$EU(ay+b) - C\,(e) \geq \overline{U} \tag{3}$$

The implemented effort with perfect information (the first best) satisfies $f_e - U^{-1'}\left(\overline{U} + C\,(e^*)\right) C_e + E[\varepsilon v^{'}]g_e = 0$[4]. A first best contract consists in enforcing the optimal effort level e^* and in paying the Agent a fixed wage leaving him with his reservation utility. This is just the classical result when one party is risk neutral: full insurance is provided to the risk averse Agent while the risk neutral Principal bears all the risk.
In imperfect information on Agent's action, the Principal chooses the transfer function $\tau(y) = (1-a)\,y - b$ that maximizes his expected utility $E[(1-a)\,y - b + v\,(z)]$ under the Individual Rationality constraint (3), and the following Incentive Compatibility constraint:

$$e \in \arg\max_{e} EU(ay+b) - C\,(e) \tag{4}$$

When the tenant is risk averse, as in Stiglitz (1974), the second best solution is Pareto inferior to the first best solution.

Proposition 2.4. *Pareto efficiency is achieved under imperfect information if and only if the Agent is risk neutral.*

Proof. Denoting e^*, τ^* the first best effort and transfer, so as to implement the first best effort e^*, the contract must both respect the individual rationality constraint and give some incentives making $\tau\,(.)$ depend on production. If e^* is implemented at the same cost than in the first best i.e. $E[ay+b] = \tau^*$, then, by Jensen's inequality and the concavity of the utility function: $EU(ay+b) - C\,(e^*) \leq U\,(\tau^*) - C\,(e^*) = \overline{U}$. The participation constraint (3) is verified only if U is linear.□

[4] The first best effort may be zero in which case the first order condition is an inequality and the optimal use of land is to leave it fallow.

By the differentiable approach, the incentive constraint becomes $aE\nu U' f_e(x,e) = C_e(e)$ and a straightforward derivation gives the following lemma:

Lemma 2.5. *In the risk neutral case, the IC constraint defines an Agent's best answer effort supply* $e(a,x)$*, differentiable such that* $e_x = -af_{ex}M$ *and* $e_a = -f_eM$ *with* $M^{-1} = af_{ee} - C_{ee} < 0$*. Hence* $e_a > 0$ *and* $f_{ex}e_x > 0$*.*

This lemma allows us to say that effort is strictly increasing with incentive power, a, whereas it is strictly increasing or decreasing with fertility x as fertility and labor are complementary or substitutes in the production function. The first order condition of the maximization program directly gives the following proposition:

Proposition 2.6. *The slope of the second best optimal contract verifies*[5]*:*

$$a^*(x) = 1 + E\varepsilon v' \frac{g_e}{f_e} - \left(1 - \frac{E\nu U'}{EU'}\right)\frac{f}{e_a f_e} \tag{5}$$

In the equation giving $a^*(x)$, the first term is the optimal contract slope or share when the tenant is risk neutral and fertility has no worth for the landowner ($a^*(x)$=1: fixed rent). The second term characterizes the trade-off between incentives in production and incentives in investment in fertility. Finally, the third term describes the optimal trade-off between production incentives and risk sharing. We obtain a complicated trade-off between production incentives, fertility incentives and sharing of production risk. As $1 - E\nu U'/EU' > 0$ because the utility is concave, the risk sharing term reduces the value of a^*, as intuition predicts, and the tenant bears less risk. We know that $e_a > 0$ in the risk neutral case. With risk aversion, income effects make comparisons more difficult.

In the risk neutral case, the first best solution is implemented in imperfect information. As effort has opposite influences on production and on land fertility, the optimal contract has low powered incentives because the share is smaller than one. Although the Agent is risk neutral, the optimal contract is not fixed rent as usual (see Stiglitz, 1974, Newbery and Stiglitz, 1979, Otsuka, Chuma and Hayami, 1992) but a share contract with a fixed part that maintains the Agent to his reservation utility level. Therefore, the risk sharing argument is not necessary to explain share contracts because investment in fertility can motivate them.

In Baker (1992), the difference between the Principal's objective and the contractible Agent's

[5]With a risk averse landowner of utility function V, the formula becomes: $a^* = 1 + \frac{E\varepsilon v'}{E\nu V'}\frac{g_e}{f_e} - f\left(1 - \frac{E\nu U' EV'}{EU' E\nu V'}\right)/e_a f_e$.

performance measure also generates distortions of incentives. In our case, we showed how these different objectives can be endogenously generated reflecting that long term and short term interests may be different.

In addition to the preferences of the contracting parties, the optimal contract depends on land quality which may explain the different patterns of contracts even without heterogeneity in preferences. It explains why a landowner may decide to self cultivate or lease out land plots and why he chooses different contracts for different plots.

The optimal contract slope a^* depends at each season on the land fertility whatever the Agent's risk aversion. There is a real "memory effect" through land fertility which depends on past actions. It has nothing to do with Rogerson's memory effect (1985) due to long term contracts providing for consumption smoothing when the Agent is risk averse. Here, we only have spot contracts but there is memory in the production process.

2.4. Decision to lease out

To analyze landowner's choice to lease out a plot of land, we compare the value of delegation (leasing out) and of self cultivation for the landowner[6].

• *Difference between the first best and the second best value of the land leasing choice: Efficiency loss due to the Agent's risk aversion*

The difference between the first best (w_{fb}) and the second best (w_{sb}) value functions is the efficiency loss induced by the delegation of the use of land. If the agent is risk neutral, the second best land value equals the first best value. With assumption 1b, 2 and 3, we have the following proposition (proof in appendix 5.3):

Proposition 2.7. *In the contractual relationship under moral hazard, when the Agent is risk averse and the second best effort is lower than the first best (i.e. when higher incentives increase effort), the efficiency loss increases with land fertility.*

The second best effort is likely to be lower than the first best since equation (5) shows that the risk sharing term will generally lead to less incentive contracts and therefore to a smaller level of effort if the utility function is such that increasing incentives actually leads to increase the implemented effort (which is the case generally considered in the share tenancy literature).

[6] Of course, we compare the value of each choice (self cultivation or delegation) with a given value function of future fertility that would integrate the different choices. We proved that the value of each option separately is increasing concave. We need to prove that the value function integrating the possibility to lease out or not is also increasing concave. It seems more difficult unless we allow for mixed strategies in the complete program.

In the canonical model where future fertility has no value, it is strictly impossible that the second best effort be higher than the first best one.

• *Difference in the land valuation between leasing out and self cultivation: Gap between the valuations of fertility for self cultivation and delegation due to the asymmetry in the cost of effort between Principal and Agent*

An implicit assumption of the Principal-Agent model is that the delegation of production is worth for the Principal because its cost of effort is sufficiently larger than that of the Agent. Modelling explicitly this assumption, we can compare the valuation of self cultivation by the landowner (w_{sc}) and the valuation of leasing out in the risk neutral case (w_{fb}). Therefore, making explicit this assumption of the Principal-Agent representation used for the relationship between a landowner and a peasant, we have the following proposition (proof in appendix 5.4):

Assumption 5 The marginal cost of effort of the landowner is larger than that of the tenant.

Proposition 2.8. *Under assumptions* 2, 3 *and* 5, *the difference between the value of leasing out land to a risk neutral agent and the value of self cultivation is increasing with fertility.*

This proposition means that the difference between the value of land when the landowner delegates its use to a risk neutral peasant for whom effort is less costly and the value of self cultivation is increasing with fertility. The idea behind this statement is that under risk neutrality the first best is achieved but as fertility increases the optimal effort increases and becomes more and more costly for the landowner in comparison to the tenant.

The last two propositions show that the difference between the value of self cultivation of a risk neutral landowner (w_{sc}) and the value of land delegation to a risk averse Agent (w_{sb}) is $w_{sc} - w_{sb} = w_{sc} - w_{fb} + w_{fb} - w_{sb}$.

By propositions 2.7 and 2.8, $w'_{sc}(x) - w'_{fb}(x) < 0$ and $w'_{fb}(x) - w'_{sb}(x) > 0$ (except in the particular case where the risk averse Agent supplies a higher effort than in the first best). The sign of $w'_{sc}(x) - w'_{sb}(x)$ depends on which of both terms dominates: the efficiency loss of delegation to a risk averse Agent or the land value gap due to the delegation to an Agent with a lower marginal cost of effort. When the Agent is risk neutral, $w'_{sc}(x)$-$w'_{sb}(x) = w'_{sc}(x)$-$w'_{fb}(x)$<0.

