Agricultural Organization and Productivity:
Land Rental Contracts

1. Introduction: Land Ownership and Tenancy

- Table 12.1 shows how unequal the distributions of land are in the countries of Asia and Latin America.
  - A huge percentage of the rural population is either landless or owns very small plots of land, in contrast with a small fraction of the population who own very large quantities of land.
  - The Gini coefficients of land distribution are very high compared to the corresponding estimates of the inequality of income distribution.
- Although there is substantial inequality in Asia, land inequalities in Latin America are higher by an order of magnitude.
  - Figure 12.1 plots Lorenz curves for land inequality in two Asian countries (India and Thailand) and two Latin American countries (Honduras and Colombia).
  - The differences in the two sets of Lorenz curves are fairly evident.

Table 12.1. Ownership distribution of farms and farmland in Asia and Latin America in the early 1970s.

Country	Average operational farm size (hectares)	Percentage of farms and farmland				Gini coefficient of land concentration
		Below 5 hectares		Above 50 hectares		
		Farms	Area	Farms	Area	
Asia						
Bangladesh	1.6	90.6	67.6	n.a.	n.a.	0.42
India	2.3	88.7	46.7	0.1	3.7	0.62
Indonesia	1.1	97.9	68.7	0	13.6	0.56
Nepal	1.0	97.2	72.1	0	0.8	0.56
Philippines	3.6	84.4	47.8	0.2	13.9	
Thailand	3.7	72.3	39.4	0	0.9	0.45
Latin America						
Brazil	59.7	36.8	1.3	16.3	84.6	0.84
Costa Rica	38.1	48.9	1.9	14.5	79.7	0.82
Colombia	26.3	59.6	3.7	8.4	77.7	0.86
Peru	16.9	78.0	8.9	1.9	79.1	0.91
Uruguay	214.1	14.3	0.2	37.6	95.8	0.82
Venezuela	91.9	43.8	0.9	13.6	92.5	0.91

Source: Otsuka, Chuma, and Hayami [1992, Table 2].

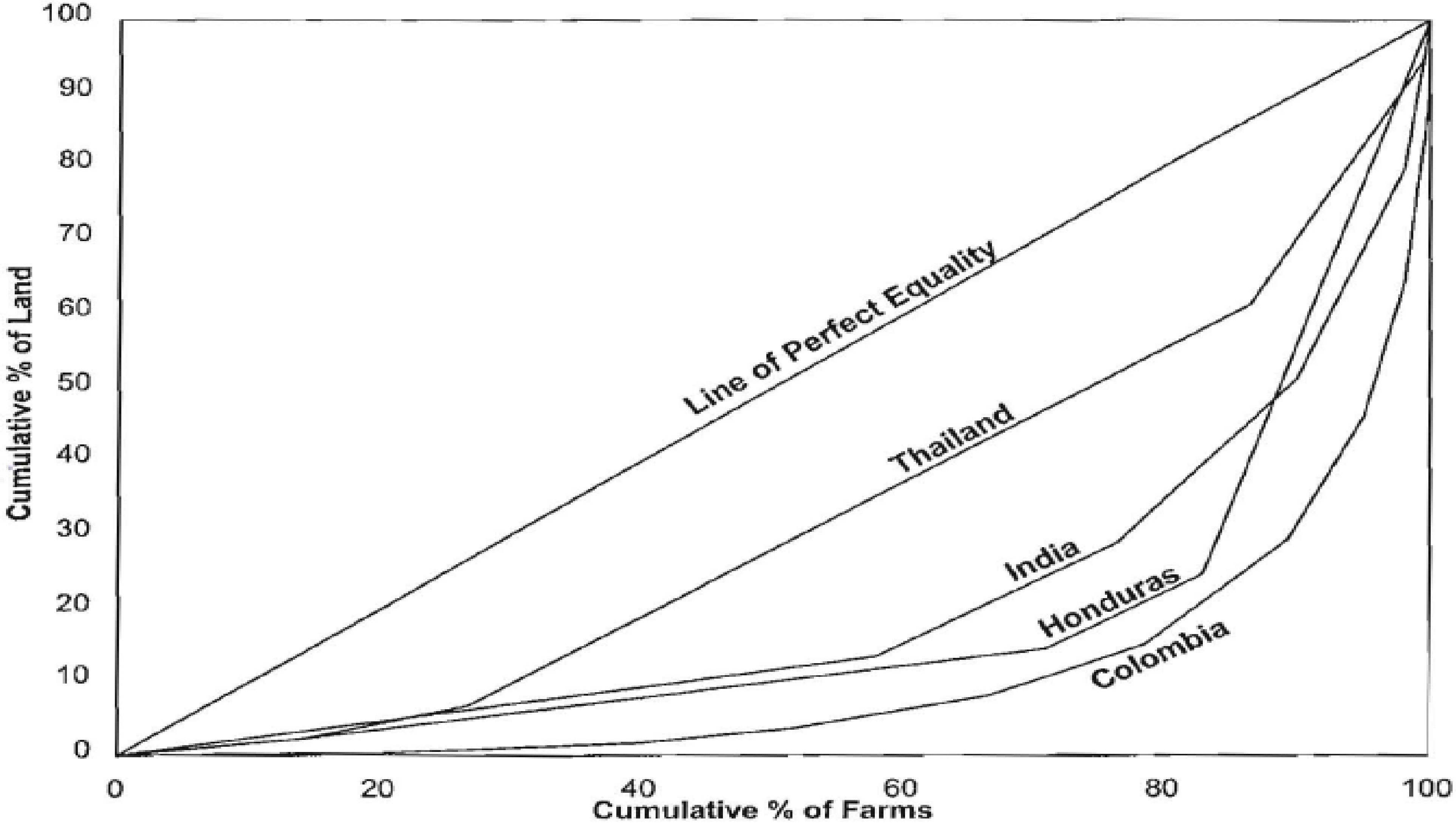

Figure 12.1. Lorenz curves for land holdings in two Asian and two Latin American countries. Source: Agricultural Censuses of Colombia [1988], Honduras [1993], India [1986], and Thailand [1988].

- Table 12.2 shows the distribution of farms and farmland by land tenure status in different parts of the world.
- The average farm size in Asia (2.3 hectares) is much lower than Latin America (46.5 hectares) and North America (161.2 hectares).
  - This reflects the population pressure in the Asian countries.
- The low per capita holdings of land in Asia and the high inequality of landholdings in Latin America have a similar effect: a significant fraction of the farms are owner operated and cultivated.
  - In Asia the fraction is particularly high, standing at around 86%.
  - The Latin American fraction is lower and also includes a significant fraction of very large farms that are cultivated with hired labor.
- The African countries are somewhat of an outlier in this respect.
  - Much of the land is held under forms of group or communal tenure, and individual claims on such plots are weak.

Table 12.2. Distribution of farms and farmland by land tenure status in the 1970 World Census of Agriculture.

	Asia	*Africa*	*Latin America*	*Europe*	*North America*	*World*
Countries	10	4	15	12	2	46
Farms (million)	93.3	3.5	8.6	11.9	3.1	120.4
Farm size (hectares)	2.3	0.5	46.5	7.6	161.2	10.0
Distribution of farms (%)						
Owner cultivation	85.8	5.2	60.3	67.6	63.2	79.2
Pure tenancy	5.9	1.6	17.1	9.3	12.0	7.1
Owner-cum-tenancy	8.2	6.9	6.6	23.0	24.8	10.0
Others	0.0	86.3	16.0	0.1	0.0	3.7
Distribution of farmland (%)						
Owner cultivation	84.0	9.2	80.4	58.9	36.6	61.1
Pure tenancy	5.9	3.0	6.2	12.5	11.9	9.0
Owner-cum-tenancy	10.1	29.1	5.6	28.5	51.5	27.2
Others	0.0	58.7	7.8	0.1	0.0	2.7
Percentage of share tenancy in tenanted land	84.5	0.0	16.1	12.5	31.5	36.1

Source: Otsuka, Chuma, and Hayami [1992, Table 1].

