Land Rental Contracts

- Observe that **land sales markets** between large landlords and small peasants are thin/segmented because:
  1. Land is overpriced for small buyers relative to value in use (borrowing capacity): the price of land internalizes tax advantages, expected speculative gains, wealth sheltering, social status effects, and collateral value.
  2. Smallholders do not have access to long term credit.
  3. Even if they can buy land on credit, fully mortgaged land does not allow them to access additional loans for working capital. Hence, they can only work the land by reducing consumption, or using own accumulated wealth.
  4. Empirically (Carter and Salgado; Deininger and Chamorro), observe that land sales markets are regressive: concentrate land.
  5. World Bank policy proposal: land market-assisted land reform. Subsidies to land market purchases by poor (landless, smallholders). But expensive.

- Observe instead that **land rental markets** between large landlords and small tenants can be active.
  1. Overpricing of the land is not reflected in rents paid.
  2. Rental contracts may be first best in context of market failures, institutional gaps, and deficits in public goods.
  3. Empirically, observe that land rental markets are progressive: distribute access to land.
  4. But land rental markets are often atrophied: weakness of property rights, lack of dispute resolution mechanisms.
     Belgium: 73 of the land rented
     Brazil: 6% of the land rented.

- Note: **Land has four main functions**:
  1. Source of income: ownership not needed.
  2. Give value to other household assets with market failures (family labor, skills): ownership not needed.
  3. Store of value for consumption smoothing: ownership needed.
  4. Collateral for access to credit: ownership needed.

- Alternative **types of contracts** for land use:
  Wage contract: landlord is the entrepreneur.
  Fixed rent contract: tenant is the entrepreneur.
  Share contract: landlord and tenant share in provision of some inputs; other inputs are provided exclusively by one partner or the other.

- **Questions**: Who gets land rental contracts, i.e., for whom is it a mechanism of access to land? Which contract is given by whom and to whom? Are rental contracts efficient, poverty reducing, and equity enhancing?

I. The puzzle of sharecropping

Define sharecropping: a contract where output is shared with no corresponding sharing of all inputs, i.e., the share in appropriation is different from the share in provision of some of the inputs (purchased inputs are usually shared through profit sharing).

Observe that sharecropping is a highly frequent contract: LDC agriculture (Asia), California strawberries (Wells, 1996), franchise contracts in risky neighborhoods (McDonald, gas stations), jeepney drivers in the Philippines on un-monitoreable and more risky rural routes (Otsuka), all taxpayers with the state (Scandinavian disincentive effect), workfare and matching grants as negative sharecropping contracts (Besley), municipal matching grants for social projects, pooling of catch among Japanese fishermen (Platteau).

Puzzle of sharecropping: output sharing implies a disincentive to provide the inputs which are not shared (e.g., labor and supervision by tenant; management and capital by landlord). It thus contains a source of inefficiency, the "Marshallian inefficiency" of sharecropping. If the contract is inefficient, why is it chosen?

Four questions:

1. **When is sharecropping chosen** as the relatively most efficient contract in spite of the Marshallian inefficiency? I.e., when is sharecropping optimal for the contracting parties (locally efficient, Pareto constrained efficient, second-best efficient)? Intuition: because it has advantages relative to other contracts such that the efficiency loss due to the Marshallian disincentive is less than the efficiency loss associated with other contracts in a second-best context of incomplete markets and incomplete contracts.

2. **How can sharecropping be made efficient?** I.e., are there conditions under which the inefficiency loss due to the Marshallian disincentive may disappear? This requires observability and enforcement of effort, or incentive compatible reasons for going from a Nash-non cooperative solution to a cooperative solution, or a non-cooperative cooperation-equivalent solution.

3. **Can sharecropping be equitable?** In a principal-agent framework, can the reservation utility of the tenant be raised? In a bargaining framework, can the fall-back option of the tenant be raised? In a market for contracts, how will rents to fixed factors be shared between landlord and tenant?

4. **Who has access to share contracts?** Can sharecropping serve as an entry point into agriculture for the poor/young? What do potential tenants need to have to be competitive on the land rental market.

5. **Entry points into agricultural ladders**: what would allow share tenants to progress toward better contracts and eventually to land ownership? (Spillman, 1919; Don Kanel).

II. The Marshallian inefficiency of sharecropping

The tenant's labor effort is not observable by the landlord, and as a consequence it is not enforceable. Because output is stochastic, the principal cannot infer the tenant's actions by observing output. Hence, the land rental contract is incomplete: the tenant's labor effort cannot be specified in the contract, i.e., it is non-contractible. His effort will be compatible with the incentive provided by the terms of the contract and the "primitives" of the problem (i.e., his objective function, the technology used, and the fixed factors in production).

Assume:

One market failure: moral hazard in tenant effort (time worked).[1]
Perfect labor market with exogenous wage p_l per unit of time worked.
No risk.
r the landlord's output share.
$1 - r$ the tenant's output share.
R fixed rent.
Hence, the contract specializes to:
Share rent if $1 > r > 0$ and $R >= 0$.
Fixed rent if $r = 0$ and $R > 0$.
A wage contract if $r = 1$ and $R < 0$.
q_l the tenant's effort (effective labor input) decided by the tenant, with a potential moral hazard problem for the landlord.
$q = q(q_l, q_x; \overline{A})$ production function.
$\overline{A}$ fixed farm size.
q_x purchased input.
$p = 1$ product price, numéraire.
p_x exogenous price of purchased input.
r' the landlord's share of the cost of the purchased input.
(r, r', R) the land rental contract. Linear contract due to R.

If a landlord has a land area $\overline{A}$ to cultivate, he can choose between three contracts:[2]

[1] Note: If the tenant chooses both time worked and effort, both of which cannot be monitored, he has no reason to shirk on effort since he can shirk on time worked just as well. This is not the same for a worker who is paid for time worked and consequently has an incentive to shirk on effort. Hence, for a tenant as opposed to a worker, there is no need to distinguish between effort and time worked.

1. A fixed rent contract ($r = 0$, $r' = 0$, $R > 0$)

In this case, the tenant is the entrepreneur. His problem is

$$\underset{q_l, q_x}{\text{Max}} \; q\left(q_l, q_x; \overline{A}\right) - p_l q_l - p_x q_x - R$$

Firt order conditions: $\dfrac{\partial q}{\partial q_l} = p_l$, $\dfrac{\partial q}{\partial q_x} = p_x$. Efficient contract.

2. A wage contract (assuming no moral hazard in worker behavior) where the landlord hires labor.

In this case, the landlord is the owner-operator. His problem is

$$\underset{q_l, q_x}{\text{Max}} \; q\left(q_l, q_x; \overline{A}\right) - p_l q_l - p_x q_x$$

First order conditions: $\dfrac{\partial q}{\partial q_l} = p_l$, $\dfrac{\partial q}{\partial q_x} = p_x$. Efficient contract.

3. A sharecropping contract ($0 < r < 1$, $0 < r' < 1$, $R >= 0$) where the tenant hires labor and controls for moral hazards in worker behavior, or employs himself at the going wage p_l.

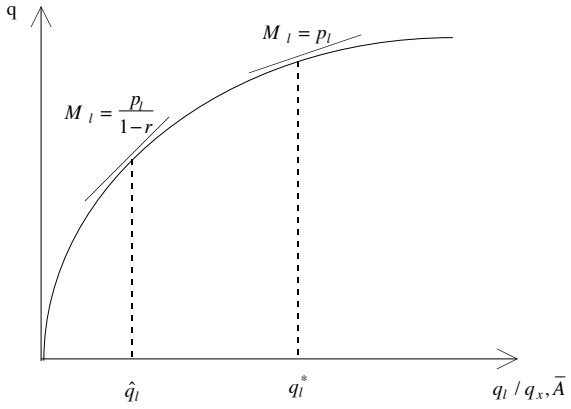
In this case, the tenant is the entrepreneur. His problem is

$$\underset{q_l, q_x}{\text{Max}} \; (1-r)q\left(q_l, q_x; \overline{A}\right) - p_l q_l - (1-r')p_x q_x - R$$

Firt order conditions: $\dfrac{\partial q}{\partial q_l} = \dfrac{p_l}{1-r} > p_l$, $\dfrac{\partial q}{\partial q_x} = \dfrac{1-r'}{1-r} p_x$

Hence, the marginal productivity of labor is higher under sharecropping, and the optimum labor effort is less, than under the two alternative contracts:

$\hat{q}_{l,\text{sharecropping}} < q^*_{l,\text{fixed rent, owner-operator}}$.