Now, assume that a landowner chooses to delegate if $w_{sc}(x)$-$w_{sb}(x) < \varepsilon$ where ε is a randomly distributed unobserved landowner specific effect (representing some kind of fixed cost). Denoting F the cumulative distribution function of ε, the probability that a landowner leases out a plot of land is $d(x) = F(w_{sc}(x)$-$w_{sb}(x))$ and then $d'(x)$=$(f(w_{sc}(x) - w_{sb}(x))[w'_{sc}(x) - w'_{sb}(x)]$

which sign is that of $w'_{sc}(x)$-$w'_{sb}(x)$. Therefore, we have the following implications:

· Under risk neutrality, the probability of delegation for a plot of land increases with its fertility.

· If tenants are risk averse, the probability of delegation can increase or decrease with land fertility. It decreases when the efficiency loss of delegation dominates the valuation gap driven by the effort cost difference between both parties. In this case, the landowner prefers to self cultivate even if it is more costly for him because the efficiency loss of the delegation is too high. We remark that the same kind of prediction applies even if future fertility has no value for the landowner. The empirical study of the probability of delegation with respect to the land value can then provide an empirical test of the presence of risk aversion since risk neutrality implies monotonicity.

2.5. Predictions and testable implications

The first question in mind is about the empirical relevance of the inclusion of fertility dynamics in the landowner's objective? Is our model supported by the data? The correlation between contract incentives and land value could behave according to the existing canonical model of Stiglitz (1974). As our model encompasses this canonical model, either we reject both models or we reject only the canonical one. In the standard literature on sharecropping there are no explicit predictions about the effect of land quality on contract choices. It is exactly what we tried to remedy in our dynamic model. If the landowner has an infinite horizon objective due to his property right, he cares about land damaging by the tenant. We compare the canonical model (Stiglitz, 1974) and our model in order to be able to test between these two competing models of moral hazard:

· Canonical Model [1]: trade-off between production incentives and risk sharing (Stiglitz, 1974): $a^* = 1 - (1 - E\nu U'/EU')f/e_a f_e$.

· Encompassing Model [2]: this model with moral hazard on land fertility use (proposition 2.6): $a^* = 1 - (1 - E\nu U'/EU')f/e_a f_e + E\varepsilon v' g_e/f_e$.

- *Risk neutrality*

Assuming risk neutrality for both contractors, the model of pure moral hazard in production would predict the choice of fixed rent contracts whatever the land value (the empirical evidence is obviously contrary to this prediction whereas our model remains consistent with data even under risk neutrality of agents). As a benchmark, we remark that the production-land value trade-off is monotone with respect to land fertility (proof of proposition in appendix 5.5):

Assumption 6 The function g governing fertility dynamics and land value are such that $\frac{\partial^2}{\partial e \partial x}(E\varepsilon v \circ g) \geq 0$[7].

Assumption 7 The function f is such that $0 \leq f_{ex} \leq (\frac{C_{ee} f_e}{C_e} - f_{ee}) \min \left\{ \frac{g_x}{-g_e}, \frac{g_{ex}}{-g_{ee}} \right\}$.

Proposition 2.9. *In the risk neutral case, under assumptions* 6 *and* 7*, $a(x)$ is an increasing function.*

So, if fertility and labor are separable or substitutes in the production function (which is the case for Cobb-Douglas functions) and if $g_{ex} \geq 0$ (meaning that the marginal negative impact of effort on fertility decreases with the fertility level, it can be seen as a formal consequence of fragile lands which can be more damaged than better ones), then $a(.)$ will be increasing[8]. If the marginal land value converges towards zero as fertility increases, then the optimal slope converges towards one which corresponds to a fixed rent contract.

- *Risk averse tenant*

First, by a continuity argument, the proposition established in the case of risk neutrality can be extended to the case of risk averse tenants having a small risk aversion. In the general case, the analysis is too complicated to derive exact implications and we need to make some approximations. The Principal's revenue is $\max_a R(a,x)$ with $R(a,x) = (1-a) f(x, e(x,a)) - b(x,a)$ where $b(x,a)$ is implicitly defined by the individual rationality constraint and $e(x,a)$ by the incentive compatibility constraint. According to the envelope theorem $\forall x$, $\frac{\partial R}{\partial a}(a^*(x), x) = 0$ and $a^{*\prime}(x) = -R_{ax}/R_{aa}$. As $R_{aa} < 0$, the sign of $a^{*\prime}(x)$ depends on $R_{ax} = -f_x - f_e e_x + (1-a) f_{ex} e_a + f_e e_{ax} - b_{ax}$. As $b_x = -a f_x \frac{E\nu U'}{EU'}$, $b_{ax} = (-f_x - a f_{ex} e_a) \frac{E\nu U'}{EU'} - a f_x \frac{\partial}{\partial a}(\frac{E\nu U'}{EU'})$, $R_{ax} = -f_x(1 - \frac{E\nu U'}{EU'} - a \frac{\partial}{\partial a}(\frac{E\nu U'}{EU'})) - f_e e_x + (1 - a(1 - \frac{E\nu U'}{EU'})) f_{ex} e_a + f_e e_{ax} \approx -f_x(1 - \frac{E\nu U'}{EU'}) - f_e e_x$ if third order effects are neglected because $0 < \frac{E\nu U'}{EU'} < 1$. Therefore $a^{*\prime}(x) \leq 0$.

Another argument is to say that the slope elasticity of production will be smaller with better land quality i.e. that the direct land productivity increase dominates all other effects on effort's productivity and incentives. Moreover, we can presume that the increase of the insurance effect will be dominated by the elasticity of production. This is likely to be true when risk aversion

[7] It is always the case with v increasing concave and assumption 3 ($g_{ex} \geq 0$), but the condition $\partial^2/\partial e \partial x(f + E\varepsilon v \circ g) \geq 0$ is sufficient and less restrictive.

[8] When $g_{ex} < 0$, $a(.)$ will be increasing if the value function is sufficiently concave so that the marginal negative effect of effort on the land value decreases in absolute value with the fertility level.

does not decrease too fast[9]. Then the following term $\left(1 - E\nu U^{'}/EU^{'}\right)/\eta_a^f$ will be non decreasing with x meaning a^* will decrease with x in the canonical model.

For Constant Absolute Risk Aversion utilities, we could approximate $E\nu U^{'}/EU^{'} \simeq 1 - af\sigma_A Var\nu$ where σ_A is the coefficient of absolute risk aversion. Then $\frac{1-a^*}{a^*} \simeq \frac{\sigma_A Var\nu f^2}{e_a f_e}$ and $\frac{f^2}{e_a f_e}$ can be supposed non decreasing with x because the increase of production squared is likely to dominate all other effects. Therefore, $\frac{1-a}{a}$ being a decreasing function of a, $a(x)$ is a decreasing function of x[10].

In our model we can easily see that $\frac{-g_e}{af_e}E\varepsilon v^{'}$ will be decreasing with x for a sufficiently concave value function. In this case $a(x)$ will increase or decrease according to which term will dominate[11]. Whatever the risk aversion, our model predicts that contract incentives are lower when the production effort of the farmer is detrimental to land fertility. Broadly speaking, if short term production induces soil overuse, "everything else equal" sharecropping contracts are more likely to be chosen than fixed rent ones.

The main findings which are relevant to point out in relation to the land tenancy literature and empirical applications are that the optimal incentives of the contract depend on the possibility of overuse of the land and on its fertility level. The model explains why a landowner may use different contracts on different plots. Under risk neutrality, the optimal contract is not fixed rent but sharecropping where the share of production going to the tenant is increasing with land fertility. If the tenant is risk averse (for example with Constant Absolute Risk Aversion utility), the optimal incentives are likely to decrease with land fertility in the pure risk sharing model[12]. In our model, optimal incentives increase with land fertility if the production/investment trade-off due to the marginal land value influence, dominates the risk sharing trade-off. The probability that a landowner leases out a plot of land can be increasing or decreasing with its fertility level but is increasing if the Agent is risk neutral. Table 1 presents a summary of these predictions:

TABLE 1 HERE

[9] Actually, it is possible that, for very decreasing risk aversions, 1-$E\nu U^{'}/EU^{'}$ will decrease sufficiently to compensate the production increase and lead to an increasing $a(x)$.

[10] A simple simulation with $U = \log$ (Constant Relative Risk Aversion utility), $f(x,e) = x^{.4}e^{.3}$, $c(e) = e^2$, and ν of mean one (production uncertainty multiplicative factor) following a β-regularized cumulative distribution $H(\nu) = \frac{\Gamma(8)}{\Gamma(4)^2}\int_0^{\nu/2} t^3(1-t)^3\,dt$ where $\Gamma(z) = \int_0^\infty t^{z-1}e^{-t}dt$ show that $a(x)$ is decreasing.