- Several countries provide for ownership or use rights to tenants who have worked the land for some prespecified number of years.
  - Several Asian countries and countries in Latin America, like Brazil or Mexico, uphold such a principle.
- Such legalization has not always had a potent effect in turning land over to the tiller.
  - Often, the reaction in Latin America has been in the direction of tenant eviction, followed by large-scale mechanized farming.
  - In the case of Asia such legal stipulation often results in a substantial amount of informal tenancy that goes unrecorded in the data.
- The significant presence of owner-cultivators in Asian countries such as Korea and Taiwan is not surprising.
  - These countries exhibit a relatively low degree of inequality in landholdings due to early land reforms.

- Whereas tenancy exists all over the world, there are variations in the forms of tenancy arrangement.
- Latin American tenancy is largely of the **fixed-rent** variety: the tenant pays a fixed sum of money to the landlord in return to the right to cultivate the land.
- Asian tenancy is characterized by a high incidence of **sharecropping**: the tenants pay the landlord an agreed-upon share of the crop.
- In Asia, on the whole, 84.5% of tenanted land is under share tenancy.
  - But the percentage range from around 30% (Thailand), through 50% (India) or 60% (Indonesia), all the way up to 90% in Bangladesh.
- In Latin America, on an average, 16.1% of tenanted land is under sharecropping; the corresponding percentages are much lower:
  - under 10% in countries such as Costa Rica or Uruguay and negligible in Peru, although relatively high at 50% in Colombia.

- Typically richer tenants engage in fixed-rent tenancy.
  - In fixed-rent tenancy the landlord is relieved of all risk: the rent is the same whether the crop does well or not.
    - In this sense, fixed-rent tenancy requires that the tenant be willing and able to bear the risks of agricultural production.
    - This is generally the case if the tenant has substantial wealth of his own.
  - This is indirect evidence that Latin American tenancies are held by large farmers.
- Contrast this with Asia where the bulk of tenancy is in the form of sharecropping.
  - Sharecropping has particular value when the tenant is small and averse to risk:
    - if a given fraction of output is paid as rent, then the tenant is, to some extent, insulated against output fluctuations, because he can share some of these fluctuations with his landlord.
  - This suggests that Asian tenancy probably reflects, on the whole, land leases from relatively large landowners to relatively small landowners.

2. Land Rental Contracts: Theory

- The land-lease market is usually more active than that of buying and selling land.

- There is a large literature on tenancy, particularly on *sharecropping*, which is an ancient and yet current institution in most parts of the world.

  – We will focus on two well accepted rationales of sharecropping:

    ○ trade-off between risk-sharing and incentive provision, and

    ○ limited liability.

- For a background and for discussion of other issues in the land market of developing countries refer to the following:

1. Ray, Debraj (1998), *Development Economics*, Princeton University Press, Ch. 12.
2. Bardhan, Pranab and Christopher Udry (1999), *Development Microeconomics*, Oxford University Press, Chapter 6.

- Tenancy involves two transactions: labour and land are exchanged with each other.
  - **Fixed rent tenancy contract:** a labourer rents in land in exchange for a *fixed* fee to the land-owner.
  - **Fixed wage contract:** the landlord hires in the labour in exchange for a fixed fee.
  - **Sharecropping tenancy contract:** a labourer rents in the land in exchange for paying the landlord a fee which is linear in output.
- Consider the production function $Q = F(L, T)$:
  - Q: output; L: labour; T: land.
- Tenant's income under these alternative contractual forms is: $y_T = s \cdot Q - R$.
- Correspondingly, landlord's income is: $y_L = Q - y_T = (1 - s) \cdot Q + R$.
- **Fixed rent tenancy contract:** $s = 1$ and $R > 0$.
- **Fixed wage contract:** $s = 0$ and $R < 0$.
- **Sharecropping tenancy contract:** $0 < s < 1$, and $R \gtreqless 0$.

- We discuss what determines the choice of land rental contracts in agriculture:
  - how the landlord chooses between a *fixed-rent* contract, a *sharecropping* contract, or a *wage* contract.
- **Sharecropping**, one of the ancient and yet current institutional arrangements in world agriculture,
  - provided the context of the application of one of the first principal-agent models in economics;
  - began the process of a whole group of development economists probing the micro-economic rationale of informal agrarian institutional arrangements
    - in poor countries in an environment of pervasive risks and information asymmetry.
- We discuss alternative theories of sharecropping with special emphasis on the roles of *risk-sharing*, *incentive provision, limited liability,* and *eviction* and *use rights*.

- The widespread prevalence of sharecropping tenancy in virtually all countries and all times has troubled economists since Adam Smith.
  - The fact that the tenant gets less than the marginal product of his inputs indicates that this agrarian institution is likely to be inefficient.
- Subsequent research based on the economics of information has shown that sharecropping tenancy is an optimal contractual response to *incomplete markets*.
- We present variants of a *principal-agent model* to capture the essence of different theories of tenancy.
  - We take as *given* the following aspects of the economic environment:
    - the production function; the preferences and endowments of landlords and tenants; market wages and rental rates.
  - Then we *derive* endogenously the *optimal contract*.

2.1 The Economic Environment

- **Production Function:**

$$Q = e + \theta. \tag{1}$$

  - Q: output;
  - e: effort put in by the cultivator;
  - θ: a random shock; distributed normally with zero mean and variance σ^2.

- The production function is linear in the tenant's effort, for simplicity.
- Output is stochastic reflecting uncertainties in agricultural production like weather fluctuations, pest attack, and so on.
  - Uncertain production is the reason for potential risk sharing and moral hazard.
- The tenant controls only the mean and not the variance of the production function.

- **Preferences:**

  All agents are *risk-averse*, and their utility as a function of income, y,takes the form:

$$u\left(y\right) = -e^{-\beta y},\ \beta > 0. \tag{2}$$

  – $\beta = -\dfrac{u''\left(y\right)}{u'\left(y\right)}$, the Arrow-Pratt measure of absolute risk aversion;

    ◦ so the utility function takes the constant absolute risk aversion (CARA) form.

- Since, under the tenancy contract, both the landlord and the tenant's incomes are linear in output, Q, consider, in general, $y = a + bQ = (a + be) + b\theta$.

- $\theta \sim N\left(0, \sigma^2\right)$, $\Rightarrow y \sim N\left((a + be), b^2\sigma^2\right) \Rightarrow -\beta y \sim N\left(-\beta(a + be), b^2\beta^2\sigma^2\right)$.

- Recall that if $X \sim N\left(\mu, \sigma^2\right)$, then $Y = e^X$ is log-normally distributed with $E\left(Y\right) = e^{\mu + \frac{1}{2}\sigma^2}$.

  – It follows that $E\left(e^{-\beta y}\right) = e^{\left[-\beta(a+be)+\frac{1}{2}b^2\beta^2\sigma^2\right]}$.

⇒ Expected utility of an agent with an income y is

$$E(u(y)) = E\left(-e^{-\beta y}\right) = -e^{-\beta\left[(a+be)-\frac{1}{2}b^2\beta\sigma^2\right]} = -e^{-\beta\left[E(y)-\frac{\beta}{2}Var(y)\right]}.$$

since $E(y) = a + be$ and $Var(y) = b^2\sigma^2$.

- Since utility is ordinal (positive monotonic transformation of the utility function does not change the preference), let us abuse the notation a bit and consider the expected utility of an agent with an income y as

$$U(y) = E(y) - \frac{\beta(W)}{2}Var(y). \tag{3}$$

  – W: monetary wealth owned by the agent.

  – Assume that the coefficient of absolute risk-aversion, $\beta(W)$, is a *declining* function of W,

    ○ that is, the wealthier the agent the less risk-averse he is.