Marshallian disincentive in sharecropping

Sharecropping is thus an inefficient contract regarding labor effort when the tenant is the sole supplier of labor.

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[2] In Otsuka and Hayami (1988), the landlord problem includes six variables: $r, r', R, \overline{A}, N$ (number of tenants), l (landlord effort on residual land $A - N\overline{A}$). Here, we take $\overline{A}$ as exogenous and hence reduce the choice problem to $r, r',$ and R.

The marginal productivity of the purchased input relative to price depends on the relative shares of product and factor. If $r = r'$, i.e., if product and factor costs are equally shared, there is no inefficiency in sharecropping in the use of the purchased input. This is achieved simply by deducting the factor cost from gross revenue before profit sharing $r\left(q - p_x q_x\right)$.

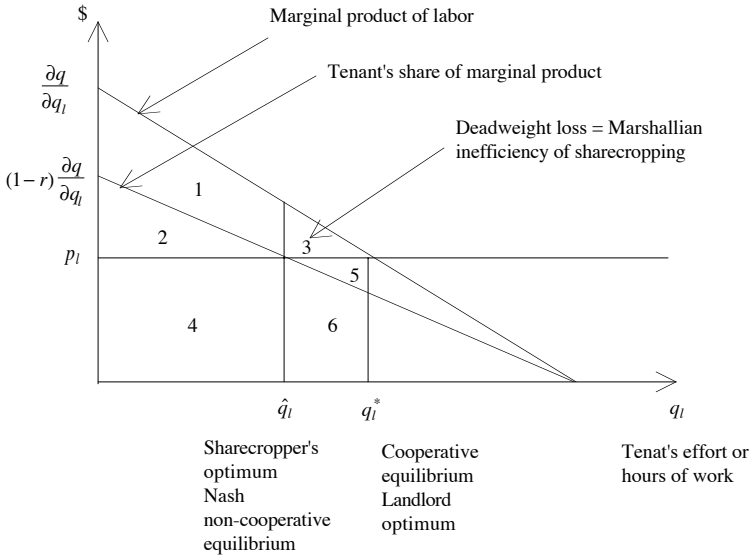

Figure 2. Marshallian inefficiency of sharecropping

This can be represented geometrically in Figure 2. In this figure (for given $\overline{A}$ and q_x):

Landlord's rent under a fixed rent contract or wage contract = area 1+2+3

Landlord's rent under a sharecropping contract = area 1

Hence, the landlord loses area 2+3: 2 is lost to the tenant and 3 is a deadweight loss (the Marshallian inefficiency).

Sharecropper's income = area 2+4

Wage-worker income = area 4, which represents the opportunity cost of the tenant on the labor market. Hence, the sharecropper's income is above its opportunity cost $p_l q_l$ by area 2.

The result is an excess supply of tenants. The landlord can thus charge a fixed rent $R = 2$ to capture the surplus from the tenant and reduce him to his reservation income 4. However, the landlord could do even better by decreasing his share r to zero and shifting to a fixed rent contract, thus eliminating the deadweight loss and increasing his rent by area 3. Hence, while Marshall is right that sharecropping implies an inefficiency, the contract should never be observed under the first best conditions (n - 1 markets performing) postulated by him. Only fixed rent or wage contracts should be observed. This implies looking for other reasons why a sharecroping contract may prevail.

III. When is sharecropping chosen as the locally efficient contract?

1. Enforceability without risk (Cheung)

If effort is contractible, the landlord can force the tenant to work at q_l^* by specifying the level of effort in the contract: this eliminates moral hazard in the tenant's behavior.

Need: Observability of tenant's effort by the landlord at zero cost.

Enforceability (i.e., a penalty is available if tenant works at $\hat{q}_l < q_l^*$).

Verifiability by third party to be able to impose sanction fairly, i.e., to enable the landlord to find new tenants if the current tenant is dismissed for working at $\hat{q}_l < q_l^*$.

Specify a complete contract (r, R, q_l^*).[3]

Landlord rent = area 1+3+5

Equilibrium contract if 5 = 2, in which case:

The tenant is at his reservation utility 2+4+6 = 4+5+6 = $p_l q_l^*$.

The landlord income 1+3+5 = 1+2+3

This contract can be specified by:

Either setting r such that 2 = 5

Or using a linear contract (r, R = 2 - 5)

This means that the sharecropping contract is identical to a fixed rent or a wage contract, with no advantage over the latter. Note that, without risk, effort can be inferred from observed output, allowing easier monitoring by the landlord. However, the Cheung hypothesis without risk does not help explain why a sharecropping contract would be chosen over a fixed rent or a wage contract.

2. Risk sharing (Newbery and Stiglitz)

There are two market failures:

Moral hazard in tenant effort (but not in hired labor effort under wage contract).

Insurance market failure.

Output and product price may be risky (denoted by ~). By sharing output, sharecropping also shares risk between landlord and tenant: the rent paid varies with the level of output achieved. Hence, the rent is adjusted ex-post to the realization of risk. If the tenant is risk averse, reducing risk will increase effort. Hence, the contract may be better than:

A fixed rent contract for the tenant if he is risk-averse.

A wage contract for the landlord if he is also risk averse.

Note, however, that reducing the tenant's risk by increasing the landlord's share also increases the Marshallian disincentive. Hence, there is a trade-off: only one instrument, r, is available to achieve two objectives: reducing risk (which increases the tenant's effort) and extracting rent (which reduces the incentive to work). There will consequently exist an optimal level of r that strikes a compromise between these two effects of r. If the landlord increases r to absorb more risk, he must decrease R to satisfy the tenant's participation constraint.

Agent income y	Worker or tenant	Landlord	When chosen
Wage contract	Hires out $y = p_l q_l$, certain	Hires in $y = \underset{\sim}{q} - p_l q_l$, risky	Landlord risk neutral
Fixed rent contract	Rents land $y = \underset{\sim}{q} - p_l q_l - R$, risky	Leases land $y = R$, certain	Tenant risk neutral
Sharecropping contract	$y = (1-r)\underset{\sim}{q} - p_l q_l - R$, risky, but less that under a fixed rent contract	$y = r\,\underset{\sim}{q} + R$, risky, but less that under a wage contract	Both risk averse. Marshallian inefficiency on q_l

Newbery and Stiglitz observe that the landlord could achieve the same degree of risk reduction by mixing fixed rent and wage contracts in a portfolio of contracts, with a share (1 - r) of the land in fixed rent contracts (riskless) and r in wage contracts (risky), while avoiding the Marshallian inefficiency. Choice of portfolio of contracts eliminates one market failure (insurance), leaving only one market failure to solve (moral hazard in tenant effort which is solved by choosing fixed rent and enforceable wage contracts). Hence, unless a landlord cannot have more than one contract (for example because his land is too small), or because there are transactions costs in contracting, or economies of scale due to indivisibilities in inputs (e.g., a tubewell), risk sharing is still insufficient to explain the occurence of sharecropping.

[3] Here, we omit the purchased input q_x for simplification.

3. Labor market imperfection: sharecropping as a screening device

There is asymmetrical information between landlord and tenant: the landlord does not know the entrepreneurial ability of potential tenants.

3.1. Hallagan worker self-selection model

With asymmetrical information, the worker chooses among contract alternatives to maximize the return Y from his entrepreneurial ability (or effective effort) e. Let:

$\overline{A}$ fixed land area
$\overline{L}$ fixed quantity of work
R fixed rent per unit of land
$F = F(e; \overline{L}, \overline{A})$, production function.

If only the worker decides (self-selection) on the choice of contract, he will choose the contract that yields him the highest income among the three alternative contracts (Figure 3):

Fixed wage: $Y = w\overline{L}$
Share contract: $Y = (1-r)F$
Fixed rent: $Y = F - R\overline{A}$

Hence, if his entrepreneurial ability is in the interval $(0, e_1)$, he chooses a wage contract.