[11] If the landlord is also risk averse, we can see that if he is sufficiently less risk averse than the tenant then we have the same implications. It can be seen as a result of a continuity argument.

[12] If risk aversion decreases very quickly then it can happen that the optimal incentives increase with land fertility. However, we won't forget this case and show why it seems empirically inconsistent.

These predictions on the determinants of the joint choice allow to perform tests between the models and to determinate which of the 4 alternatives best rationalizes the data. We do not observe the characteristics of the tenants. We suppose that preferences are homogeneous. This assumption is generally implicit in most empirical studies. It enables us to infer the effect of land quality on the optimal contract. Of course, if model [1] is rejected, it is in favor of model [2] or of another unknown alternative which would be consistent with the data.

A remark on Cross-Section versus Longitudinal tests of predictions:

We derived some cross sectional predictions from our dynamic model in order to check whether empirical evidence support the model. However, this cross sectional analysis is consistent with the main dynamic effects. In particular, the model does not rule out the importance of cycles in the decisions to leave land fallow but can help to explain them. A consequence of the model is that the optimal cultivation choice (sharecropping or fixed rent if the landowner decides to lease out and own cultivation or leaving land fallow otherwise) depends on the fertility level which changes over time. As fertility can increase or decrease from one period to the other, it can give rise to different schemes of fertility and land tenure dynamics. The model can generate fertility cycles and then cyclical patterns of land allocation and fallow. It is commonly admitted that leaving land fallow is generally intended to let the soil rest and that it is practiced when fertility is low. The model gives a possible rationale to the observed cyclical behaviors due to the possible cyclical fertility evolution (see Dubois, 1998b, for further explanation).

3. Empirical Evidence from a rural area of the Philippines

The main relevant question concerns the empirical consistency of our dynamic model, and whether it can be distinguished from the canonical framework (Stiglitz, 1974) or from other existing models explaining tenancy contracts (Allen and Lueck, 1993). Even if the theoretical model gives a new interesting viewpoint on land tenancy, it seems important to be able to assess its empirical explanatory power.

Among the few studies on sharecropping caring about land quality, Ai, Arcand, Ethier (1996) and Shaban (1987) include soil type and irrigation characteristics as explanatory variables to control for this kind of heterogeneity only. In a transaction costs model with risk neutrality, Allen and Lueck (1992, 1993, 1996) point out the importance of the difference between farmer's perceived cost of land and its true cost. Using US data on agricultural contracts, they run logit regressions explaining the choice of crop share versus cash rent contracts and find that the probability of a sharecropping contract increases with the possibility of soil overuse by the farmer. Actually, cultivating row crops (such as corn) is more likely to induce excessive tilling which raises production in the short run but also leads to wind erosion, nutrient depletion and loss of moisture in the fields. On the other hand, irrigation is negatively related to the probability of sharecropping because irrigated land cannot be overused by the farmer. The econometric study of Allen and Lueck may suffer from endogeneity biases but it remains very insightful on the various factors determining tenancy forms. Except the papers of Allen and Lueck, empirical studies about sharecropping generally rely on data on tenants' behavior. Very few studies use data on landowners. We want to assess the relationship between land quality, production technology (depending on the cultivated crop) and contract by looking at landowner's decisions.

3.1. Features of the surveyed rural area

The Philippines data that we use are drawn from a survey conducted by IFPRI and RIMC[13] in the South Bukidnon Province of Mindanao. The sample consists in 448 households from ten villages[14]. Information is available on land tenure and land ownership, demographic characteristics, consumption and nutrition, asset ownership, off farm labor supply. Table 2 gives descriptive statistics of the variables. Each household was interviewed four times at four month intervals. A remarkable feature of these data is that an estimate by the owner of the value of each plot under each tenancy status is available. As shown by Bouis and Haddad (1990), land contracts between landowners and peasants are frequent in this rural area. It is to be noted that the Philippine land reform requiring the transformation of share tenancy to leasehold tenancy has been slow to implement and its application is very disparate across islands of the archipelago. Otsuka (1991) studies the consequences of the land reform decree of 1972 in Luzon and Panay Islands during the late seventies and the eighties. In Mindanao, its implementation happened much more later. In particular, it had not yet been implemented at the time of the survey (1984-1985) in the Bukidnon region. The frequency of share tenancy in our sample also proves it.

TABLE 2 HERE

In this Philippines region, the incompleteness of markets seems to be quite pervasive: land transactions are rare and access to credit is almost impossible. In our sample, average owned

[13]International Food Policy Research Institute (Washington D.C.) and Research Institute for Mindanao Culture (Xavier University, Cagayan de Oro, Philippines).

[14]The municipalities are Valencia, Maramag, Kalilangan, Quezon, Don Carlos, Kadingilan, Kitao-tao, Dangcagan, Kibawe and Damulog.

land areas over all landowning and landless households are small (about 2.11 hectares by household or 0.26 hectares by household member) and more than 57% of households are landless. The average owned area of landowners is more than 6.1 hectares. Moreover the average population density in the rural area studied is 149 inhabitants by km^2 so that land is a scarce factor of production. There are spot markets for wage labor. In the contractual relationship, land being scarce while labor is abundant, landlords have monopsony power on the labor market and monopoly power on the land market. The assumption that landowners are much less risk averse than tenants can be supported by the fact that, in the surveyed area, most landowners own several plots of land rented out at fixed rent or on a share basis and moreover the average real income per capita of tenants and wage laborers is half that of households who own some plot of land (P27.7 against P51.4 per week). Landowners are really richer than leasing in tenants. These descriptive features allow us to use a partial equilibrium analysis and the Principal-Agent framework. Moreover, the adverse selection problem about tenants' capacities and agricultural know-how does not appear to be important, as it is often argued in village economies. The Principal Agent model that we use seems well suited for modelling leasing behavior in this area. Besides, Bouis and Haddad (1990) report that land fertility is an important factor in the determination of yields and agricultural incomes. They report that land fertility decreased over the 1960's to the 1980's, according to a very large majority of peasants, because corn yields had dramatically fallen due to fertility decrease. Consequently, agricultural incomes fell and almost all landowners were aware of this problem. Maintaining land quality is a sensitive issue. Land value clearly depends on its fertility. It seems legitimate to consider that the management of the fertility of the land is an important issue in the economic and organizational choices of landlords. Sharecropping is practiced using different production shares. In the empirical analysis, we have to pool all sharecropping contracts in the same category because the data do not provide the share ratios for rented out plots of land. Thanks to the share ratios reported only for the rented in plots of land, we know however that three prevalent sharing rules are used 1/4, 1/3 and 1/2 for the sharecropper[15]. Leasing in and leasing out peasants belong to the sample. We study the leasing out behavior of landowners to test our model against possible alternatives. We only distinguish between two systems of leasing out: fixed rent contracts and sharecropping contracts because we cannot take into account the value of the share ratios. Some observations on landowners could not be used because of inconsistent responses but they are few (nine cases).

[15]If the land value variable were also available for rented in plots of land, we could also test some predictions of the model using these contracts and the more detailed information on sharing rules.

As can be seen in Bouis and Haddad (1990), three main crops are grown in the Philippines area studied: corn (dry), sugar and rice (generally using irrigation systems). The corn growing period is between 3 and 4 months and is roughly equal to the 4 months intervals between the survey interviews.

In addition, the theoretical model developed above considers the case of short term contracts only. Long term contracts would mitigate the conflict of interest between parties in the land maintenance. Nevertheless, the modelling of short run relationships justified theoretically by the assumption of impossible commitment to long term agreements seems to be empirically plausible. Actually, in the sample, the change of contracts (we do not know if it is a renegotiation with the same tenant or if the tenant has changed) relatively often occurs. For example, during the survey, the frequency of modified sharecropping contracts during one year was equal to 52% and the frequency of modified fixed rent contracts was equal to 47%. This means that the terms of the contracts often change. Unfortunately, we do not have the duration of contracts in our data. However, these large rates are likely to reflect that contracts are generally short term even if we cannot strictly control for the heterogeneity of contracts lengths in the estimations.

3.2. Incentives, land value and cropping system

We know that incentives to corn production are bad for long term investment in the land quality and do not seem to have much importance in the rice or sugar production. In the described environment, the model predicts that incentives must be smaller for corn production and that the reduction of incentives given by a smaller output share should be smaller for better lands than for bad lands in the case of corn production.