- **Endowments:**
  - The landlord owns a piece of land, monetary wealth W_L, and no labour.
  - The tenant owns no land, monetary wealth W_T, and 1 unit of labour.
- **Markets:**
  - The insurance markets are missing.
  - Land, labour and goods markets are perfectly competitive.

$\Rightarrow$ Landowner could buy the tenant's labour services at the market wage rate w, and the labour-owner could lease in the landlord's land at the market rental rate ρ.

$\Rightarrow$ The reservation (expected) utility of the landlord is ρ, that is, $U_L \geq \underline{U}_L = \rho$, and the reservation (expected) utility of the tenant is w, that is, $U_T \geq \underline{U}_T = w$.

- **Cost of Effort:**
  - Distinguish between labour and effort: the former is the potential to work, and the latter is the actual intensity of work.
  - It is costly to exert effort:

$$c(e) = \frac{1}{2}ce^2,\ c > 0. \tag{4}$$

- **Contracting:**
  - Effort, e, is neither observable nor monitorable.

  $\Rightarrow$ The tenant would need incentives to put in effort.

  - We restrict ourselves to *linear contracts*, that is, the tenant's income, y_T, is a linear function of output:

$$y_T = s \cdot Q - R, \text{ where } 0 \leq s \leq 1.$$

    - Let us summarize this contract as (s, R), where
      - s is referred to as the 'share' component and R as the 'fixed-rent' component.

2.2 The First Best

- Under the contract, (s, R) , the expected utilities of the tenant and the landlord are:

$$U_T(e, s, R) = E(s \cdot Q - R) - \frac{\beta(W_T)}{2} Var(s \cdot Q - R) - \frac{1}{2}ce^2$$

$$= s \cdot e - R - \frac{\beta(W_T)}{2} s^2\sigma^2 - \frac{1}{2}ce^2.$$

$$U_L(e, s, R) = E((1 - s) \cdot Q + R) - \frac{\beta(W_L)}{2} Var((1 - s) \cdot Q + R)$$

$$= (1 - s) \cdot e + R - \frac{\beta(W_L)}{2} (1 - s)^2 \sigma^2.$$

- Hence the **social surplus** is

$$S(e, s, R) = U_T(e, s, R) + U_L(e, s, R) = e - \frac{\beta(W_T)}{2} s^2\sigma^2 - \frac{\beta(W_L)}{2} (1 - s)^2 \sigma^2 - \frac{1}{2}ce^2.$$

- The first best is defined by the optimal effort level, e^*, and contract structure, (s^*, R^*) , that maximizes the social surplus.

- The optimal effort level and the share are the solutions of the F.O.C.'s:

$$\frac{\partial S}{\partial e} = 1 - ce = 0, \text{ and}$$

$$\frac{\partial S}{\partial s} = -\beta\left(W_T\right)s\sigma^2 + \beta\left(W_L\right)\left(1-s\right)\sigma^2 = 0,$$

which yields

$$\tilde{e} = \frac{1}{c}, \text{ and} \tag{5}$$

$$\tilde{s} = \frac{\beta\left(W_L\right)}{\beta\left(W_L\right)+\beta\left(W_T\right)}. \tag{6}$$

- The maximized value of social surplus is

$$\tilde{S} = \frac{1}{2c} - \left[\frac{\beta\left(W_T\right)\beta\left(W_L\right)}{\beta\left(W_L\right)+\beta\left(W_T\right)}\right]\frac{\sigma^2}{2}. \tag{7}$$

- As long as $\tilde{S} > w + \rho$, there are gains to be made from trade between the landowning and labour-owning agents.
  - Recall that the reservation (expected) utilities of the tenant and the landlord are w and ρ, respectively.
- The precise division of the gains would depend on the bargaining regime.
  - We adopt the bargaining protocol that is usually adopted in the contract theory literature:
    - the principal can make 'take it or leave it' offers to the agent subject to providing the agent with his reservation (expected) utility.
      - We adopt this bargaining protocol in the form of adding the **participation constraint** of the tenant: $U_T \geq w$.

2.3 Risk Sharing versus Incentive Provision

- Stiglitz (1974) was the first to formalize sharecropping as a compromise between risk-sharing and incentive provision.
  - Stiglitz introduced the first principal-agent model in economics literature to study the *moral hazard* problem with respect to *unobservable* (and therefore *non-contractible*) work effort.

- When effort is unobservable, the tenant would need incentives to put in effort.
  - Then fixed-rental contracts ($s = 1$) will be optimal from the point of view of *incentives*, but that would put too much *risk* on the tenant.
    - A *sharecropping* contract will achieve the right balance between risk-sharing and incentive provision.
      - This is essentially the story of Stiglitz (1974).

- **Incentive Compatibility Constraint:**
  - Since the landlord cannot observe e (and hence cannot specify e in the contract), he has to try to influence it through the choice of s and R.
  - This adds the *incentive compatibility constraint* into the contracting problem:

$$e = \arg\max_{\{e\}} U_T(e, s, R) = \arg\max_{\{e\}} \left[s \cdot e - R - \tfrac{\beta(W_T)}{2} s^2 \sigma^2 - \tfrac{1}{2} c e^2 \right] = \frac{s}{c}.$$

- **The Optimal Contracting Problem:**

$$\begin{cases} \max\limits_{\{s,R\}} U_L(e, s, R) \\ \text{subject to} \\ U_T(e, s, R) \geq w\text{: tenant's participation constraint (PC), and} \\ e = \arg\max\limits_{\{e\}} U_T(e, s, R)\text{: tenant's incentive compatibility constraint (ICC).} \end{cases}$$

- Substituting the expressions for expected utilities, the contracting problem becomes

$$\begin{cases} \max\limits_{\{s,R\}} \quad (1-s)\cdot e + R - \frac{\beta(W_L)}{2}(1-s)^2\sigma^2 \\ \text{subject to} \\ s\cdot e - R - \frac{\beta(W_T)}{2}s^2\sigma^2 - \frac{1}{2}ce^2 \geq w : \text{(PC), and} \\ e = \dfrac{s}{c} : \text{(ICC).} \end{cases}$$

- Since the objective function increases with R, (PC) must hold with equality.

$\Rightarrow R = s\cdot e - \frac{\beta(W_T)}{2}s^2\sigma^2 - \frac{1}{2}ce^2 - w.$

- Substituting this expression for R into the objective function the problem becomes

$$\begin{cases} \max\limits_{\{s\}} \quad e - \frac{\beta(W_T)}{2}s^2\sigma^2 - \frac{\beta(W_L)}{2}(1-s)^2\sigma^2 - \frac{1}{2}ce^2 - w \\ \text{subject to} \quad e = \dfrac{s}{c}. \end{cases}$$

– That is,

$$\max_{\{s\}} \quad \frac{s}{c} - \tfrac{\beta(W_T)}{2} s^2\sigma^2 - \tfrac{\beta(W_L)}{2}\left(1-s\right)^2\sigma^2 - \frac{s^2}{2c} - w.$$

– F.O.C.:

$$\frac{1}{c} - s\beta\left(W_T\right)\sigma^2 + \left(1-s\right)\beta\left(W_L\right)\sigma^2 - \frac{s}{c} = 0,$$

which yields

$$s^* = \frac{1 + c\beta\left(W_L\right)\sigma^2}{1 + c\left[\beta\left(W_L\right) + \beta\left(W_T\right)\right]\sigma^2}, \tag{8}$$

and consequently,

$$e^* = \frac{s^*}{c}, \tag{9}$$

$$R^* = \frac{\left(s^*\right)^2}{2c}\left[1 - c\beta\left(W_T\right)\sigma^2\right] - w. \tag{10}$$

- Observation 1:
  - As long as $\sigma^2 \neq 0$ (that is, there is some uncertainty and variation in production) and/or $\beta(W_T) \neq 0$ (that is, the tenant is not risk-neutral), $0 < s^* < 1$,
    - that is, *sharecropping* is the optimal form of contract.
  - Share contracts and fixed-rent contracts could coexist depending on the riskiness of production of different crops and on the attitudes towards risk of different tenants.
  - For fixed wage contracts to be seen the tenant has to be infinitely risk-averse.
  - The contractual form depends on
    - the attitudes towards risk of the parties ($\beta(W_L)$ and $\beta(W_T)$),
    - the variance of output (σ^2), and
    - the marginal cost of effort (c).
  - In contrast, in the first-best, the tenant's share depended only on the attitudes towards risk of the contracting parties.