If his entrepreneurial ability is in the interval (e_1, e_2), he chooses a share contract.

If his entrepreneurial ability is grater than e_2, he chooses a fixed rent contract.

Thus, sharecropping could be seen as a transitional contract between wage and fixed rent if tenants' ability increases over time by learning-by-doing.

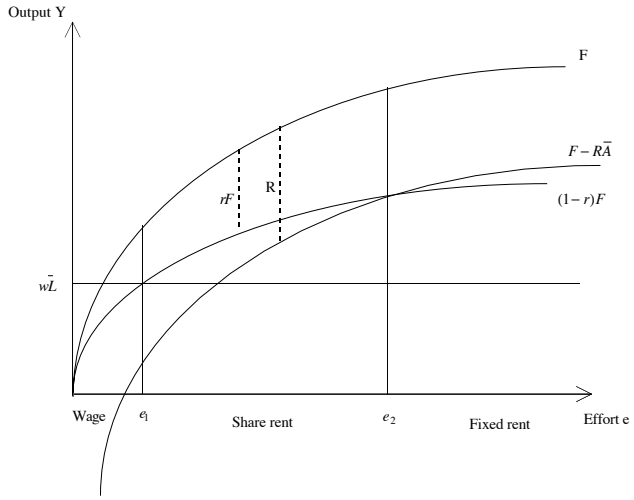

Figure 3. Worker self-selection model

However, since it is the landlord who ultimately decides on the choice of contract, he only offers:

a wage contract if $e < e_1$.

a fixed rent contract if $e_1 < e < e_2$.

Since $R > rF$ when $e_1 < e < e_2$, the landlord should never offer a sharecropping contract when the tenant wants one.

The worker self-selection model thus does not explain sharecropping under certainty since it should never be offered by the landlord. It, however, allows to explain why some workers select wage contracts and others fixed rent contracts.

3.2. Sharecropping as a screening device

For a landlord, good tenants should be given fixed rent contracts while bad tenants should be given wage contracts (Allen). If a landlord is not informed about the skills of potential new tenants, he can use a sharecropping contract as a transitional screening device. However, in a village community, it is unlikely that landlords could not obtain from others information about the farming ability of potential tenants, thus avoiding to incur the inefficiency cost of sharecropping as a screening device (Bardhan).

4. Two market failures

When $m > 1$ markets fail, these failures cannot be compensated for by the performance of the other (n - m) markets. (Only when $m = 1$ markets fail can this failure be compensated for by the performance of the $n - 1$ other markets.) In this context, sharecropping may be a superior contract to the alternatives of fixed rent and wage contract. Typical market failures (of which we need at least two simultaneously for sharecropping to hold) are:

No insurance market and risk aversion.

Missing market for family labor and moral hazard in hired labor with costly monitoring.

Missing market for management know-how, or for bullocks.

Missing market for credit: access to credit for tenant is constrained by lack of collateral (Laffont and Matoussi, 1995).

Moral hazard in land use by the tenant and costly monitoring (Murrell, 1983) (Figure 4).

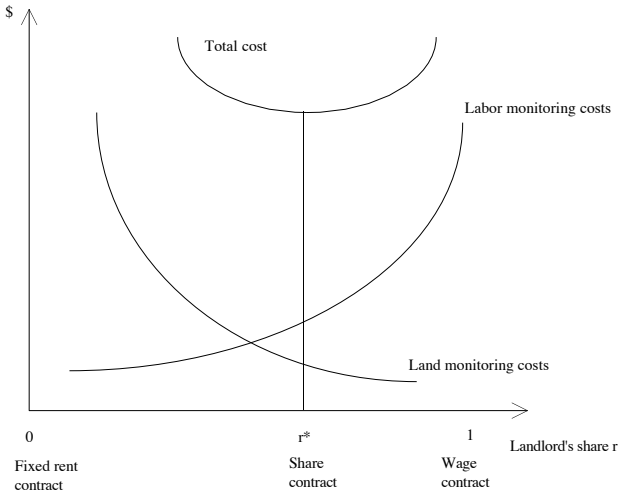

Figure 4. Choice of sharecropping under two market failures

In this case, sharecropping will in general imply a Marshallian inefficiency. However, the second best context where this inefficiency occurs may be such that the alternative contracts are even more inefficient. This is because sharecropping offers a number of advantages: risk sharing through setting rent as output sharing, provision by one of the two parties of services for which markets are failing (management, supervision, credit), and mitigated labor and land monitoring costs. Hence, under these conditions, sharecropping finds a rationale for its widespread existence: it may be chosen because it is locally efficient. However, sharecropping will still be socially inefficient (a socially second best contract) if there is a Marshallian inefficiency, and will not be equitable if it is developed in the context of principal-agent relations or of unequal bargaining power between landlord and tenant over the sharing of the efficiency gains from the contract compared to alternatives.

IV. When is sharecropping an efficient contract (i.e., when is there no Marshallian inefficiency)?

In this case, $\hat{q}_l = q_l^*$: even though the contract contains a disincentive through output sharing, the incentive compatible level of effort (Nash non-cooperative solution) is identical to the Pareto optimum level of effort. There are three categories of conditions under which this may obtain (fully or partially).

1. Contractible effort

This is the Cheung solution. We have seen that it requires costless monitoring, enforcement, and verifiability. Hayami and Otsuka find that sharecropping is observed when there is risk and low monitoring costs: local landlord with few tenants to supervise, landlord with strong coercive power (interlinkages, ability to mobilize social sanctions), simple production systems easy to monitor, tenant's behavior that can be compared to that of other farmers, including that of the landlord himself if he is a resident farmer.

2. Incentive compatibility between the sharecropping solution and the cooperative solution

2.1. Technological constraint. Fixed labor/land technical coefficient implying no scope for factor substitution. Lack of choice restricts the possibility of moral hazard in effort. Newbery uses this to explain why landlords with sharecroppers would oppose the diffusion of new technologies that increase substitution possibilities and thus weaken monitoreability of tenants' efforts.

2.2. Altruism, Identity. The sharecropper may internalize the social optimum, for instance if he identifies with the landlord (who may be a kin) or if he works harder than needed to justify his existence (to himself) based on his own perception of what is morally right (self-esteem (Akerlof)), or if he derives utility from higher social rank derived from reputation established by the level of effort (Erica Seki for Japanese fishermen communities with output pooling in spite of heterogeneous skills). Social norms are thus important to sustain efficient share contracts.

2.3. Safety-first. If the tenant is very poor and shows extreme risk aversion to income shocks, he willingly will work at the maximum level of effort in spite of the Marshallian disincentive, just for fear of falling below a minimum survival threshold of output (Sadoulet, Fukui, and de Janvry)

2.4. Equal sharing of all costs and benefits. If there is no risk, and factors are shared in the same proportion as products, then the Marshallian disincentive disappears (D. G. Johnson, E.O. Heady). Hence, the landlord should participate in all markets (credit, purchased inputs) in which the tenant transacts in order to mitigate the Marshallian disincentive (Braverman and Stiglitz, 1982). Note that this implies assortative matching: landlords look for tenants with an ability equal to theirs to share in costs (Sharma and Drèze, 1996).

2.5. Induce cooperation through a repeated game (infinite contract; or uncertain termination with high probability of continuing). This is an application of the Folk Theorem. Use gift exchange to insure that, on every year, the gain from cooperation is greater then the gain from defaulting (sub-game perfect equilibrium, see Radner). This implies sharing with the tenant some of the net social gains from cooperation to compensate him for the extra effort (Sadoulet, Fukui, and de Janvry)

3. Interlinked contracts

3.1. Change the incentive structure of the tenant to move $\hat{q}_l$ toward q_l^*

In a two-season model, decreasing credit in the idle period reduces repayment costs in the work period, which in turn increases income and thus reduces risk aversion, and increases effort (Subramanian). Hence, the landlord benefits from raising interest on loans to his tenants in the idle period (a

pretty mean strategy!). A more ethical solution would be to offer tenants risk-coping instruments (e.g., patronage). This would allow them to take more risk in production without having to starve them in the idle period. Another alternative proposed by D.Gale Johnson, based on the observation that sharecropping in the U.S. Midwest is not inefficient, is to keep the size of farm small to lower, through the income effect, the tenant's marginal utility of leisure.