Using a binary Probit model to estimate the determinants of fixed rent versus sharecropping contracts, the equation (5) suggests that the land value must be included among determinants. The value of each plot is evaluated by the landowner (the land value per hectare is used)[16]. We test whether the likelihood of fixed rent versus share contracts is increasing with land quality (some preliminary non parametric tests of independence of the distribution of contracts among the land value quantile strongly reject the independence meaning that the contract choice is actually correlated with land value). We have to remark that the land value estimation available in the data corresponds rather to $v(x)$ than to the fertility index x. But the increasing

[16] In the regressions beyond, we used the logarithm of the land value per hectare, but similar results are obtained with the specification including the land value and its square. Moreover, likelihood ratio tests between these two models (Vuong (1989)) for the contract choice show they are not statistically distinguishable.

relationship between both values allows to implement the empirical tests with the land value instead of the unobserved fertility index without modifying the signs of coefficient estimates.

TABLE 3 HERE

As shown in Table 3, in the decision of landowners, a sharecropping contract is more likely when corn is produced than for rice or other productions (the reference crop is sugar and other crops). This result is consistent with the prediction that in the case of corn production the risk of soil exploitation by the renter leads the landowner to propose a less incentive contract (sharecropping against fixed rent). For better lands, the probability of fixed rent rather than share-tenancy increases. As the contract choice may depend also on landowner's risk preferences, we introduce some observable characteristics which are likely to be correlated with risk aversion in order to control for this heterogeneity. As exogenous agricultural risk could be different between areas because of climatic and other environmental differences, we included village dummies in all the probit regressions. We can see in Table 3 that results are very similar with respect to the influence of land value and crop production on the probability to choose a sharecropping versus a fixed rent contract. Several specification tests like testing for omitted variables, homoscedasticity[17] have been made (Dubois, 1998a) and allowed to validate the estimation. Moreover, estimations of finite sample bias evaluated with bootstrap and indirect inference techniques showed that the inference remains robust. Consequently, the empirical evidence is consistent with the predictions of the model and not with the pure risk sharing model as long as the assumptions of the theoretical model are valid.

Crop specific effects

Our model predicts that conditional, on the technology, if the production effort is damaging for land, as it is commonly admitted for corn production, then the optimal share of production should be strictly smaller than one and be increasing with land quality. As the production functions and fertility dynamics depend on cultivated crops, we analyze the contract choice by decomposing the land value with crop dummies. As shown, the likelihood of a fixed rent contract against sharecropping is lower for corn production than for rice or sugar production and is higher for better land quality. What is really remarkable in this model and its empirical application is that the land value effect in the determination of the optimal contract slope exists

[17]Assuming that residuals could depend on a set of exogenous variables z, we can write $Var(\eta) = (\exp(\mu z))^2$ in the latent model $y_{2i}^* = x_i\gamma + \eta_i$. We can make a Lagrange Multiplier test of $\mu = 0$. We made several heteroscedasticity tests showing that we cannot reject homoscedasticity with respect to variables such as owned land area, owned total land value, household size.

empirically and, as our model says, its marginal effect in the contract determination diminishes with the land value.

Is there a bias from the endogeneity of crop choices?

It could be argued however that as the crop cultivated on the leased out plot is a decision variable for landowners or farmers, there is some endogeneity bias in the estimates of Table 3. To check if the endogeneity of crop choices actually biases the coefficients, we implement a test of statistical exogeneity. It consists in recasting the model in a two dimensional one and runs as follows:

In a first step, one implements a Lagrange Multiplier test (ξ) of no correlation between crop choice C_i and contract choice y_{2i} including exogenous "instrumental" variables z_i in the crop determination. This step tests the lack of simultaneous equation bias in the contract choice. In a second step, we test the validity of instruments by another score test (ζ) of nullity of the coefficients of the instrumental variables in the contract equation i.e. we test the exclusion of these z_i from the contract choice because they could be omitted variables in the contract choice. This step is an over-identifying restrictions test. The results of these orthogonality tests for corn are in table 3 and show that we cannot reject the hypothesis of no simultaneity bias. The same tests made in the case of rice allow us not to reject the null hypothesis with even more confidence.

We have no structural model that gives a meaning to the sign of variable coefficients in the auxiliary equation for crop but we can give some interpretation. Actually, it seems that the crop cultivated depends on location (distances are proxy variables). It can be a consequence of the difference in profitability or riskiness of corn production versus sugar production which depend on the location of landowners. Actually, sugarcane is more profitable than corn (see Bouis and Haddad, 1990) only if cultivated near the sugar mill.

Landowners unobserved specific effects

A further critique of our testing procedure comes from unobserved specific effects for landlords. In relation to the model, heterogeneity in risk aversion or in preferences for the present leads theoretically to different choices resulting from the trade off between risk sharing and production of fertility investment. In order to account for the heterogeneity of landowners, we introduce some landlords specific effects in the latent model writing: $a_{ijt} = \alpha x_{jt} + a_i + u_{ijt}$ where a_{ijt} is the incentive slope of the contract given by landlord i on plot j at time t. The observation of different contracts on different plots of a same landowner allows us to compute a "within-landowner between-plots" estimate. Supposing that the specific effect is randomly normally distributed in the population of landowners, we can estimate a random effects probit model. Because of non sufficient time variations for the algorithm to converge, we cannot estimate the random effects probit with period-specific effects and only time dummies are used. The Table 3 shows that the empirical results remain robust to these unobserved landlords specific effects as the coefficient variables of interest remain statistically significant.

Finally, we deduce that the canonical model is insufficient to explain the empirical findings whereas our model is consistent with empirical regularities. Contingent to the validity of the assumptions of the theoretical model, we tested for the presence of the land value effect in the contract choice of landowners.

3.3. Simultaneous choice to lease out and of contract

Another economic and econometric issue of this paper is that we are able to avoid the sample selection bias that plagues studies on tenancy choices. Contracting choices are generally explained on the basis of observed sets of contracts only. The choice set of landowners is broader and the contract choice is simultaneous to the choice to contract. As there is no reason to *a priori* think that they are independent, the contract choice equation may suffered from a selection bias problem. Formally, denoting y_{1i}^* the latent variable governing the decision to lease out a land plot: y_{1i}^*, the landowner decides to lease out land if $y_{1i}^*>0$. He chooses between fixed rent or share tenancy according to y_{2i}^* and $y_{2i} = 1_{y_{2i}^*>0}$ is one for fixed rent and zero for share tenancy. Then writing the full econometric model with the bivariate censored form: $y_{1i}=1_{y_{1i}^*>0}$, $y_{2i}=1_{y_{2i}^*>0}$ observed if $y_{1i}=1$ where the latent model is $\left\{\begin{smallmatrix} y_{1i}^*=x_i\beta+\varepsilon_i \\ y_{2i}^*=x_i\gamma+\eta_i \end{smallmatrix}\right.$ with $\left(\begin{smallmatrix}\varepsilon_i \\ \eta_i\end{smallmatrix}\right) \hookrightarrow N\left(0, \left(\begin{smallmatrix}1 & \rho \\ \rho & 1\end{smallmatrix}\right)\right)$, we can test if the correlation ρ is zero. Under the null that error terms of both probit regressions are uncorrelated, one can run two independent probit regressions and then perform a score test of $H_0=\{\rho=0\}$. The score test statistics for each specification show that we cannot reject H_0. However, we know from Andrews (1989) that the power of our test statistic may be low and that even a relatively high correlation might stay undetected. Therefore, we estimate by maximum likelihood the bivariate censored model. Results of the censored bivariate model with the different specifications (with or without additional explanatory variables) do not allow to identify always precisely the correlation parameter but give all the same evidence with respect to the coefficient of interest. The standard deviation of the correlation coefficient is sometimes large and estimating the inverse power function $\pi(.)$ of ρ (Andrews (1989)) with $\pi(0.95)=3.60\times\widehat{se_\rho}$

and $\pi(0.5)$=1.96×$\widehat{se_\rho}$, we can see that for large intervals of correlation values we have a high probability of type II error and there is no range of possible values for the correlation parameter for which the test would have high power. However, the less imprecise results presented in Table 4 are consistent with the predictions of the model. The value of the correlation parameter ρ shows that there is some selectivity bias in the probit regressions on the sample of landowners who lease out some land. Results found previously on the determinants of the contract choice carry over and are robust to the inclusion of land left fallow by landowners in the sample of non leased out plots.