- Observation 2:
  - Compare the effort level e^* (equation (9)) under this contract with the efficient (first-best) effort level $\tilde{e}$ (equation (5)):

$$e^* = \frac{s^*}{c} < \frac{1}{c} = \tilde{e}$$

as long as $0 < s^* < 1$, that is, under sharecropping.

    - Thus sharecropping is an *inefficient* institutional arrangement compared to fixed-rent tenancy.

  - The difference in effort levels, $\tilde{e} - e^* = \dfrac{1 - s^*}{c}$, is called the 'agency costs' associated with sharecropping tenancy.

- Observation 3:
  - As uncertainty goes up ($\sigma^2 \uparrow$), the share of the tenant, the effort level and the fixed-rent component goes down.
    - Thus reduction in exogenous uncertainty would imply a movement towards fixed-rent tenancy.
- Observation 4:
  - An increase in the productivity of labour ($c \downarrow$) will increase the share of the tenant, the effort level and the fixed-rent component.
- Observation 5:
  - As the market wage rate (w) goes up, the fixed component of the rent goes down, but nothing else is affected.
    - This is a consequence of the fact that we take mean-variance utility function and effort does not affect the variance of output.

- Observation 6:
  - The more risk-averse a tenant is ($\beta\left(W_T\right)\uparrow$), $s^* \downarrow$, $e^* \downarrow$, and $R^* \downarrow$.
  - The more risk-averse a landlord is ($\beta\left(W_L\right)\uparrow$), $s^* \uparrow$, $e^* \uparrow$, and $R^* \uparrow$.
  - If we assume that the landlord is very rich so that he is risk-neutral ($\beta\left(W_L\right) = 0$), then the share of the tenant is

$$s^* = \frac{1}{1 + c\beta\left(W_T\right)\sigma^2} > 0 = \tilde{s}.$$

    That is, the optimal contract is sharecropping than the wage contract.
  - If instead the tenant is risk-neutral ($\beta\left(W_T\right) = 0$) while the landlord is risk-averse (($\beta\left(W_L\right) > 0$)), we get $s^* = 1$, and
    - only in this case we get full efficiency ($e^* = \dfrac{1}{c} = \tilde{e}$).

2.4 Tenancy Contracts under Limited Liability

- We now consider a somewhat modified version of the principal-agent model which emphasizes, along with moral hazard, a **limited liability constraint**:
  - *the tenant is liable upto his own wealth level* W_T.
    - This reflects a credit market imperfection.

- The first theoretical model with the limited liability constraint is that of Shetty (1988).
  - Main contribution is the recognition of the *ex post* limited liability constraint:
    - in bad states of nature, the rent cannot be paid completely.

- Laffont and Matoussi (1995) postulates an *ex ante* limited liability constraint:
  - the fixed component of the rent has to be paid in advance;
  - the amount of money that could be taken away (in advance) from the tenant as a fixed-rent is bounded above by his wealth W_T.

- We follow Laffont and Matoussi (1995) to illustrate how the *ex ante* limited liability constraint explains
  - the emergence of *sharecropping* contracts, and
  - the associated *tenancy ladder* where landlord prefers wealthier tenants.
- Consider the same economic environment developed in section 2.1 with the following two modifications:
  - both the landlord and the tenant are risk-neutral (in order to highlight the role of limited liability we downplay the role of risk sharing):

$$\beta\left(W_L\right) = 0 = \beta\left(W_T\right),$$

  - we add the ex ante limited liability constraint that the fixed component of the rent has to be paid in advance and this amount is bounded above by his wealth W_T:

$$R \leq W_T.$$

- **The Optimal Contracting Problem:**

$$\begin{cases} \max\limits_{\{s,R\}} U_L(e,s,R) \\ \text{subject to} \\ U_T(e,s,R) \geq w\text{: tenant's participation constraint (PC), and} \\ e = \arg\max\limits_{\{e\}} U_T(e,s,R)\text{: tenant's incentive compatibility constraint (ICC), and} \\ R \leq W_T\text{: tenant's limited liability constraint (LLC).} \end{cases}$$

- As before, the incentive compatibility constraint requires: $e = \dfrac{s}{c}$.

- Using $\beta(W_L) = 0 = \beta(W_T)$ and $e = \dfrac{s}{c}$, we have

$$U_L(e,s,R) = (1-s)\cdot e + R = \frac{s(1-s)}{c} + R,$$

$$U_T(e,s,R) = s\cdot e - R - \tfrac{1}{2}ce^2 = \frac{s^2}{2c} - R.$$

- Then the contracting problem becomes

$$\begin{cases} \max\limits_{\{s,R\}} \quad \dfrac{s\,(1-s)}{c} + R \\ \text{subject to} \\ \dfrac{s^2}{2c} - R \geq w : \text{(PC), and} \\ -R \geq -W_T : \text{(LLC).} \end{cases}$$

- Form the Lagrangian

$$\mathcal{L} = \frac{s(1-s)}{c} + R + \lambda \left[\frac{s^2}{2c} - R - w \right] + \mu \left[-R + W_T \right],$$

so that the first-order necessary and sufficient conditions are

$$s\text{:} \qquad \frac{1-2s}{c} + \lambda \cdot \frac{s}{c} = 0, \tag{i}$$

$$R\text{:} \qquad 1 - \lambda - \mu = 0, \tag{ii}$$

$$\lambda\text{:} \qquad \lambda \left[\frac{s^2}{2c} - R - w \right] = 0,\ \lambda \geq 0,\ \frac{s^2}{2c} - R - w \geq 0, \tag{iii}$$

$$\mu\text{:} \qquad \mu \left[-R + W_T \right] = 0,\ \mu \geq 0,\ -R + W_T \geq 0. \tag{iv}$$

- **Case I: Neither constraint binds:**
  - Then $\lambda = 0$, and $\mu = 0$; but this contradicts (ii).

  $\Rightarrow$ This case cannot arise in a solution to the contracting problem.

- **Case II: PC binds, LLC does not bind:**
  - Then $\mu = 0$, so that (ii) $\Rightarrow \lambda = 1$, and hence (i) $\Rightarrow s = 1$.
  - PC binds $\Rightarrow R = \dfrac{1}{2c} - w$.
  - LLC does not bind $\Rightarrow W_T > R, \Rightarrow W_T > \dfrac{1}{2c} - w$.
  - **Conclusion:** When $W_T > \dfrac{1}{2c} - w$, $\left(s^* = 1, \text{ and } R^* = \dfrac{1}{2c} - w\right)$ solves the contracting problem.

- **Case III: LLC binds, PC does not bind:**
  - Then $\lambda = 0$, so that (ii) $\Rightarrow \mu = 1$, and (i) $\Rightarrow s = \frac{1}{2}$.
  - LLC binds $\Rightarrow R = W_T$.
  - PC does not bind $\Rightarrow W_T < \frac{1}{8c} - w$.
  - **Conclusion:** When $W_T < \frac{1}{8c} - w$, $\left(s^* = \frac{1}{2},\ \text{and } R^* = W_T\right)$ solves the contracting problem.