3.2. Limited liability on rent payments

Limited liability on rent induces greater risk taking by the tenant, which would partially compensate for the Marshallian disincentive on effort. Reciprocally, if a landlord must give limited liability insurance to his tenants as an inescapable social norm, he can decrease excess risk-loving behavior by tenants by giving them sharecropping contracts, justifying the existence of sharecropping (Shetty, 1988; Basu, 1992).

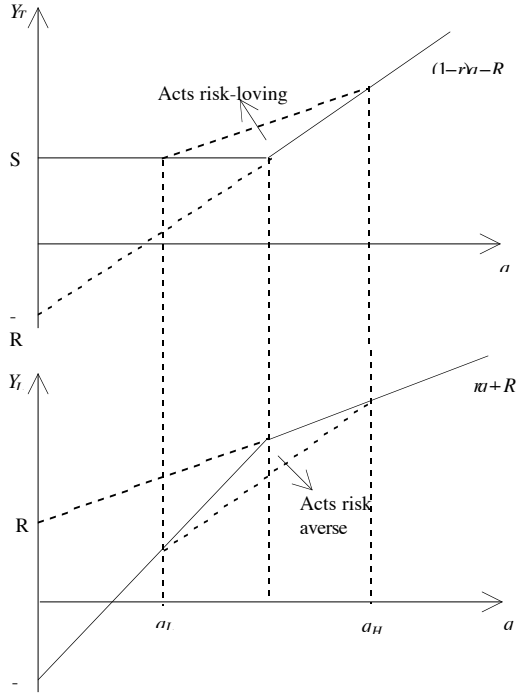

Figure 5. Sharecropping under limited liability
Upper figure is for the tenant
Lower figure is for the landlord

S outlut level to which tenant has prior right (insurance)
q output level
$Y_T = \text{Max}\left[(1-r)q-R, S\right]$, tenant's problem
$Y_L = \text{Min}\left(rq+R, q-S\right)$, landlord's problem

Risk taking by the tenant, induced by limited liability, partially compensates for the disincentive of sharecropping.

Insurance becomes more valuable for the tenant when (1 - r) increases, i.e. when he bears a higher share of risk (steeper slope of his income function).

Increasing (1 - r) can both:	decrease the Marshallian disincentive
	increase the value of insurance
but at a cost for the landlord of:	lower rent
	higher insurance cost as the probability of default rises.

Hence, it is in the best interest of the landlord to provide limited liability. He is not doing it only due to social norms or altruism.

3.3. Interlinked transactions

If there are other links between the tenant and his landlord (i.e., social capital), the latter can threaten of canceling these other transactions if the tenant does not work at q_l^*, inducing cooperation. This would apply in a context of patron-client relations or of tenancy with a kin who is providing other benefits to his tenant such as credit or insurance. For the role of kinship in inducing efficient sharecropping, see Sadoulet, de Janvry, and Fukui.

3.4. Adoption of new technologies

Sharecroppers may be in a better position to adopt a profitable but risky new technology compared to independent producers of equal wealth since sharecropping reduces risk. If landlords share in cost, it also allows to subsidize the fixed costs of adoption. In addition, sharecropping avoids the liquidy cost of rent compared to fixed rent which must be paid at the beginning of the season, thus relaxing the liquidity constraint on adoption. On this basis, Rosenzweig and Shaban (1995) reject arguments advanced by Bahduri (1973), Rao (1971), Newbery (1975), and Braverman and Stiglitz (1986) according to which sharecropping reduces the adoption of new technologies. Using data from the Philippines and India they find that the combination of sharecropping and availability of new high yielding varieties leads to efficient and equitable outcomes as it promotes adoption by small farmers.

V. Sherecropping under risk without enforceability of effort

1. Definitions

L = tenant's effort. Unobservable directly; unobservable indirectly as cannot infer effort from outcome due to risk. Hence generally unenforceable, i.e., effort cannot be specified ex-ante in the contract (is non-contractible), but can be anticipated by the landlord from the tenant's expected response to incentives.
$T - L$ = leisure
θ random term ~ (1, σ^2), ex-post relative to decision on L (price and output risks)
$q(L;\overline{A})$ production function with $q'_L > 0,\ q''_L < 0,\ q(0) = 0$
Landlord income: $Y = rq(L)\theta + R$
Tenant's income: $y = (1-r)q(L)\theta - R$

Two decisions:
Effort L decided by the tenant and sole provider
Contract terms (r, R) decided by the landlord

Principal (landlord)-agent (tenant) framework: landlord maximizes the expected utility Z of his income w.r.t. the terms of the contract s.t.:
(1) tenant's anticipated work behavior: maximization of expected utility W of income and leisure w.r.t. the labor effort given the terms of the contract (incentive compatibility constraint).
(2) tenant's participation constraint given his reservation utility level $\overline{W}$ (landlord is not a monopolist since he is a tenant utility taker)

2. Determination of optimum contract

Landlord and tenant are both risk averse: expected utility specification to display risk aversion.
Two market failures: insurance and moral hazard in effort (Stiglitz, 1974).
Assume that there is no labor market.
Landlord's problem:

$\text{Max}_{r,R}\ Z = EV\left[rq(L)\theta + R\right]$, subject to:

$\text{Max}_L\ W = EU(y,L)$, tenant's anticipated work behavior (incentive compatibility constraint),

$U_y' > 0, U_y'' < 0, U_L' < 0, U_L'' > 0$, ($-U_L'$ is the marginal utility of leisure)

$\text{Max}\ W \geq \overline{W}$, tenant's reservation utility constraint (voluntary participation constraint).

Logic of solution. Three steps:
Step 1. Solve the tenant's problem given the terms of the contract (*r, R*). This gives the tenant's reaction function to the terms of the contract, $L = L(r, R)$
Step 2. Impose the participation constraint $W \geq \overline{W}$ which creates a relation $f(r,R) = 0$. Hence, R is used for maximum extraction.
Step 3. Solve the landlord's problem w.r.t. (*r, R*) given $L = L(r, R)$ and $f(r,R) = 0$. Hence, r is used as the optimum compromise between risk sharing and direct work disincentive.

Step 1: Solve the tenant's problem

$\text{Max}_L\ W = EU(y,L) = EU\left[(1-r)\theta q - R, L\right]$

F.o.c.: $\dfrac{\partial W}{\partial L} = EU_y'(1-r)\theta q_L' + EU_L' = 0.$

Hence, $(1-r)q_L' E\left(U_y'\theta\right) + U_L' = 0$, and $q_L' = -\dfrac{U_L'}{(1-r)EU_y'\theta}$,

where $-EU_L' = -U_L'$ is the marginal utility of leisure which is not stochastic
U_y' is the marginal utility of income.

Note 1: $\text{Max}_L W$ without risk and without sharecropping ($r = 0$, fixed rent $R > 0$)

$\text{Max}_L W = \text{Max}_L U(q-R,L) \rightarrow \dfrac{\partial W}{\partial L} = U_y' q_L' + U_L' = 0 \rightarrow q_L' = -\dfrac{U_L'}{U_y'}$, efficient (identical to owner-operator)

Note 2: $\text{Max}_L W$ with risk and without sharecropping

$\text{Max}_L W = \text{Max}_L U(\theta q - R, L) \rightarrow \dfrac{\partial W}{\partial L} = EU_y'\theta q_L' + U_L' = 0 \rightarrow q_L' = -\dfrac{U_L'}{EU_y'\theta}$, efficient under risk.

Note 3: To analyze the role of risk on L, compare U_y' and $EU_y'\theta$:

Recall: $Cov(x,y) = E(x-\bar{x})(y-\bar{y}) = Exy - \bar{x}\bar{y}$

$Cov\left(U_y', \theta\right) < 0$ as if $\theta \uparrow, y \uparrow, U_y' \downarrow$

Hence, $Cov\left(U_y', \theta\right) = EU_y'\theta - EU_y' E\theta < 0 \rightarrow EU_y'\theta < EU_y' = U_y'$ if no risk.