TABLE 4 HERE

An important issue is to determine how the probability to lease out a plot of land evolves according to its value. A probit estimation of the decision to delegate the use of land on the land value per hectare shows it is increasing with land value (controlling for other explanatory variables: land area owned, owned assets, corn and rice dummies, household size, education of father and mother, village and time dummies). This result may suggest that the efficiency loss induced by delegation never offsets the increased cost induced by self cultivation. However, estimation results using different specifications (logarithmic and with powers of land value per hectare) appear in Table 5.

TABLE 5 HERE

The maximum of the parabolic approximation for the second model is at a land value of 5 557 P/h. (corresponding to the 78^{th} percentile of the distribution of plot values per hectare). In the first specification one can say that the probability for a landowner to cultivate himself a plot of land is strictly decreasing with its fertility. With the second specification, the probability for a landowner to cultivate a plot of land instead of delegating its use is U shaped with respect to the fertility level[18]. In the first model, the inefficiency loss of land delegation does not dominate the cost difference between the landowner and the peasant. In the second, the cost difference gap dominates the efficiency loss for fertility levels lower than some level and the contrary happens for large fertility.

In order to test between these two specifications to know which one is the closest to the true

[18]Taking into account unobserved specific effects of landowners that could represent heterogeneity in the cost of effort, we estimated the random effect probit model of choice to lease out. It gave the same results with respect to the U shape and similar coefficients.

model, we implement the inference procedure of Vuong (1989) which derives some likelihood ratio tests allowing to test between strictly non nested or overlapping models. The test consists in two steps, the first tests if the variance of the likelihood ratio statistic is significantly different from zero meaning that the two models are distinguishable. In the case of Table 5, the variance is $n\widehat{\omega}_n^2 = 9.79$. Its asymptotic distribution is a weighted sum of chi-squares which weights are the 47 eigenvalues[19] of a variance covariance matrix $\widehat{W_n}$ and a Monte Carlo simulation shows that the statistic corresponds to the 94% critical level. This allows to infer that models are distinguishable. The second step allows to test between both non nested models thanks to the likelihood ratio statistic $n^{-1/2}LR_n(\widehat{\theta}_n, \widehat{\gamma}_n)/\widehat{\omega}_n = -6.55$ which is far below the 1% significance level of the standard normal distribution. Therefore we can reject the null hypothesis that the models are equivalent in favor of G_γ being better than F_θ. Implementing the previous test with adjusted LR statistics which are equivalent, we obtain the same result. With the correction factors corresponding to Akaike and Schwarz information criteria, we found respectively -6.24 and -5.45.

The test shows that the second model performs better than the first. We conclude that the probability that a landowner delegates the use of a plot of land is indeed inverse U shaped i.e. it is increasing below some fertility level and decreasing above. It means that for high land values, the efficiency loss of delegation is too large and the landowner prefers to cultivate himself the plot of land even if he has a higher marginal cost of effort. This empirical result is inconsistent with the assumption that agents are risk neutral because of the presence of an efficiency loss. It confirms the presence of risk aversion and rejects a pure "transaction cost" approach where people would be risk neutral and contacts would be explained only by the land conservation argument.

Therefore, the joint empirical findings on contract incentives and on the leasing out decision seem to be inconsistent with the pure risk sharing model (without valuation of future land fertility) while they remain in our model[20].

Nonparametric Estimation

In order to check whether the empirical U shape function, found for the probability to lease out with respect to land value per hectare, is not due to the parametric assumption of error

[19]Eigenvalues range from -1.27 to 0.57.

[20]In the canonical model with an agent having a very decreasing risk aversion, the optimal incentives can be increasing with fertility. But then we would expect the probability of delegation to be increasing for high fertility levels where the optimal contract is nearly a fixed rent and the second best reaches the first best. On the contrary, the probability of delegation is decreasing at high fertility levels meaning that this very special case of utility shape could not explain the empirical results in the canonical model.

terms and the quadratic specification on land value, we estimate the probability of leasing out land non parametrically. Writing $y_{1i}^{*} = r(x_i) + \varepsilon_i$ and $y_{1i} = 1_{y_{1i}^{*}>0}$, we estimate $\widehat{r}(x)$ with a Nadaraya-Watson kernel estimator $\widehat{r}(x) = \frac{\sum_{i=1}^{n} y_{1i} K\left(\frac{x_i - x}{h}\right)}{\sum_{i=1}^{n} K\left(\frac{x_i - x}{h}\right)}$. We can also include other explanatory variables z and estimate $\widehat{r}(x, z)$ with multivariate kernels.

The figure 1 shows the estimated regression function[21] of the decision to contract on the land value per hectare (/1000 P). However, does this U shape persist when other explicative variables are introduced? Including them sequentially, we can estimate and plot the regression functions.

FIGURE 1 HERE

FIGURE 2 HERE

The three dimensional plots show the estimates of the regression functions when another variable is included. We remark that globally, the inverse U shape of land value remains in all cases (the variables included are total owned area, household size, household members by owned hectare of land, education of father, education of mother, age of household head). This descriptive and visual empirical fact confirms the results obtained when we control for all variables simultaneously in the parametric regressions.

4. Conclusion

This Principal-Agent model of moral hazard with a stock variable in the production function allowed us to show the importance of land fertility in the determination of the optimal contract. The optimal contract depends on the technology of production and the land fertility dynamics as well as risk aversion. We derived an endogenous land value function and testable implications about the form of the contract. Because of the long term - short term conflict of objectives and the damaging effect on fertility of land overuse, the second best contract is a sharing arrangement even if agents are risk neutral. This is one of the main original point of this model in the literature on land tenancy. Optimal incentives depend on the possibility of overuse of the land and on its fertility level. The model explains why a landowner uses different contracts on different plots of land. Also, the leasing out decision of a landowner depends on the difference in cost of effort between the landowner and the peasant and the efficiency loss due to the delegation to a risk averse agent.

[21] Estimation with Gaussian kernel and bandwidth $h = 1.14$. The same results are obtained with Epanechnikov kernel.

From the empirical study reported in this paper, the most important results are that the pure risk sharing model and the pure transaction cost approach are rejected in this Philippines area while our model integrating both trade-off seems to be empirically consistent. Landowners choose more incentive contracts (fixed rent versus share tenancy) for more valuable plots of land and less incentive ones when cropping practices, such as for corn, induces more overuse of the land. The probability of a landowner to lease out a plot of land is inverse U shaped with respect to land value.
Using these Philippines data, the predictions of our model are empirically consistent. The monotonic relationship between incentives given by the contract and the land value seems relatively robust to various specification tests. The inverse U shape of the probability to lease out with respect to land value is also explained by our model.

Finally, the soil quality appears to be an important economic factor in the choice of tenancy agreements. This is to be considered for policy design with respect to land conservation, production levels and efficiency of agricultural organizations. Actually, it is often argued that development policies recommending to prevent sharecropping contracts in favor of renting at fixed rate must be accompanied by measures allowing to improve access to insurance because sharecropping provides risk sharing to the tenant. However, we showed that even with risk neutrality a sharecropping contract can be optimal if commitment failure prevent the credible use of long term contract leading to a conflict between short term and long term interests between the landowner and the tenant. Leasing at fixed rent can have deleterious effects on long term production because of the impoverishment of land. Therefore, policies promoting the enforcement of long term contracts may be necessary in addition to giving access to insurance. Social institutions able to improve the enforcement of long term contracts with formal agreements would likely incite landowners to use long term agreements. Moreover, our model shows that the decisions of landowners to lease out land being also endogenous, the regulation of contracting institutions may have an impact not only on contracting practices but also on leasing out decisions of landowners who may prefer to manage land cultivation themselves (hiring laborers) instead of leasing out at fixed rent to a tenant. The econometric study made in this paper actually shows that leasing out decision are not independent of contracting choices. At last, this paper shows that the long term efficiency of land and labor contracts may lead to different implications for development policy design.

5. Appendix

5.1. Proof of proposition 2.2

In the case of risk neutrality, the value function is the first best one and the proof is straightforward. However, the method adapted from tools found in Stokey, Lucas, and Prescott, 1989, consists in defining an operator T which is shown to be a contraction mapping with a unique fixed point which is increasing (and concave) because T maps the set of continuous (and concave) functions onto itself (see details in Dubois (1998a). In the risk neutral case, T is defined by $Tw(x) = \underset{a\geq 0}{Max}\ f(x,e(x,a)) - C(e(x,a)) - \overline{U} + \rho Ew(\varepsilon g(x,e(x,a)))$
$= f(x,e(x,a^*(x))) - C(e(x,a^*(x))) - \overline{U} + \rho Ew(\varepsilon g(x,e(x,a^*(x))))$
where $a^*(x) = \arg\max_a f(x,e(x,a)) - C(e(x,a)) - \overline{U} + \rho Ew(\varepsilon g(x,e(x,a)))$ and $e(x,a) = \arg\max_e aE[\nu f(x,e)] - C(e)$. To prove that the solution of the functional equation is an increasing function, it needs to show that if w is increasing, then Tw is also. The same applies for the concavity. With the envelope theorem $\frac{\partial Tw}{\partial x}(x) = f_x + \rho E\varepsilon w' g_x + e_x(f_e - C_e) + \rho E\varepsilon w' e_x g_e = f_x + \rho E\varepsilon w' g_x$ because $af_e = C_e$ and $(1-a)f_e + \rho E\varepsilon w' g_e = 0$. If As $w' > 0$, then $\frac{\partial Tw}{\partial x}(x) > 0$ because $f_x > 0$ and $g_x > 0$.