- **Case IV: Both PC and LLC bind:**
  - LLC binds $\Rightarrow R = W_T$.
  - Then PC binds $\Rightarrow s = \sqrt{2c\,(w + W_T)}$.
  - (i) $\Rightarrow \lambda = 2 - \dfrac{1}{s}$.
    - Then $\lambda \geq 0 \Rightarrow s \geq \dfrac{1}{2}$

$$\Rightarrow \sqrt{2c\,(w + W_T)} \geq \frac{1}{2} \Rightarrow W_T \geq \frac{1}{8c} - w.$$

  - Since $\mu \geq 0$, (ii) $\Rightarrow \lambda \leq 1, \Rightarrow s \leq 1$

$$\Rightarrow \sqrt{2c\,(w + W_T)} \leq 1 \Rightarrow W_T \leq \frac{1}{2c} - w.$$

- **Conclusion:** When $\dfrac{1}{8c} - w \leq W_T \leq \dfrac{1}{2c} - w$, $\left(\dfrac{1}{2} \leq s^* = \sqrt{2c\,(w + W_T)} \leq 1,\right.$ and $\left.R^* = W_T\right)$ solves the contracting problem.

- When the tenant is wealthy enough ($W_T > \frac{1}{2c} - w$) that the LLC does not bind, then from the 'risk sharing versus incentive provision' model we know that
  - $s^* = 1$ and, from the binding PC, $R^* = \frac{1}{2c} - w$.

- When W_T is just below $\frac{1}{2c} - w$, then the landlord would want to maintain $s = 1$ and keep R equal to $\frac{1}{2c} - w$,
  - but this is not feasible any more, the LLC starts binding.
    - One option is to keep $s = 1$ (so that effort remains at the efficient level), and allow the PC not to bind.
    - The other option is to reduce s and secure some of the rents the tenant is earning (if PC does not bind, the tenant earns rents by definition) at the cost of reducing effort.
    - It turns out that the second option is more profitable to the landlord.

- Thus we see a *sharecropping* contract even when both parties are risk-neutral.
  - It arises from the fact that because of limited liability the maximum amount that the tenant will be able to pay to the landlord as a fixed fee is just W_T
    - which may be small so that it might not be possible for the principal to squeeze as much as possible out of the tenant.

- Can this process continue as W_T becomes smaller and smaller?
  - The answer is no.
    - If $W_T < \dfrac{1}{8c} - w$, then the landlord sets $s^* = \dfrac{1}{2}$ and would not bother reducing the tenant's payoff down to the reservation level as the cost in terms of incentives would be too much.

• We can summarize the solution to the contracting problem as follows:

W_T	s^*	R^*	U_L
$W_T < \frac{1}{8c} - w$	$\frac{1}{2}$	W_T	$U_L < \frac{3}{8c} - w$
$W_T = \frac{1}{8c} - w$	$\frac{1}{2}$	W_T	$\frac{3}{8c} - w$
$\frac{1}{8c} - w < W_T < \frac{1}{2c} - w$	$\frac{1}{2} \leq \sqrt{2c\,(w + W_T)} \leq 1$	W_T	$\frac{3}{8c} - w < U_L < \frac{1}{2c} - w$
$W_T \geq \frac{1}{2c} - w$	1	$\frac{1}{2c} - w$	$\frac{1}{2c} - w$

• As the tenant's wealth increases ($W_T \uparrow$),

– tenant's cropshare increases ($s^* \uparrow$), & landlord's expected utility increases ($U_L \uparrow$).

• This implies a **tenancy ladder**: richer tenants are preferred by the landlord and are given higher crop shares.

- Observation 1:
  - Share contracts and fixed-rent contracts could coexist, but not pure wage contracts.
    - The contractual form would depend on the tenant's reservation payoff (w), his wealth level (W_T), and the marginal cost of effort (c).
- Observation 2:
  - The effort level e^* would, in general, be different from the surplus maximizing level, $\frac{1}{c}$.
    - The difference, which can be called 'agency costs' associated with sharecropping tenancy, is $(1 - s^*)\,\frac{1}{c}$.
  - Sharecropping is less efficient than fixed-rental tenancy which is the optimal contract only when the tenant's wealth exceeds $\frac{1}{2c} - w$.

- Observation 3:
  - As uncertainty goes up ($\sigma^2 \uparrow$), nothing changes as, by assumption, both parties are risk-neutral.
- Observation 4:
  - An increase in the productivity of labour ($c \downarrow$) will, in general, decrease the tenant's cropshare and increase his effort level.
    - The fixed-rent component would go up for the richest tenants for whom the LLC was not binding.
- Observation 5:
  - As the wage rate w goes up, the cropshare and effort goes up and the fixed-rent remains unchanged if the LLC is binding.
    - Otherwise it affects nothing.

2.5 Discussion

- In the model with limited liability, fixed rent tenancy is associated with highest productivity, but it is not in the landlord's interest to choose.
  - Tension between rent extraction and incentive provision because of the presence of moral hazard and limited liability.
  - Policy implications: *land reform* or *tenancy reform* can improve productivity even without any technological change.
- In the model with risk sharing vs. incentive provision also sharecropped plots of land would be less productive than those under fixed rental tenancy.
  - If due to land or tenancy reform the landlord is eliminated from the scene, productivity will go up. However, note that
    - If the landlord is eliminated the tenant's welfare will in fact go down since he is effectively buying insurance from the landlord and so if given the opportunity, would want to continue to buy insurance from the landlord or someone else.

- More general point: sometimes people loosely say sharecropping is inefficient.
  - Economists interpret efficiency in the Pareto sense: something is inefficient if someone could be made better off without making the other person worse off.
  - In both the models we saw, sharecropping emerges when we maximize the landlord's expected payoff subject to providing the tenant with a given level of payoff.
    - But then, by construction, they are Pareto-efficient.
  - However, because of incentive problems due to lack of perfect monitoring, the allocation is *constrained Pareto-efficient*.
  - Still, no policy maker can make one party better off without making the other worse off.

2.6 Other Theoretical Issues

- **Dynamic Issues:**
  - It is possible to improve efficiency using dynamic contracting.
  - One simple argument (see Banerjee, Gertler and Ghatak, 2002) is an efficiency-wage like argument.
    - If the tenant's reservation payoff is very low, he earns rents.
    - That means firing threats if output is low can be added as an incentive device.

- **Investment Incentives:**
  - Suppose investment is contractible; for example, something like an irrigation equipment.
    - To the extent it is complementary with effort level, it will be under-supplied because effort is undersupplied.
  - Suppose investment is non-contractible (say, care and maintenance of land).
    - Then we get an additional argument in favour of sharecropping: under fixed rent, tenant will over-exploit the land.
    - Also, now eviction threats can harm investment incentives by raising the tenant's effective discount rate.

- **Alternative Models of Agricultural Organization:**
  - Pure risk sharing: both landlord and tenant are risk averse, but there is no moral hazard (Cheung, 1969).
    - No direct implication for productivity under sharecropping but other predictions are similar to the risk sharing vs. incentive provision model.
  - Partnership or double moral hazard: both landlord and tenant provide unobservable inputs and sharecropping gives both parties incentives as opposed to just one (Eswaran and Kotwal, 1985).

3. Land Rental Contracts: Evidence

Two Key Empirical Questions:

- How much does contractual structure affect productivity?
  - For example, if we see sharecropping instead of owner cultivation or fixed-rent contract, how much of output is potentially lost due to the agency problems?

- What drives contractual choice? Is it the need to share risk, or to give incentives? Which form of transactions costs drives this?
  - For example, is it true that riskier crops are associated with sharecropping, or that wealthier tenants receive a higher crop share?

Some Empirical Issues:

- "Productivity in plot A owned by landlord 1, cultivated by tenant 1 under a fixed rent contract is higher than that of plot B owned by landlord 2, cultivated by tenant 2 under a sharecropping contract" tells us little about the productivity loss associated with sharecropping.
  - If we make a comparison such as above, unobserved heterogeneity is important.
    - Need to control for type of farmer (better farmers may choose fixed rent contracts and worse farmers sharecropping).
    - Need to control for land quality – better quality plots are likely to be owner-cultivated.
  - Endogenous matching of landlord and tenant:
    - More risk averse tenants are likely to match with landlords whose plots are good for safe crops.
      - Then share of tenant will be found to be increasing in the riskiness of the crop; seemingly contradicts the risk-sharing vs. incentives model.