Conclude that:

$\dfrac{U_L'}{U_y'} < \dfrac{U_L'}{EU_y'\theta} < \dfrac{U_L'}{(1-r)EU_y'\theta}$, $\dfrac{U_L'}{U_y'} < \dfrac{U_L'}{(1-r)U_y'}$

$\left(q_L'\right)_{\text{No risk, no shc}} < \left(q_L'\right)_{\text{Risk, no shc}} < \left(q_L'\right)_{\text{Risk, shc}}$, $\left(q_L'\right)_{\text{No risk, no shc}} < \left(q_L'\right)_{\text{No risk, shc}}$

Hence, $L^*_{\text{No risk, no shc}} > L^*_{\text{Risk, no shc}} > L^*_{\text{Risk, shc}}$, $L^*_{\text{No risk, no shc}} > L^*_{\text{No risk, shc}}$.

Sharecropping is inefficient, both without risk and with risk (Marshallian disincentive).
Solving the tenant's f.o.c., gives the tenant's response function: $L = L(r,R)$.

Step 2: Impose the tenant's reservation utility constraint

$W = EU\left[(1-r)q\theta - R, L\right] = W(L, r, R) = \overline{W}$.

Taking the total differential,

$d\overline{W} = \dfrac{\partial W}{\partial L}dL + \dfrac{\partial W}{\partial r}dr + \dfrac{\partial W}{\partial R}dR = 0$. Since $\dfrac{\partial W}{\partial L} = 0$ (tenant's optimum behavior satisfied),

$-EU_y' q\theta dr - EU_y' dR = 0 \rightarrow \dfrac{dR}{dr} = -q\dfrac{EU_y'\theta}{EU_y'}$.

This establishes a relation between r and R: $R = R\left(r, L; \overline{W}\right)$. Given this constraint, the landlord maximizes Z w.r.t. only one instrument, r.

Step 3: Solve the landlord's problem

$\text{Max}_r Z = EV\left[rq(L)\theta + R\right]$

s.t. $L = L(r,R)$, tenant's reaction function anticipated by the landlord,

$R = R\left(r, L; \overline{W}\right)$, tenant's reservation utility constraint.

F.o.c.: $\dfrac{\partial Z}{\partial r} = EV'\left(q\theta + rq_L'\theta\dfrac{dL}{dr} + \dfrac{dR}{dr}\right) = 0$, or

$EV'q\theta + EV'rq_L'\theta\dfrac{dL}{dr} - EV'q\dfrac{EU_y'\theta}{EU_y'} = 0$, hence:

$$r = -q\frac{1 - \dfrac{EU_y'\theta}{EU_y'}\Big/\dfrac{EV'\theta}{EV'}}{q_L'\dfrac{dL}{dr}}.$$

We need to approximate $V', V'\theta, U_y', U_y'\theta$ as a function of r, σ^2, and risk aversion.

Take a Taylor expansion of V and U at $\theta = 1$.[4] Let: $\tilde{V} = V(\theta = 1)$, $\tilde{U} = U(\theta = 1)$.

$V(Y) = V(rq\theta + R)\big|_{\theta=1} \approx \tilde{V} + (\theta - 1)\tilde{V}_Y' rq + \dfrac{(\theta-1)^2}{2}\tilde{V}_Y'' r^2 q^2$. Hence,

$\dfrac{\partial V}{\partial Y} = V' = \tilde{V}' + (\theta - 1)\tilde{V}'' rq + \ldots$ and[5]

$EV' = \tilde{V}'$

$EV'\theta = \tilde{V}' + \sigma^2 rq\tilde{V}''$, i.e.,

$\dfrac{EV'\theta}{EV'} = 1 + \sigma^2 rq\dfrac{\tilde{V}''}{\tilde{V}'}$.

Similarly, a Taylor expansion for $U\left[(1-r)q\theta - R\right]\big|_{\theta=1}$ gives:

$EU' = \tilde{U}'$

$\dfrac{EU'\theta}{EU'} = 1 + \sigma^2(1-r)q\dfrac{\tilde{U}''}{\tilde{U}'}$.

Let: $R_L = -\dfrac{\tilde{V}''}{\tilde{V}'}$, landlord's absolute risk aversion (or relative risk aversion $\rho_L = -YR_L = -Y\dfrac{\tilde{V}''}{\tilde{V}'}$)

$R_T = -\dfrac{\tilde{U}''}{\tilde{U}'}$, tenant's absolute risk aversion.

The optimum contract is, in implicit form:

---

[4] Taylor expansion around $x = a$: $f(x)\big|_{x=a} = f(a) + (x-a)f'(a) + \dfrac{(x-a)^2}{2!}f''(a) + \ldots$

[5]

$$r = -q\left[\frac{1-\frac{1-\sigma^2(1-r)qR_T}{1-\sigma^2 rqR_L}}{q_L'\frac{dL}{dr}}\right] = \phi(r)\left[\frac{(1-r)R_T - rR_L}{1-\sigma^2 rqR_L}\right],$$

where $\phi(r) = -\dfrac{\sigma^2 q^2}{q_L'\dfrac{dL}{dr}} > 0$ if $\dfrac{dL}{dr} < 0$ (as when $r \downarrow$, $(1-r) \uparrow$, $L \uparrow$).

Hence:

If $R_T = R_L = 0$, the optimal contract is $r = 0$, i.e., a fixed rent contract for risk neutral tenant and landlord.

If $R_T > 0$, $R_L = 0$, the optimal contract is $r > 0$, i.e., a share rent contract for a risk averse tenant in spite of the Marshallian inefficiency.

Note: $r \uparrow$ with the level of risk, σ^2.
with the level of risk aversion of the tenant, R_T.

In both cases, the landlord raises his share to absorb more risk (while decreasing R to satisfy the tenant's participation constraint), at the cost of a greater Marshallian disincentive on the tenant. Hence, the choice of r is a compromise between indirect work incentive through insurance and Marshallian direct work disincentive effects.

3. Sharecropping under risk with enforcement (Cheung)

The landlord can enforce the tenant's effort L, hence there is no moral hazard. There is only one market failure (insurance). Assume that no portfolio of contracts is possible. The contract is (r, R, L). Hence, landlord and tenant can agree on a contract that achieves optimum risk sharing, leading to first best resource allocation.

Landlord problem: $\underset{r,R,L}{\text{Max}}\ Z = EV\left[rq(L)\theta + R\right]$

s.t. tenant's reservation utility level, $W = EU\left[(1-r)q\theta - R, L\right] = W(L, r, R) = \overline{W}$, or,

$\underset{r,R,L}{\text{Max}}\ Z = EV\left(rq\theta + R\right) + \lambda\left[EU\left((1-r)q\theta - R, L\right) - \overline{W}\right]$

F.o.c.:

(1) $\dfrac{\partial Z}{\partial L} = EV'\theta r q_L' + \lambda\left[EU_y'\theta(1-r)q_L' + EU_L'\right] = 0$

(2) $\dfrac{\partial Z}{\partial r} = EV'\theta q + \lambda\left(-EU_y'\theta q\right) = 0$

(3) $\dfrac{\partial Z}{\partial R} = EV' + \lambda\left(-EU_y'\right) = 0$.

1. Tenant's optimum effort anticipated by the landlord

From (1): $q_L' = -\dfrac{\lambda U_L'}{EV'\theta r + \lambda EU_y'\theta(1-r)}$

from (2): $EV'\theta = \lambda EU_y'\theta$

Hence, $q_L' = -\dfrac{\lambda U_L'}{\lambda EU_y'\theta r + \lambda EU_y'\theta(1-r)} = -\dfrac{U_L'}{EU_y'\theta}$, efficient under risk.

2. Optimum contract

From (2)/(3): $\dfrac{EV'\theta}{EV'} = \dfrac{EU_y'\theta}{EU_y'}$

Using Taylor expansion gives: $r = \dfrac{R_T}{R_L + R_T}$, optimum risk-sharing with no Marshallian inefficiency.

If the tenant is risk neutral: $R_T = 0$, $r = 0$, fixed rent.