5.2. Proof of proposition 2.3

We need to prove that if w is increasing then Tw is also increasing where $Tw(x) = \max_a (1-a)E[\nu f(x,e(x,a))] - b(x,a) + \rho Ew(\varepsilon g(x,e(x,a)))$. With the envelope theorem, $\frac{\partial Tw}{\partial x} = (1-a)[f_x + e_x f_e] - \left(\frac{\partial b}{\partial x}\right)_{|\overline{U}} + \rho E\varepsilon w'(g_x + g_e e_x)$. Differentiating the equation defining $b(x,a)$ we have $\left(\frac{\partial b}{\partial x}\right)_{|\overline{U}} = -af_x \frac{E\nu U'}{EU'}$. So $\frac{\partial Tw}{\partial x} = f_x\left(1 - a\left(1 - \frac{E\nu U'}{EU'}\right)\right) + (1-a)e_x f_e + \rho E\varepsilon w' g_x$ with $(1-a)f_e = \left(1 - \frac{E\nu U'}{EU'}\right)\frac{f}{e_a} - E\varepsilon w' g_e$ by proposition 2.6. Moreover, $e_a = \frac{E\nu U' + a(E\nu^2 U'' - E\nu U'' E\nu U'/EU')f}{C_{ee} - aE\nu U' f_{ee} - a^2 E\nu^2 U'' f_e^2} f_e$, $e_x = a\frac{E\nu U' f_{ex} + a(E\nu^2 U'' - E\nu U'' E\nu U'/EU')f_e f_x}{C_{ee} - aE\nu U' f_{ee} - a^2 E\nu^2 U'' f_e^2}$ and $C_{ee} - aE\nu U' f_{ee} - a^2 E\nu^2 U'' f_e^2 > 0$. We know that $0 < \frac{E\nu U'}{EU'} < 1$. Hence supposing $E\nu^2 U'' - E\nu U'' E\nu U'/EU'$ is positive or small in magnitude if negative, we have $e_a > 0$ and e_x of the sign of f_{ex} like in the risk neutral case. If $f_{ex} \geq 0$ then $a \leq 1$, $e_x \geq 0$ and $\frac{\partial Tw}{\partial x} \geq 0$. Also we have, $\frac{\partial Tw}{\partial x} = f_x + \frac{(1 - E\nu U'/EU')aE\nu U'[f_{ex} f - f_e f_x]}{E\nu U' + a\left(E\nu^2 U'' - E\nu U'' E\nu U'/EU'\right)f} + \rho E\varepsilon w' g_x \geq 0$ if $e_a \geq 0$ and $f_{ex} f - f_e f_x \geq 0$ i.e. $\frac{\partial}{\partial x}(f_e/f) \geq 0$. For Cobb-Douglas production functions we have $f_{ex} f - f_e f_x = 0$. For the concavity, we need that w concave implies that Tw is also. As $f_{xx} \leq 0$, $g_{xx} \leq 0$, $w'' \leq 0$, and $\frac{\partial^2 Tw}{\partial x^2} = f_{xx} + \rho E\varepsilon w' g_{xx} + \rho E\varepsilon w'' g_x^2 + [\rho E\varepsilon w'' g_x g_e + \rho E\varepsilon w' g_{ex} + f_{ex}]e_x + \frac{\partial}{\partial x}\left[\frac{(1 - E\nu U'/EU')aE\nu U'[f_{ex} f - f_e f_x]}{E\nu U' + a\left(E\nu^2 U'' - E\nu U'' E\nu U'/EU'\right)f}\right]$. Hence assuming that third order effects are negligible i.e. that second order effects dominate higher order ones, $\frac{\partial^2 Tw}{\partial x^2} \simeq f_{xx} + \rho E\varepsilon w' g_{xx} + \rho E\varepsilon w'' g_x^2 \leq 0$.

5.3. Proof of proposition 2.7

Assume there is a given value function w then the value of the first best and second best problems are the fixed point of the operators T_{fb} and T_{sb} defined by : $T_{fb}w(x) = \underset{e}{Max}\ f(x,e) - C(e) - \overline{U} + \rho Ew(\varepsilon g(x,e))$ and $T_{sb}w(x) = \underset{a}{Max}\ (1-a)E[\nu f(x,e(x,a))] - b(x,a) + \rho Ew(\varepsilon g(x,e(x,a)))$ where $b(x,a)$ allows to satisfy the individual rationality constraint. First, $T_{fb}w(x) - T_{sb}w(x) \geq 0$ (equals zero when the Agent is risk neutral). Then we have (see appendix 5.1 and 5.2): $\frac{\partial}{\partial x}T_{fb}w(x) = f_x(x,e_{fb}) + \rho E\varepsilon w'(\varepsilon g(x,e_{fb}))g_x(x,e_{fb})$ and $\frac{\partial}{\partial x}T_{sb}w(x) = f_x(x,e_{sb})$ $+ \rho E\varepsilon w'(\varepsilon g(x,e_{sb}))g_x(x,e_{sb})$ with assumption 1b. w being concave and $f_{ex} \geq 0$, $g_e \leq 0$, $g_{ex} \geq 0$, we have: $\frac{\partial}{\partial x}[T_{fb}w(x) - T_{sb}w(x)] > 0$ if $e_{fb} > e_{sb}$ and the opposite if $e_{fb} < e_{sb}$. In some very extreme cases, the Agent's risk aversion can be such that $e_{fb} < e_{sb}$ implying that $\frac{\partial}{\partial x}[T_{fb}w(x) - T_{sb}w(x)] < 0$. However, in most cases, it is likely that $e_{fb} > e_{sb}$ because in the second best the landowner needs to share risk with the Agent giving less incentives than that of the first best.

5.4. Proof of proposition 2.8

Assume there is a given value function w. In the risk neutral case, the value of self cultivation and of delegation (which is that of the first best since we are in the risk neutral case) are the fixed point of operators T_{sc} and T_{fb} defined by $T_iw(x) = \underset{e_i}{Max}\left[f(x,e_i) - C_i(e_i) - \overline{U}_i + \rho Ew(\varepsilon g(x,e_i))\right]$ for $i = sc,\ fb$, where C_{fb} and C_{sc} are respectively the Agent's and Principal costs of effort. By the envelope theorem $\frac{\partial}{\partial x}T_iw(x) = f_x(x,e_i) + \rho E\varepsilon w'(\varepsilon g(x,e_i))g_x(x,e_i)$. The implemented effort are defined by $f_e(x,e_i) + \rho E\varepsilon w'(\varepsilon g(x,e_i))g_e(x,e_i) = C_i'(e_i)$. As $\frac{\partial}{\partial e}[f_e(x,e) + \rho E\varepsilon w' g_e(x,e)]$ $= f_{ee}(x,e) + \rho E\varepsilon^2 w'' g_e^2(x,e) + \rho Ew' g_{ee}(x,e) < 0$ (because $f_{ee} < 0$, $g_{ee} < 0$, $w'' < 0$, $w' > 0$) and $C_{fb}'(.) < C_{sc}'(.)$, we deduce that $e_{sc} < e_{fb}$. With $f_{ex} \geq 0$, $g_e \leq 0$, $g_{ex} \geq 0$, w increasing concave, we have: $\frac{\partial}{\partial x}[T_{fb}w(x) - T_{sc}w(x)] > 0$.