3.1 Contractual Structure and Productivity: Shaban (1987)

- Shaban's (1987) study, using ICRISAT data, is one of the most careful contribution in this area.
  - It is not enough to simply check whether there are differences in yield per acre across sharecropped land and other forms of land use.
    - We must carefully control for several other factors that systematically vary with the form of tenancy (and not just the application of labour or other non-monitored inputs).
  - Shaban's study goes a long way toward handling these serious difficulties.
- The main idea (which handles quite a lot of otherwise uncontrollable variations) is to study the productivity of the *same household* that owns some land and sharecrops other land.
  - The ICRISAT data is full of such 'mixed' families.

- At one stroke, this insight permits the researcher to control for all sorts of family-related characteristics that vary systematically across owned and sharecropped land.
  - Families that own land may have better access to working capital than families that sharecrop, in which case the productivity on owned land may be higher.
    - However, this cannot be attributed to inefficiency of sharecropping.
  - A poor sharecropper may have few alternative uses for his labour and thus may farm the land more intensively despite the disincentive effect of sharecropping.
    - Then productivity will not be too different across owned or sharecropped land.
      - But this does not rule out the possibility that the inefficiency is still there.
  - Land quality may vary systematically across tenanted and untenanted land.
    - Shaban (1987) included plot values as well as dummy variables for irrigation and other measures of soil quality in the regression.
- After all these variables are controlled for, the only remaining differences are expected to stem from the form of the tenancy contract.

Data:

- Study of 8 Indian villages from the ICRISAT dataset.
- From each village 40 households are selected over several years (30 cultivating and 10 labour households).
- Cropwise information on
  - inputs: family male/female labour, hired male/female labour, bullock pair labour, seed, fertilizer, other inputs (value of pesticide, manure, cost of fuel for irrigation equipment);
  - output;
  - plot characteristics: irrigated area, plot value, shallow/medium and deep/poor/other soil.

- He does not have data on contracts.
  - Notes that contracts are the same within the village but vary across villages.
  - In all villages landlord provides land only and tenant provides all bullock and family labour.
  - In all villages output is shared equally.
  - In some villages, cost of all other inputs is borne fully by tenant; in some villages, it is shared equally; in some villages costs of some items are shared (fertilizer, seed, hired labour) and not others.
- Tenancy is not that widespread: more than 75% of households are owner-cultivators; about 15% of them are mixed sharecroppers-owner cultivators.

Econometric Specification:

- For simplicity assume each household has one sharecropped plot and one owner-operated plot.
  - In practice they could have several of each, and Shaban takes a weighted average with the weights reflecting relative plot size.
  - Also, assume that the data are for one year only. In practice it is for several years, and Shaban averages this.
- For the **sharecropped** plot the specification for the variable x of interest (input intensity or productivity) is

$$x_h^s = \alpha_h + \sum_j \beta_j D_{hj}^s + \gamma_s E_h + \eta_h$$

  - α_h is household specific intercept and E_h is a village dummy;
  - D_{hj}^s capture various land quality measures relating to the *sharecropped* plot such as plot value, soil quality, irrigation status;
  - η_h is the error term.

- If data were for one period only, having both a village and a household intercept would be superfluous.
  - Shaban puts in both since he observes the same household over time and this allows him to control for the average (over time) productivity of a household as well as village fixed effects.
- For the **owner-operated** plot the specification for the variable x of interest (input intensity or productivity) is

$$x_h^o = \alpha_h + \sum_j \beta_j D_{hj}^o + \gamma_o E_h + \varepsilon_h$$

  - α_h is household specific intercept and E_h is a village dummy;
  - D_{hj}^o capture various land quality measures relating to the *owner-operated* plot such as plot value, soil quality, irrigation status;
  - ε_h is the error term.

- Taking differences,

$$x_h^o - x_h^s = \sum_j \beta_j \left(D_{hj}^o - D_{hj}^s\right) + \theta E_h + \nu_h.$$

  – The common household specific term is taken out.

  – Coefficient $\theta \equiv \gamma_o - \gamma_s$ captures the degree to which average productivity differences between sharecropped and owned plots differ between villages.

    ◦ Contracts vary across villages but not within. Also they are fixed over time. Therefore, θ is picking up this contract specific effect.

      - Ideally we would want plot-wise contract information here.

- This final equation provides a convenient decomposition of the different sources of the mean difference in input and output intensities on owned and sharecropped land:

  – irrigation status, plot value, soil quality, and sharecropping.

$\Rightarrow$ With land quality (plot value, irrigation and soil quality) held constant, village dummies capture the pure effect of sharecropping.

Results:

1. First, the sample is restricted to owned and sharecropped plots of 352 households who are mixed sharecroppers.

- Output and input intensities per acre are higher on the owned plots of a mixed sharecropper compared with the sharecropped plots.
  - Average differences: 32.6% for output; between 19 and 55% for the major inputs.
- Differences in irrigation across tenure status are important in explaining a large fraction (40%) of the input and output differences; but certainly not all.
  - Controlling for irrigation, plot value, and soil quality, the average differences between owned and sharecropped plots are higher by 16.3% for output, 20.8% for family male labour, 46.7% for family female labour, and 16.6% for bullock labour.

2. Mixed sharecropper for single crop (sorghum) – 76 households.

- One problem with the previous analysis is that it does not control for the type of the crop.
  - Mixed tenants could be growing different crops in plots that also vary in tenure status.
- Runs the same regression with respect to a single crop (sorghum).
  - Again the vector of mean differences is significantly positive except for hired female labour.
  - The decomposition of the intensity differences shows that controlling for irrigation, plot value, and soil quality, output per acre is higher on the owned land relative to the sharecropped land by 27.6%.
    - The percentage difference is 31.8% for family male labour, 32.8% for family female labour, and 16.6% for bullock labour.

3. Mixed fixed rent tenants – 90 households.

- One could argue that the previous results are not due to sharecropping per se, but tenancy in general.
  - In particular, given tenancy legislation all contracts are short-term and these could lead to lower investment and due to complementarity, lower input-intensity.
- To test this Shaban takes owner cum fixed rent tenants only.
- The results show that mean differences are not significantly different from zero and the effect of tenancy is not significantly different from zero in seven out of eight inputs and output.

3.2 Contractual Structure and Productivity: Braido (2008)

- Braido (2008) challenges the conventional wisdom that share contracts reduce incentives for optimal production decisions.
- Braido (2008) raises question of possible unobserved variations in soil type in the ICRISAT data between sharecropped plots and others: maybe sharecropped plots are of inferior quality (observable by farmers but not by external investigators).
  - Then farmers will apply less inputs and effort on sharecropped plots.
- Contracts are endogenous, and owner-operated lands are typically better.
  - Therefore, regressions comparing output and input use across land contracts tend to overestimate the impact of ownership.
  - Braido (2008) presents robust evidence that the productivity disadvantage of sharecropping is strongly related to this land quality selection problem.

- Braido (2008) uses the same ICRISAT dataset used by Shaban (1987).
- First he replicates the findings of Shaban (1987) that sharecropped plots are less productive and employ inputs less intensively than owner-operated plots.
  - Regressions (in Table 3 of the paper) show that owner-operated fields are around 40% more productive than those under sharecropping and fixed rent.
  - Owned plots are also 17% more valuable and use about 40% more of nonlabour and labour inputs than leased plots.
  - Productivity, land value, and input use are not statistically different across plots leased under fixed rent and sharecropping.
- Next he models the log output (expressed in monetary units per acre) as a function of dummy variables for each land contract and other control variables, namely,
  - land and cropping characteristics (e.g., land value, irrigation, soil type, main crop, year, and season) and household-period fixed effects (account for unobserved characteristics of the household in each particular period – year and season).