If the landlord is risk neutral: $R_L = 0$, $r = 1$, wage contract with no moral hazard

If both are risk averse: $R_T,\ R_L > 0$, $0 < r < 1$, sharecropping

Note 1: if $R_T \uparrow$, $r \uparrow$, the landlord's share of risk increases, but without disincentive effect since L is set by the landlord at the efficient level.

Note 2: $r_{\text{enforcement}} > r_{\text{non-enforcement}}$: if the sharecropper's effort cannot be observed, he must be given an incentive to work (higher $(1-r)$) and hence he has to assume a higher share of risk. This creates a Marshallian inefficiency under risk due to non-observability.

4. If there is a labor market and the tenant hires all labor (but the quantity of labor hired by the tenant is not-enforceable by the landlord)

Two market failures: insurance and moral hazard (by the tenant) on hired labor. There is no moral hazard in hired labor's effort due to ability of the tenant to monitor and enforce effort.

Tenant problem: $\text{Max}_L\ EU\left[(1-r)\theta q - wL - R\right]$.

F.o.c.: $EU_y'(1-r)\theta q_L' - EU_y' w = 0$.

Hence, $q_L' = \dfrac{w}{1-r}\dfrac{EU_y'}{EU_y'\theta}$, inefficient.

Using a Taylor expansion, $\dfrac{EU_y'\theta}{EU_y'} = 1 - \sigma^2(1-r)qR_T$.

Hence, $q_L' = \left(\dfrac{w}{1-r}\right)\left(\dfrac{1}{1-\sigma^2(1-r)qR_T}\right)$.

The optimum effort

$L^* \downarrow \left(q_L' \uparrow\right)$ with $\sigma^2 \uparrow$, $R_T \uparrow$, $r \uparrow$ (direct disincentive effect through $\dfrac{w}{1-r}$), $r \downarrow$ (risk - sharing effect through $\sigma^2(1-r)qR_T$).

Choice of contract:

1. *Owner-operator*: $\text{Max}_L\ EV(\theta q - wL) \rightarrow EV'\theta q_L' - EV'w = 0 \rightarrow q_L' = w\dfrac{EV'}{EV'\theta} = w\left(\dfrac{1}{1-\sigma^2 qR_L}\right)$,

efficient under risk. $L^* \downarrow$ with $\sigma^2 \uparrow$, $R_L \uparrow$.

2. *Fixed rent contract*: $q_L' = w\dfrac{EU_y'}{EU_y'\theta} = w\dfrac{1}{1-\sigma^2 qR_T}$, efficient under risk. $L^* \downarrow$ with $\sigma^2 \uparrow$, $R_T \uparrow$.

The landlord chooses to rent if $\dfrac{EU_y'}{EU_y'\theta} > \dfrac{EV'}{EV'\theta}$, i.e., if $R_T < R_L$.

3. *Sharecropper*: $q_L' = \left(\dfrac{w}{1-r}\right)\left(\dfrac{EU_y'}{EU_y'\theta}\right) = \left(\dfrac{w}{1-r}\right)\left(\dfrac{1}{1-\sigma^2(1-r)qR_T}\right)$, inefficient.

Hence, choose sharecropping if $\left(\dfrac{1}{1-r}\right)\left(\dfrac{EU_y'}{EU_y'\theta}\right) < \dfrac{EV'}{EV'\theta} \rightarrow$ if $R_L > \dfrac{r + (1-r)^2\sigma^2 qR_T}{\sigma^2 q}$ instead of owner-operator. Inefficient, but provides insurance to tenant.

4. *Cooperating sharecropper*: no disincentive effect through share, but insurance benefit (effect of r on risk)

$q_L' = w\dfrac{1}{1-\sigma^2(1-r)qR_T} = \dfrac{w}{\dfrac{EU_y'}{EU_y'\theta}} = \dfrac{w}{\dfrac{EV'}{EV'\theta}}$. Hence, optimum risk sharing is obtained when $\dfrac{EU_y'}{EU_y'\theta} = \dfrac{EV'}{EV'\theta}$, i.e., when $r = \dfrac{R_T}{R_T + R_L}$.

This is the same rule as under enforceable effort (Cheung) since the level of effort is also optimum here.

Note: Using relative risk aversion ρ instead of absolute risk aversion R, $\rho = yR_T$, the first order conditions are:

$q'_L = \frac{w}{(1-r)} \frac{1}{1-\rho\, s_\theta\, \sigma^2}$ where

$s_\theta = \frac{(1-r)q}{y}$ is the expected share of risky income in total household income.

In q'_L, L falls when r rises corresponding to the direct Marshallian disincentive effect.

In s_θ, L increases when r rises corresponding to the insurance effect. Note that, because of the participation constraint $\overline{W}$, R must fall if r rises (R can be positive).

Hence, L increases when w, ρ, s_θ, and σ^2 fall and when the tenant's total income y rises.

VI. Sharecropping under tenant liquidity constraint (Laffont and Matoussi, 1995)

There are two market failures (no risk):
- The tenant's effort is not observable, leading to moral hazard in effort and the need to design an incentive contract.
- There is a missing market for credit and the tenant has a liquidity constraint $\overline{K}$.

Let: x be a purchased input with price $p_x = 1$ specified in the contract by the landlord of which he pays the share r'.
$U(y,L) = y - U(L)$, separable utility function in income and leisure
S be the tenant's subsistence living expenses.
Sharecropping contract is (r, r', R).

The landlord's problem is:

$Max_{r,r',R,x}\ rq(L,x) - r'x + R$

subject to:

$(1-r)q(L,x) - (1-r')x - R - S - U(L) \geq \overline{W}$, tenant's participation constraint

$\overline{K} - (1-r')x - R - S \geq 0$, tenant's liquidity constraint

$Max_L (1-r)q(L,x) - (1-r')x - R - S - U(L)$, tenant's anticipated work behavior,

or tenant's foc: $(1-r)q'_L - U'_L = 0$, tenant's reaction function to the terms of the contract $L(r, r', R, x)$.

If the tenant's liquidity constraint is not binding, there is only one market failure. It can be handled by choosing a fixed rent contract ($r = 0$, $r' = 0$, $R > 0$) that results in no disincentive on effort. Hence, resource allocation is efficient.

If the tenant's liquidity constraint is binding, $\overline{K} < (1-r')x - R - S$. Hence, the landlord has no choice on r' and R and he must pay $x - (\overline{K} - S)$ of the variable input. In this case, the landlord's problem becomes:

$Max_{r,x}\ rq(L,x) - \left[x - (\overline{K} - S)\right]$

subject to:

$(1-r)q(L,x) - U(L) \geq \overline{W} + \overline{K}$, tenant's participation constraint,

$(1-r)q'_L - U'_L = 0$, tenant's anticipated work behavior (imposed with the Lagrange multiplier μ).

Solution: $\frac{\partial q}{\partial L} = U'_L + \mu\left[U''_L - (1-r)q''_L\right] > U'_L$, inefficient: there is under-provision of effort.

$\frac{\partial q}{\partial x} = \frac{1 - \mu(1-r)q''_{Lx}}{1 - \mu(1-r)q'_L / q} < 1$, inefficient: there is oversue of x if x and L are substitutes.

The result is that:

The landlord's utility increases with $\overline{K}$ for given x.

The tenant's share (1 - r) increases with $\overline{K}$.

The tenant's level of effort L and the level of output q increase with $\overline{K}$.

Conclusions:

i) With only one market failure (moral hazard on effort), landlords only choose sharecropping contracts if tenants are liquidity constrained (introducing a second market failure). If the tenant is unconstrained, he can pay the rent R and the optimal contract is fixed rent since it induces no Marshallian disincentive on effort. Hence, $\overline{K}$ affects the choice of contract (see Figure 6)

ii) Under sharecropping, $\overline{K}$ affects the tenant's share: the poorer he is (lower $\overline{K}$), the lower his share is (since he contributes less to x) and the less effort he will provide. Below a certain level of $\overline{K}$, the landlord will prefer a wage contract in spite of the moral hazard associated with hired labor.