5.5. Proof of proposition 2.9

With risk neutrality, the first best can be achieved. Writing $H(e,x) = f(x,e) - C(e) - \overline{U} + Ev(\varepsilon g(x,e))$, $e^*(x) = \arg\max_e H(e,x)$ and the incentive slope allowing to implement the first best effort e^* is defined by the incentive constraint $a^*(x) f_e = C_e$. According to the envelope theorem $\forall x$, $\frac{\partial H}{\partial e}(e^*(x), x) = 0$ and $\frac{\partial e^*(x)}{\partial x} = -H_{ex}/H_{ee}$. As, $H_e = f_e - C_e + E\varepsilon v' g_e$. Therefore, $H_{ee} = f_{ee} - C_{ee} + E\varepsilon v' g_{ee} + E\varepsilon^2 v'' g_e^2 < 0$ and $H_{ex} = f_{ex} + E\varepsilon^2 v'' g_e g_x + E\varepsilon v' g_{ex}$. If $g_{ex} \geq 0$, then $H_{ex} > 0$ with $f_{ex} > 0$ and v increasing concave, g increasing in x and decreasing in e. However, $g_{ex} \geq 0$

is not necessary and $E\varepsilon^2 v'' g_e g_x + E\varepsilon v' g_{ex} = \frac{\partial^2}{\partial e \partial x}(E\varepsilon v \circ g) \geq 0$ is sufficient. In these cases, we have $\frac{\partial e^*(x)}{\partial x} \geq 0$. Then $\frac{\partial a^*(x)}{\partial x} = \frac{(C_{ee} f_e - f_{ee} C_e) e_x - f_{ex} C_e}{f_e^2} > 0$ if $f_{ex} = 0$. If $f_{ex} > 0$, we must check that the direct incentive effect will not dominate the substitution disincentive effect of an increase of fertility. We have $\frac{\partial a^*(x)}{\partial x} = \frac{C_{ee} f_{ex}(1-a) f_e + (C_{ee} f_e - f_{ee} C_e)\left[E\varepsilon v' g_{ex} + E\varepsilon^2 v'' g_e g_x\right] + f_{ex} C_e \left[E\varepsilon v' g_{ee} + E\varepsilon^2 v'' g_e^2\right]}{-f_e^2\left[f_{ee} - C_{ee} + E\varepsilon v' g_{ee} + E\varepsilon^2 v'' g_e^2\right]}$ where the denominator is negative. If $f_{ex}=0$, $\frac{\partial a^*(x)}{\partial x} > 0$. As $C_{ee} f_{ex}$ (1-a) $f_e > 0$, $(C_{ee} f_e$-$f_{ee} C_e) < 0$, $(E\varepsilon v' g_{ex} + E\varepsilon^2 v'' g_e g_x) > 0$ and $E\varepsilon v' g_{ee} + E\varepsilon^2 v'' g_e^2 < 0$. Supposing that $(C_{ee} f_e$-$f_{ee} C_e)\, g_{ex} + f_{ex} C_e g_{ee} > 0$ and $(C_{ee} f_e$-$f_{ee} C_e)\, g_x + f_{ex} C_e g_e > 0$ is sufficient. We must check that f_{ex} is not too large, i.e. $f_{ex} < \min\left[(f_{ee} - C_{ee} f_e / C_e)\frac{g_x}{g_e}, (f_{ee} - C_{ee} f_e / C_e)\frac{g_{ex}}{g_{ee}}\right]$ because $g_{ee} \leq 0$ and $g_{ex} \geq 0$. The proof that $\lim_{x\to\infty} a^*(x) = 1$, relies on f_{ee} and C_{ee} bounded, $\|g_e / f_e\|$ bounded above and $\lim_{x\to\infty} v'(x) = 0$ or v' bounded above and $\forall e$, $\lim_{x\to\infty} \|g_e / f_e\| = 0$.

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Table 1: Comparison of predictions

	Pure risk sharing model		Present model	
Agent's Preferences	Risk Neutral	Risk Averse	Risk Neutral	Risk Averse
Optimal Share a(x)	1	<1 and decreasing	<1 and increasing	increasing or decreasing
Leasing Out Choice d(x)	increasing	increasing or decreasing	increasing	increasing or decreasing
	(1)	(2)	(3)	(4)

Table 2: Descriptive Statistics

Variable	Average	Std. Dev.	Obs.
Land area owned	2.11	3.88	1792
Mother's education (years)	6.25	2.72	448
Father's education (years)	5.70	3.03	448
Household size	6.81	2.47	448
Value of Productive assets	4709	9133	448
Value of Non productive assets	14166	35334	448
Age of Household head	37.1	8.25	448
Land value per hectare	4173	4785	1229
Corn dummy	0.54	0.49	1229
Rice dummy	0.08	0.27	1229
Sugar dummy	0.33	0.47	1229

Table 3: Probability of Fixed Rent versus Share-Tenancy

Dependent Variable 1 Fixed Rent 0 Share Tenancy	Probit Model										Random Effects Probit Model			
	i		ii		iii		iv		v		vi		vii	
Variable	Coef.	t val.	Coef.	t val.	Coef.	t val.	Coef.	t val.	Coef.	t val.	Coef.	t val.	Coef.	t val.
Log land val/h.	0.71	(2.44)	0.84	(2.67)	0.89	(2.56)					1.65	(2.17)		
Corn*log(val/h)							1.71	(2.40)	2.60	(2.83)			2.87	(1.97)
Rice*log(val/h)							0.21	(0.56)	0.12	(0.26)			0.15	(0.14)
Other*log(val/h)							0.16	(0.75)	0.37	(1.32)			-0.16	(-0.20)
Corn	-0.72	(-2.28)	-0.90	(-2.47)	-1.05	(-2.61)	-13.5	(-2.31)	-19.9	(-2.61			-23.9	(-1.87)
Rice	-0.05	(-0.14)	-0.46	(-0.88)	-0.55	(-1.05)	0.19	(-0.05)	1.44	(-0.33)			-0.33	(-0.03)
Land area owned			0.07	(1.73)	0.05	(1.22)			0.03	(0.57)				
Household size			-0.04	(-0.55)	-0.09	(-1.10)			-0.12	(-1.40)				
Education of father			0.012	(0.24)	-0.07	(-1.06)			-0.13	(-1.62)				
Education of mother			-0.05	(-0.84)	-0.10	(-1.38)			-0.12	(-1.52)				
Value of productive assets			-2.2 10^{-5}	(-1.17)	-8.4$10^{-6}$	(-0.41)			-1.4 10^{-5}	(-0.63)				
Value of non prod. assets			-6.6 10^{-6}	(-1.51)	-5.3 10^{-6}	(-1.12)			-3.4 10^{-6}	(-0.96)				
Intercept	-6.51	(-2.77)	-6.98	(-2.54)	-6.32	(-2.20)	-2.32	(-1.32)	-1.31	(-0.57)	-16.1	(-2.49)	-3.07	(-0.54)
With 3 village dummies	no		no		yes		yes		yes		no		no	
With time dummies	yes		yes		yes		yes		yes		yes		no	
	$\chi_2(6)=11.7$		$\chi_2(12)=20.2$		$\chi_2(15)=26.95$		$\chi_2(11)=17.83$		$\chi_2(17)=33.07$		$\chi_2(4)=6.6$		$\chi_2(5)=20.86$	
Mean log likelihood	-57.87		-53.62		-50.28		-54.84		-47.22		-41.24		-34.13	
Estimate of $\sigma_u^2/(1+\sigma_u^2)$ and standard error ($\sigma_v^2=1$)											0.88, 0.11		0.90, 0.07	
Likelihood Ratio Test of No Random Effects ($\chi_2(1)$)											39.46		45.1	
Nb. of obs.					147						147			
Orthogonality Tests for Corn Choice											5% critical level			
$\hat{\xi}$	0.01		0.00		0.00		0.01		0.00		$\chi^2(1)=3.84$			
$\hat{\zeta}$	4.62		2.25		1.02		1.00		1.14		$\chi^2(2)=5.99$			
Orthogonality Tests for Rice Choice														
$\hat{\xi}$	0.02		0.01		0.00		0.00		0.01		$\chi^2(1)=3.84$			
$\hat{\zeta}$	4.61		2.26		1.01		1.00		1.14		$\chi^2(2)=5.99$			

Village dummies for Dangcagan, Kitao-tao and Maramag

Instruments: Distance to nearest grocery (+), Distance to nearest village center (+)

Table 4: Censored Bivariate Probit of Choice to Lease Out and Contract Choice[22]