- Table 4 summarizes the regression results.
  - The regressions define sharecropping to be the omitted dummy (that is, the baseline category for comparison).
- The regression in column 1 does not control for land characteristics and type of crop grown, while the regression in column 2 does.
  - Land value, irrigation, soil type, and main crop account for about half of the productivity advantage of owned lands.
  - Similar to the results of Shaban, the owned plots of each given household are approximately 23% more productive than their sharecropped fields, after controlling for land characteristics.
  - Lands under fixed rent are *not* significantly more productive than lands under sharecropping, which contradicts the distorted-incentive prediction.

Table 4

Land Productivity, by Log Per-Acre Output

	(1)	(2)	(3)	(4)	(5)
Ownership dummy	.47**	.23**	.07+	−.01	−.01
Robust t-statistic	4.83	4.01	1.77	−.46	−.45
Robust standard error	.10	.06	.04	.03	.03
Fixed-rent dummy	.12	.03	−.04	−.07	−.07
Robust t-statistic	.95	.27	−.55	−1.10	−1.10
Robust standard error	.12	.10	.07	.06	.06
Log per-acre nonlabor input			.61*		−.01
Log per-acre labor input				1.03**	1.05**
Log per-acre land value		.43**	.27**	.19**	.19**
Dummies for irrigation, soil type, and main crop	No	Yes	Yes	Yes	Yes
N	10,704	10,702	10,688	10,702	10,688

Note. Results are for ordinary least squares regressions. The cluster method is used to compute robust t-statistics and standard errors; this accounts for the fact that the household, rather than the plot, is the primary sampling unit. All regressions include a constant term and 2,773 dummy variables generated through the iteration of codes identifying the household and the period (year and season).

+ Significant at the 10% level.

* Significant at the 5% level.

** Significant at the 1% level.

- Regressions in columns 3–5 introduce nonlabor and labor inputs as control variables.
  - Conditional on input use, the productivity advantage of owned lands becomes statistically nonsignificant at the 5 percent level, which indicates that owned lands are more productive because they use inputs more intensively.
- The key messages from these regressions are the following.
  - Since land quality is heterogeneous across farms under different contracts, one must be careful when interpreting differences in farm productivity as evidence of incentive problems.
    - Land quality is not perfectly measured by variables such as land value, irrigation, and soil type.
      - Therefore, regressing farm productivity on contract dummies – as in columns 1 and 2 – generates upward-biased estimates for the coefficient of the contract form associated with the better lands (in this case, ownership).
  - The productivity disadvantage of share contracts is fully explained by observed inputs, which does not support the existence of hidden actions (that is, actions that affect productivity and cannot be inferred from observed variables).

- The above regressions indicate that one must understand the input choices better, since they are strongly related to the productivity difference across land contracts.
  - Owner-operated farms use nonlabour and labour inputs more intensively, and this explains the productivity advantage of the ownership contract over sharecropping and fixed rent (Table 4).
    - Braido (2008) develops a structural model to test the efficiency of input allocation across farms under different contracts.
- Define Y_i as the amount of output produced in plot i, and assume that

$$Y_i = A_i K_i^{\alpha_k} L_i^{\alpha_l} T_i^{(1-\alpha_k-\alpha_l)} \exp(\varepsilon_i);$$

  - K_i and L_i represent the amount of nonlabour and labour input used;
  - T_i is the cropped area;
  - A_i is a technological factor;
  - ε_i is an unobserved random term.

- Consider the problem of a landlord who chooses the amount of labour and nonlabour inputs to be used in each plot.

- The efficient level of each input must solve

$$\max_{\{K_i,L_i\}} \bar{p}_i E\left[A_i K_i^{\alpha_k} L_i^{\alpha_l} T_i^{(1-\alpha_k-\alpha_l)} \exp\left(\varepsilon_i\right)\right] - \bar{r}_i K_i - \bar{w}_i L_i,$$

  where $(\bar{p}_i, \bar{r}_i, \bar{w}_i)$ is the vector of expectd prices.

- The necessary and sufficient first-order conditions for this maximization problem are

$$\bar{p}_i \alpha_k E\left[A_i K_i^{\alpha_k-1} L_i^{\alpha_l} T_i^{(1-\alpha_k-\alpha_l)} \exp\left(\varepsilon_i\right)\right] = \bar{r}_i,$$

  and

$$\bar{p}_i \alpha_l E\left[A_i K_i^{\alpha_k} L_i^{\alpha_l-1} T_i^{(1-\alpha_k-\alpha_l)} \exp\left(\varepsilon_i\right)\right] = \bar{w}_i.$$

  – These conditions equalize the expected marginal revenue of each input to its expected marginal cost.

- These conditions are equivalent to

$$\frac{\bar{r}_i K_i}{\bar{p}_i E\left(Y_i\right)} = \alpha_k, \text{ and } \frac{\bar{w}_i L_i}{\bar{p}_i E\left(Y_i\right)} = \alpha_l.$$

  – If inputs were chosen efficiently, these first-order conditions should be satisfied for all plots.

    ◦ Regardless of differences in land quality and farmer ability, inputs should be used up to the point at which the expected marginal revenue equals the expected marginal cost.

    ◦ Then the inverse average productivities $\frac{\bar{r}_i K_i}{\bar{p}_i E\left(Y_i\right)}$ and $\frac{\bar{w}_i L_i}{\bar{p}_i E\left(Y_i\right)}$ should be constant across households and plots under different contracts.

- In the absence of monitoring, sharecropping tenants would choose inputs by equalizing their share of the expected marginal revenue (say, s_y) to their fraction of the expected marginal costs (say, s_k and s_l).

- Then the sharecropping first-order conditions are

$$\frac{\bar{r}_i K_i}{\bar{p}_i E\left(Y_i\right)} = \alpha_k \cdot \left(\frac{s_y}{s_k}\right), \text{ and } \frac{\bar{w}_i L_i}{\bar{p}_i E\left(Y_i\right)} = \alpha_l \cdot \left(\frac{s_y}{s_l}\right).$$

  – These conditions are distorted because $\frac{s_y}{s_k}$ and $\frac{s_y}{s_l}$ are typically smaller than one, since the landlords do not share the cost of many inputs (especially home-produced inputs, owned bullocks, and family labour).

- Therefore, the classical distortion attributed to sharecropping would imply lower levels for the inverse average productivities, namely,

$$\frac{\bar{r}_i K_i}{\bar{p}_i E\left(Y_i\right)} = \alpha_k \cdot \left(\frac{s_y}{s_k}\right) < \alpha_k, \text{ and } \frac{\bar{w}_i L_i}{\bar{p}_i E\left(Y_i\right)} = \alpha_l \cdot \left(\frac{s_y}{s_l}\right) < \alpha_l.$$

- Table 5 presents the regression results where sharecropping is the baseline contract.
  - The coefficients associated with the ownership dummy are negative in five of the six regressions and are always statistically insignificant.
  - Coefficients associated with the fixed-rent dummy are also statistically insignificant.
- Thus the empirical results do not reject the hypothesis that the expected marginal productivities are constant across farms under ownership, fixed rent, and sharecropping.
  - The input choices do not seem to be distorted by the contract form, which casts doubts on the importance of incentive problems associated with sharecropping.
- We can infer that Shaban's results were actually driven by variations in soil quality observed by farmers before planting, but unobserved by the ICRISAT investigators.