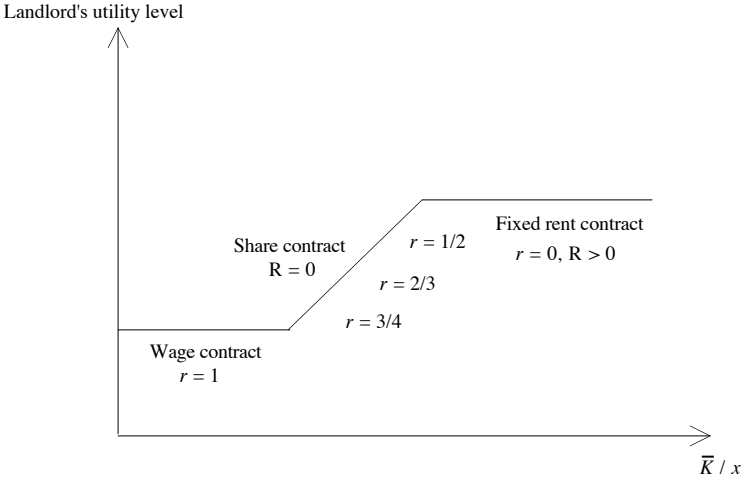

Figure 6. Choice of contract under liquidity constraint

Empirical validation: observe in a Tunisian village that:

i) The level of working capital of the tenant ($\overline{K}$) explains the choice of contract.

ii) Output per unit of land declines when the tenant's output share decreases (inefficiency of sharecropping).

VI. Sharecropping under market failures for two factors (Eswaran & Kotwal, 1985)

Production function: $q = q(t, s, L, M, \overline{A})$, non-stochastic.

where t = management (measured in time)
s = supervision (measured in time)
L = labor with wage w
M = other inputs with price p_M
$\overline{A}$ = land (fixed factor).

There are no markets for t and s which can both be provided by each agent. There are markets for L and M and the optimum levels of L and M are jointly decided for profit maximization, with sharing of cost equal to the sharing of output. Hence, these two inputs will be optimally applied while there is moral hazard in the provision of management and supervision by both landlord and tenant.

Relative efficiencies of landlord and tenant in management and supervision:

	Efficiency in management	Efficiency in supervision
Landlord (agent 1)	1	$0 \le \gamma_1 \le 1$
Tenant (agent 2)	$0 \le \gamma_2 \le 1$	1

where: γ_1 = efficiency of landlord in supervision,
γ_2 = efficiency of tenant in management.

1. Fixed wage contract:

Landlord problem (principal):

$$\text{Max}_{t_1,s_1,L,M} \;\; \Pi_l^w = \left[pq\left(t_1,\gamma_1 s_1,L,M,\overline{A}\right) - p_M M - wL\right] + \left(1 - t_1 - s_1\right)v$$

subject to: $0 \le t_1 \le 1$, $0 \le s_1 \le 1$, $0 \le t_1 + s_1 \le 1 = E$, time constraint
$Y_2 = u$

where v = landlord's opportunity cost per unit of time
u = worker's (agent) reservation income per unit of time = wage
$Y_1^w = \Pi_1^w$ landlord income under wage contract
Y_2^w = worker's income under wage contract
E = 1 time endowment of each partner.

Incomes: Landlord $Y_1^w = \Pi_1^w$
Tenant $Y_2^w = u$.

2. Fixed rent contract

Tenant's problem (agent):

$$\text{Max}_{t_2,s_2,M,L} \;\; \Pi_2^r = \left[pq\left(\gamma_2 t_2, s_2, L, M, \overline{A}\right) - p_M M - wL\right] + \left(1 - t_2 - s_2\right)u.$$

Landlord's problem (principal):

Chooses the level of rent R for $Y_2^r = u$, i.e., $\text{R} = \text{Max}\left(0, \tilde{\Pi}_2^r - u\right)$.

Incomes: Landlord $Y_1^r = R + v$
Tenant $Y_2^r = \tilde{\Pi}_2^r - R = u$.

3. Share rent contract (α, β)

The landlord does the management and the tenant the supervision, both with a Marshallian disincentive to provision.

Joint decision on M and L (cooperative)

Total profits for both partners:
$\Pi^{sc}\left(t_1, s_2\right) = \text{Max}_{M,L} \;\; pq\left(t_1, s_2, L, M, \overline{A}\right) - p_M M - wL$
f.o.c.: $pq'_M = p_M$, $pq'_L = w$ (no Marshallian inefficiency).

Separate decisions on s_2 and t_1

Sharing of revenue net of input cost:
Landlord $S_1 = -\alpha + (1-\beta)\Pi$.
Tenant: $S_2 = \alpha + \beta\Pi$.

where: α = tenant's fixed rent.

β = tenant's share of total profit.
$(1 - \beta)$ = landord's share of profit.

Tenant chooses s2:

$\text{Max}_{s_2} \;\; \beta\Pi\left(t_1, s_2\right) + \left(1 - s_2\right)u, \;\; 0 \le s_2 \le 1$
Decision rule: $\beta\Pi'_{s_2} = u$ (implies Marshallian inefficiency)
Tenant's reaction function: $s_2 = s_2\left(t_1, \beta\right)$

Landlord chooses t1:

$\text{Max}_{t_1} (1-\beta)\Pi\left(t_1, s_2\right) + \left(1 - t_1\right)v,$
Decision rule: $(1-\beta)\Pi'_{t_1} = v$ (implies Marshallian inefficiency)
Landlord's reaction function: $t_1 = t_1\left(s_2, \beta\right)$

This is a non-cooperative Nash game with reaction functions
$s_2 = s_2\left(t_1, \beta\right)$, $t_1 = t_1\left(s_2, \beta\right)$,
and solution $s_2(\beta)$, $t_1(\beta)$.

Choice of contract

As principal, the landlord has the last say on the choice of contract. He chooses α^* and β^* that maximize his income subject to the tenant's reservation utility:

$$\text{Max}_{\alpha,\beta} \;\; Y_1^{sc} \quad \text{s.t.} \quad \alpha + \beta\Pi + \left(1 - s_2\right)u = u$$

The reservation utility constraint sets α equal to: $\alpha^* = s_2 u - \beta\Pi$.

The landlord thus maximizes: $\text{Max}_\beta \;\; Y_1^{sc} = -\alpha^* + (1-\beta)\Pi + \left(1 - t_1\right)v$
$= \Pi + \left(1 - t_1\right)v - s_2 u$

The resulting incomes are:
$Y_1^{sc} = \Pi^*\left[t_1\left(\beta^*\right), s_2\left(\beta^*\right)\right] + \left[1 - t_1\left(\beta^*\right)\right]v - s_2\left(\beta^*\right)u$
$Y_2^{sc} = u$.

The choice between the three contracts is made by the landlord who selects the highest level of income he can achieve:
Landlord: max $\left(Y_1^w, Y_1^r, Y_1^{sc}\right)$
Tenant: u, u, u.

Comparative statics:

i) Increase the importance of management relative to labor supervision (e.g., adoption of HYV in India): the critical value γ_1^c falls and γ_2^c increases. Some fixed rent contracts are transformed into wage and sharecropping contracts (Figure 3).

ii) Increased labor intensity (increased importance of supervision) without decreasing the importance of management, e.g., shift from field crops to strawberries in California. This increases the critical value of γ_1. Some wage contracts are transformed into sharecropping.

iii) Mechanization which decreases the importance of supervision by being labor saving ($\gamma_1^c \downarrow$): some sharecropping contracts are transformed into wage contracts.

iv) Increased opportunity cost of landlord time (industrialization, increased wage of skilled labor): the critical value for γ_1 increases and that for γ_2 falls. Landlords shift out of wage contracts into tenancy contracts.