(t values in ())	Equation 1 Lease Out Choice		Equation 2 Contract Choice		Equation 1 Lease Out Choice		Equation 2 Contract Choice	
Variables	Coeff.	t val.	Coeff.	t val.	Coeff.	t val.	Coeff.	t val.
Log land val. per h.			0.52	(14.24)				
Corn*log(val/h)							1.08	(5.87)
Rice*log(val/h)							-0.36	(0.33)
Other*log(val/h)							-0.35	(0.96)
Land val. per h.	0.857	(24.63)			0.776	(11.1)		
Land val. per h.^{2}	-0.0777	(-2.40)			-0.0774	(-11.07)		
Owned land area	0.138	(3.95)	-0.025	(-0.70)	0.10	(7.79)	-0.04	(1.01)
Corn	0.001	(0.02)	-0.33	(-9.2)			-12.44	(-2.54)
Rice	0.43	(12.3)	0.46	(13.1)			-0.12	(-0.11)
Education of father	-0.03	(-0.86)	-0.006	(-0.18)	-0.02	(-1.22)	0.02	(0.18)
Education of mother	0.06	(1.83)	-0.048	(-1.37)	0.05	(2.59)	-0.07	(-0.95)
Household size	-0.03	(-1.04)	0.06	(1.76)	-0.03	(-1.44)	-0.01	(-0.83)
Age of household head	0.014	(0.52)	-0.09	(-3.33)	0.015	(2.20)	-0.006	(-0.24)
Value of productive assets	$-5.7\ 10^{-6}$	(-0.20)	$1.05\ 10^{-5}$	(0.41)	$-5.5\ 10^{-6}$	(-1.18)	$-6.8\ 10^{-6}$	(1.42)
Value of non prod. assets	$-8\ 10^{-7}$	(-0.03)	$-7.1\ 10^{-6}$	(-0.26)	$-1.1\ 10^{-6}$	(-1.30)	$-1.5\ 10^{-6}$	(-1.22)
Intercept	-4.0	(-114.9)	0.73	(21.1)	-3.44	(-8.79)	4.67	(4.25)
With time dummies	yes		yes		yes		yes	
Correlation $\widehat{\rho}$	-0.91 (se=0.20)				-0.94 (se=0.16)			
Mean Log-likelihood	-0.402				-0.291			
Nb. of obs.	824				1079			
Sample	Without Fallow Plots of Land				With Fallow Plots of Land			

Table 5: Non Nested Models of Choice to Contract

Probit of Choice to Lease Out (1) vs Self Cultivation (0)				
	$[F_\theta]$		$[G_\gamma]$	
Variables	Coeff.	(t val.)	Coeff.	(t val.)
log(val/h)	0.37	(6.71)		
(val/h)			0.87	(9.53)
$(\text{val/h})^2$			-0.078	(-8.36)
Owned land area	0.18	(5.84)	0.22	(6.76)
Owned land area^2	-0.003	(-2.71)	-0.0042	(-3.24)
Corn	0.06	(0.51)	0.019	(0.16)
Rice	0.27	(1.44)	0.29	(1.58)
Household size	-0.03	(-1.51)	-0.047	(-1.84)
Age of household head	0.021	(2.86)	0.018	(2.46)
Education of father	-0.03	(-1.37)	-0.029	(-1.31)
Education of mother	0.08	(3.20)	0.067	(2.45)
Value of productive assets	$-8.1\ 10^{-6}$	(-1.70)	$-1\ 10^{-5}$	(-2.16)
Value of non productive assets	$-3.7\ 10^{-7}$	(-0.42)	$-3.2\ 10^{-7}$	(-0.35)
Intercept	-5.91	(-9.57)	-4.54	(-10.1)
With 8 village dummies				
With time dummies				
Mean Log-likelihood	-0.346		-0.310	
Nb. of obs.		1060		
Vuong Test	$n\widehat{\omega}_n^2=9.79$			(Weighted χ_2)
	$n^{-1/2}LR_n(\widehat{\theta}_n,\widehat{\gamma}_n)/\widehat{\omega}_n=-6.55$			(N(0,1))

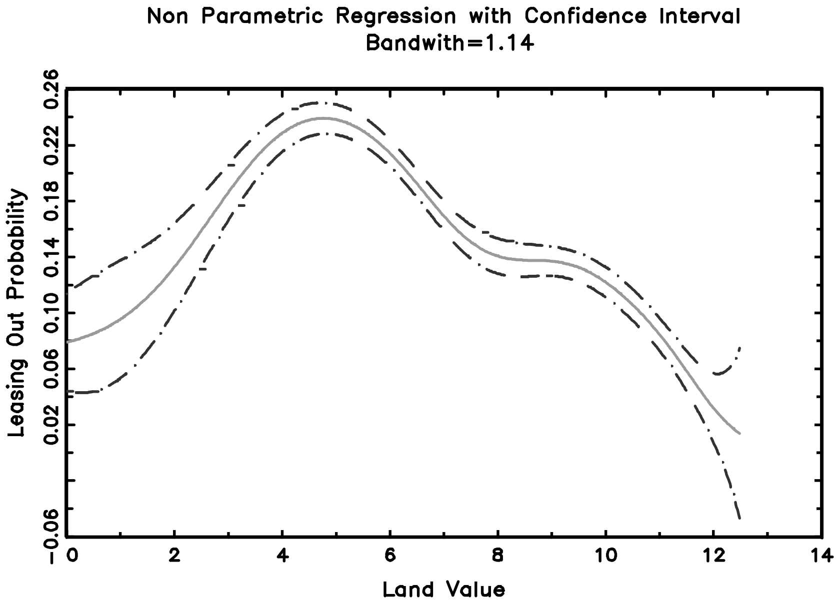

Figure 1: Probability of Delegation with respect to Land Value

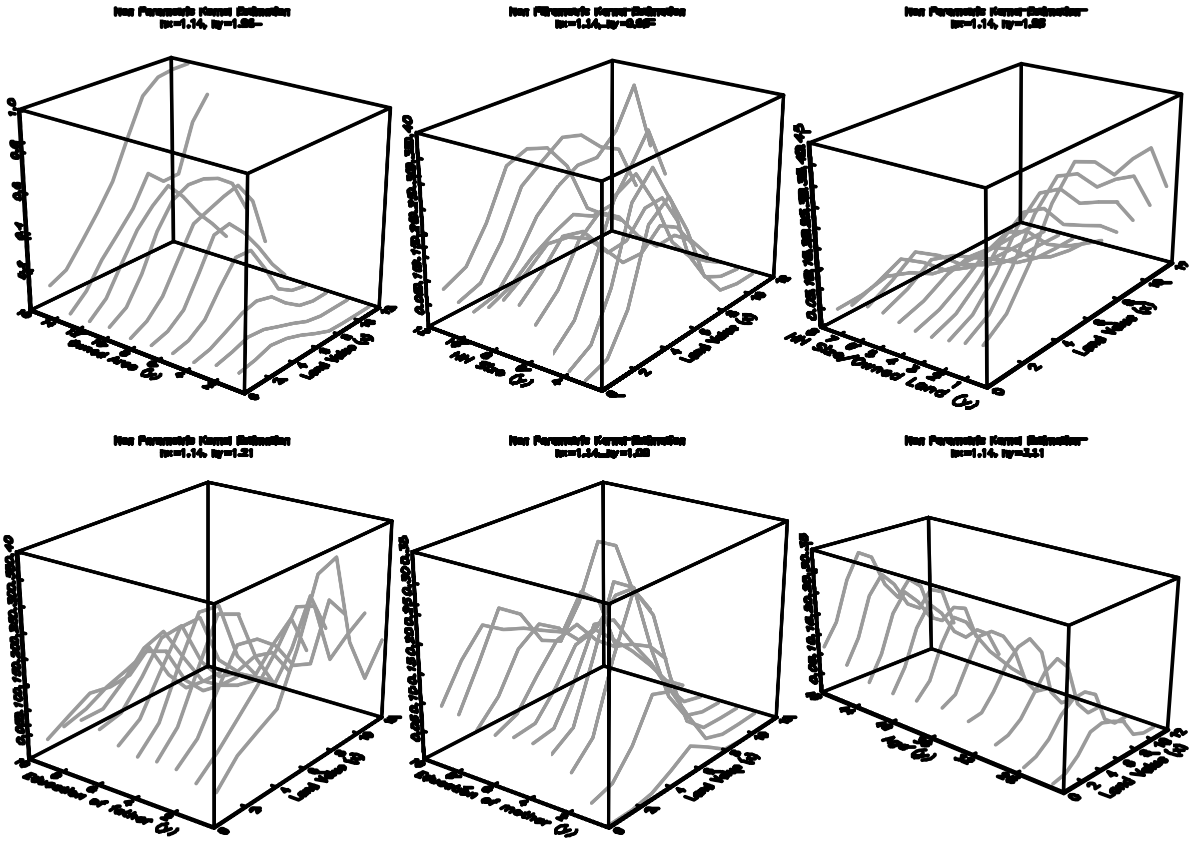

Figure 2: Non Parametric Estimation of Probability of Delegation