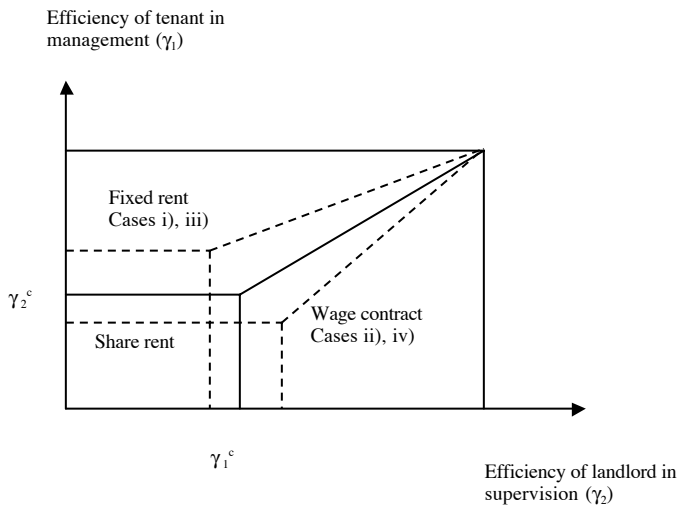

Figure 7. Choice of contract under double moral hazard

VII. Optimal rental contract with endogenous asset depletion: the repeated moral hazard problem (Pierre Dubois, 1999)

The landlord is concerned with future land fertility (future revenues).
The tenant only has one year contracts as there is no credible commitment to renew the contract.
The tenant's current effort (L_t) increases output (q_t), but decreases land fertility (x_t).

Production function: $q_t = \theta_t q(L_t, x_{t-1}), \frac{\partial q}{\partial L} > 0$, where θ is a stochastic term.

Realized output: $\theta_t q_t$

Soil fertility equation: $x_t = \varepsilon_t x(L_t, x_{t-1}), \frac{\partial x}{\partial L} \leq 0$, where ε is a stochastic term.

L is a decision variable for the tenant (effort).
x is a state variable (land fertility).
The landlord specifies a non-linear contract (r, R).
The landlord is risk neutral; the tenant is risk averse.

The landlord problem:

$\text{Max}_{r,R}\ E\sum_{t=0}^{\infty}\rho^t\left[rq_t(L_t, x_{t-1})\theta_t + R_t\right]$, s.t.:

Tenant's incentive compatibility constraint: $\text{Max}_L W = EU\left[(1-r)q_t\theta_t - R_t\right]$

Tenant's participation constraint: $\text{Max}_L W \geq \overline{W}$

Static solution (see above):

$$r = -q\frac{1 - \frac{EU_y^{'}\theta}{EU_y^{'}}}{q_L^{'}\frac{dL}{dr}} = \phi(r)(1-r)R_T$$

Solution with dynamic asset depletion:

$$r = \phi(r)(1-r)R_T + \frac{E\varepsilon v^{'}\left|\frac{\partial x}{\partial L}\right|}{\frac{\partial q}{\partial L}}$$

where the last term is negative. Hence:

Under tenant risk neutrality ($R_T = 0$), the optimum contract is no longer fixed rent ($r = 0$), but sharecropping to lower the tenant's incentive to exercise effort.

Under tenant risk aversion, his share decreases with $\left|\frac{\partial x}{\partial L}\right|$, i.e., with sensitivity of the land to degradation due to the level of effort. Hence, the tenant's share is lower, the more fragile the plot is to degradation. The Marshallian disincentive is used to reduce the tenant's effort and the degradation of the land caused by his efforts.

Empirical evidence from the Philippines: higher shares (more incentive contracts) observed on more valuable land (i.e., land of better quality and less sensitive to overuse),

Conclusion: sharecropping second-best optimum for soil conservation under non-observability of effort and insurance market failure.

First best policy is to help enforce long term contracts to reduce the short term-long term incentives conflict between tenant and landlord.

VIII. How to regulate a sharecropping contract that creates negative externalities? The multitask problem (Chambers and Quiggin, 1996; Aggarwal and Lichtenberg, 2000)

Contract over a joint product (multitask):
- Agricultural output that creates private benefits for the two parties: $Q = f(X, Z)$.
- Pollution (chemical runoff) that creates no cost or benefit to the two parties but a negative social externality: $P = h(X, Z)$.

Q and P are observable to both agents and to the regulator (social planner).

Double moral hazard model (Eswaran and Kotwal): X provided by the principal (e.g., an agroprocessor providing chemical inputs), Z by the agent (e.g., a grower providing labor).

Price of X is w; price of Z is v.

No output possible without both inputs; each input can only be provided by one agent. Hence, sharecropping is the only feasible contract.

Non-linear sharecropping contract: payment to the agent = $\alpha + \beta Q$.

The principal's problem is:

$\text{Max}_{\alpha,\beta,X,Z}(1-\beta)f(X,Z) - \alpha - wX$

$s.t.\quad (1-\beta)f_X = w$, principal's optimum provision of X

$\beta f_Z = v$, agent's optimum provision of Z

$\alpha + \beta f - vZ \geq R$, agent's participation constraint.

R is the agent's reservation income.

The social planner wants to impose Pigouvian taxes on the two polluters to internalize as a cost the negative externality: s on the principal and t on the agent per unit of observed pollution. What are the optimum taxes?

The social planner's problem with only one agent would be:

$$\text{Max}_{X,Z} f(X,Z) - wX - vZ - ch(X,Z) - R$$

where c is the marginal cost of environmental damage.

The first conditions are:

$f_X = w + ch_X$

$f_Z = v + ch_Z$

Hence, the optimum Pigouvian tax should be set equal to the marginal cost c of environmental damage.

The social planner's problem with two sharecropping agents with joint responsibility of paying for environmental damage is:

$$\text{Max}_{\beta,X,Z} f(X,Z) - wX - vZ - (s+t)h(X,Z) - R$$

$$s.t. \quad (1-\beta) f_X - w - s h_X = 0, \text{ principal's optimum provision of } X$$

$$\beta f_Z - v - t h_Z = 0, \text{ agent's optimum provision of } Z.$$

The solution is the optimum tax rates:

$$s = c - \beta \frac{f_X}{h_X} = (1-\beta)c - \beta \frac{w}{h_X}$$

$$t = c - (1-\beta) \frac{f_Z}{h_Z} = \beta c - (1-\beta) \frac{v}{h_Z}$$

Hence, t < c and s < c. The optimal tax paid by each agent is less than c. The optimal tax paid by both agents

$$s + t = c - \frac{\beta w}{h_X} - \frac{(1-\beta)w}{h_Z} < c$$

is also less than the full cost of environmental damage. This is because both partners are already producing below social optimum due to the double Marshallian disincentive.

IX. Summary of determinants of contract choice

Determinants of choice of the sharecropping contract as the relatively most efficient contract can be summarized in Figure 2.

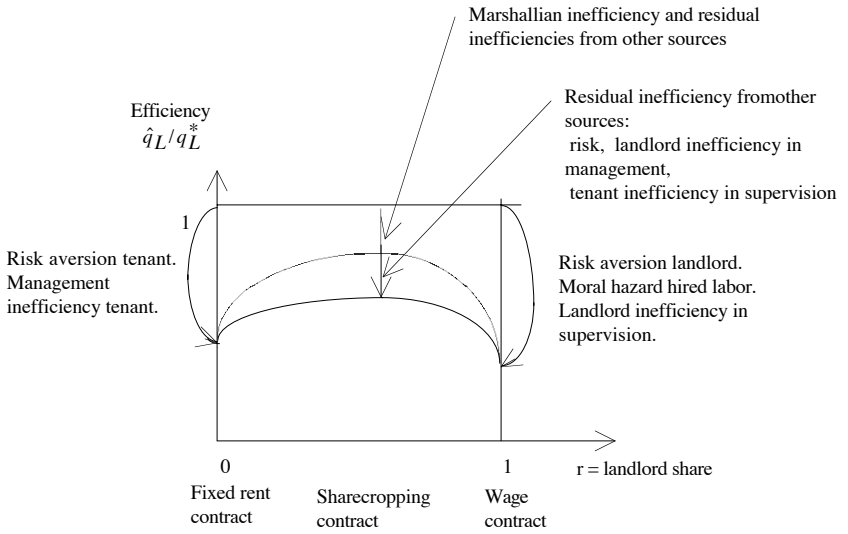

Figure 8. Relative efficiency of sharecropping

Hence, a test of the relative efficiency of sharecropping is:

Sharecropping is the relatively more efficient contract if:
(Marshallian inefficiency + residual inefficiencies due to second best effects on sharecropping) < Second best effects on the other contacts.

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