Table 5

Econometric Test for the Profit-Maximization Conditions

	Log Nonlabor Input − Log Output (N = 10,690)			Log Labor Input − Log Output (N = 10,704)		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
Ownership dummy	−.05	−.05	.03	−.05	−.03	−.03
Robust t-statistic	−1.20	−1.16	.63	−1.16	−.68	−.93
Robust standard error	.05	.04	.04	.04	.04	.04
Fixed-rent dummy	.23	.24+	.09	.15	.18	.06
Robust t-statistic	1.54	1.72	1.19	1.19	1.49	.96
Robust standard error	.15	.14	.07	.12	.12	.07
Main crop dummies	No	Yes	Yes	No	Yes	Yes
Household-period fixed effects	No	No	Yes	No	No	Yes
Constant	−.87**	Yes	Yes	−1.36**	Yes	Yes

3.3 Contract Choice: Ackerberg and Botticini (2002)

- Empirical work on contracts typically regresses contract choice on observed principal and agent characteristics. If
  - some of these characteristics are unobserved or partially observed, and
  - there are incentives whereby particular types of agents end up contracting with particular types of principals, then
    - estimated coefficients on the observed characteristics may be misleading.
- Ackerberg and Botticini (2002) address this **endogenous matching** problem using a data set on agricultural contracts between landlords and tenants in early Renaissance Tuscany.
- Controlling for endogenous matching has an impact on parameters of interest, and **tenants' risk aversion** appears to have influenced contract choice.

- Much of the empirical literature on contract choice, often in an agrarian or franchising context, has focused on testing two possible determinants of contract choice:
  - risk-sharing and incentive provision, and
  - enforcement costs and transaction-specific assets.
- Interestingly, there seems to be little empirical support of risk sharing as an important determinant of contract choice in either franchising or agriculture.
  - Allen and Lueck (1995, p. 447) state that “accumulated evidence confronting risk sharing and transaction costs – covering such topics as franchising, gold mining, sharecropping, and timber – actually favours the transaction cost framework.”
- Other empirical works have found support for moral hazard, capital constraints, and multitasking issues as important determinants of contractual arrangements.

- There is a potential problem with much of the empirical literature mentioned above that deserves attention.
  - Many potentially relevant characteristics may be unobserved, partially observed, or observed with error by an econometrician.
    - The implications of this observability problem do not seem to have been fully realized.
- Ackerberg and Botticini (2002) argue that if principals and the agents they contract with are “matched” with each other according to economic variables (and they argue that there are incentives for such **endogenous matching**), then
  - this observability problem is important and casts doubts on estimated coefficients in regressions of contract choice on observed characteristics.
- They suggest techniques for ameliorating these problems and show that these techniques influence estimates in a data set on agrarian contracts.

- To exemplify incentives for endogenous matching and its implications, consider Allen and Lueck (1992), which examines whether the inherent riskiness of a crop affects the type of contract used for that crop.
  - Their hypothesis is that if risk effects are an important determinant of contract choice, then very risky crops will be more likely to be associated with share contracts than with fixed-rent contracts.
  - Empirically, they do not find this correlation and conclude that risk sharing is not an important determinant of contract choice.
- Consider an alternative explanation of this empirical result in which risk sharing is in fact important.
  - Suppose that half the potential tenants in the economy are risk-neutral and the other half are risk-averse. Similarly, half the crops are very risky and half are somewhat less risky.
  - "Endogenous matching" implies that the risk-averse tenants would be attracted to the less risky crops, and the risk-neutral ones to the risky crops.

- Then the risky crops would be associated with fixed-rent contracts (because the tenants are risk-neutral, the optimal contract is fixed-rent), whereas the less risky crops, cultivated by risk-averse tenants, would be associated with share contracts.
- This example gives an empirical implication *exactly the reverse* of that argued by Allen and Lueck: fixed rent contracts are found on the risky crops.
- The problem here is that while the “riskiness of crop” may be exogenous to the landlord who owns the land,
  - it is *endogenous*, through principal-agent matching, to the type of tenant attracted to it.

- If a tenant's risk aversion were perfectly observed by the econometrician, the endogeneity problem would be solved by regressing contract choice on crop riskiness and risk aversion.
- However, economists rarely profess to exactly observe a tenant's risk aversion.
  - Rather, they use a proxy or proxies for risk aversion such as wealth or property.
- Ackerberg and Botticini (2002) show that using proxies for risk aversion in such regressions does not solve the endogenous matching problem.
  - With endogenous matching, the "crop variability" variable will still be correlated with the error term through the proxy error, that is, the unobserved component of risk aversion.

- This article addresses this problem and suggests potential solutions.
- These solutions involve consideration of a "matching equation" that describes how principals and agents are matched with one another.
  - What we require is instruments that affect the matching equation but do not affect the contractual choice or proxy equations.
  - Ackerberg and Botticini (2002) suggest and apply the use of geographical-based instruments that can affect the matching equation through, for example, differences in the exogenous distribution of land type across regions.

Identification:

- Consider a standard moral hazard model in which a principal and an agent are contracting over a task to be done.
- Suppose that theory gives us a contract choice equation describing the second-best contract y as a function of the characteristics of the principal/task (p) and agent (a):

$$y = \beta_0 + \beta_1 p + \beta_2 a + \epsilon. \tag{1}$$

  – Examples of p might be the inherent riskiness of the principal's crop or franchise, monitoring ability, risk aversion, or transactions costs.

  – a might measure the agent's risk aversion, productivity, or opportunity cost of effort.

  – y might indicate the share of output or revenue paid to the agent (e.g., royalty rate) or the discrete type of contract used (e.g., wage, share, or fixed-rent).

  – ϵ is measurement error in y, uncorrelated with p and a.

- In empirical work, characteristics in p or a are seldom perfectly observed.
  - For example, an econometrician does not perfectly observe an agent's risk aversion.
- There are often proxies available for these variables (e.g., observed wealth may proxy for unobserved risk aversion).
- Past empirical works have proceeded by substituting these proxies into equation (1) for the true variables and using standard estimation techniques (e.g., OLS).
- Ackerberg and Botticini (2002) argue that such a procedure is problematic when there is "matching" of heterogeneous principal and agents in a microeconomy, that is,
  - when there are incentives for certain types of agents to match (contract) with certain types of principals.

- Consider the case in which p and a are scalars and p is perfectly observed by the econometrician.
  - The agent characteristic a is not fully observed, but one observes a proxy w for it.
  - Suppose the proxy relationship is $a = \theta w + \eta$, with η mean independent of w.
- Substituting this into the contract choice equation gives us

$$y = \beta_0 + \beta_1 p + \beta_2 \theta w + \beta_2 \eta + \epsilon. \tag{2}$$

  - Goal of the empirical exercise is to estimate the coefficient β_1 and the product $\beta_2\theta$.
- Suppose that principals and agents match according to the following linear matching equation:

$$p = \gamma_0 + \gamma_1 a + \nu = \gamma_0 + \gamma_1 \theta w + \gamma_1 \eta + \nu, \tag{3}$$

  - ν is “matching error” (caused, for example, by frictions in a search process).
  - Note that without ν, estimating β_1 and $\beta_2\theta$ would be hopeless since p and w would be collinear.

- Given this matching, it is clear that simple OLS estimation of equation (2) is problematic.
  - Because of matching, the principal's characteristic p will typically be correlated with the unobserved component of the agent's characteristic, η.
  - As a result, p will be correlated with the econometric error term ($\beta_2\eta + \epsilon$) in (2).
  - This both directly biases the estimate of β_1 and indirectly biases the estimate of $\beta_2\theta$ (since the matching equation implies that p and w are correlated).

Data:

- They have data on 902 plots owned by 128 landlords from three towns in Tuscany based on census and property survey archives of the 15th century.

- The data is on the nature of contracts (share and fixed rent), the crop type (vines, cereals, and mixed), and tenant wealth.

- The distinction between cereals and vines is relevant for both the risk-sharing hypothesis and the multitasking model.
  - While cereals were subject to weather variability, vines were much more sensitive.
    - As such, all else equal, one might expect vines more likely to be associated with share contracts than with fixed-rent contracts.
  - Vines had interesting multitasking features.
    - A tenant's effort could be devoted to maximizing current production or to maintaining and improving the assets for future production.

- ○ Peasant tenants could boost current production by pruning in a certain way or putting manure near the roots.
  - \- However, this could damage the vines and result in less output in subsequent years.
- ○ Thus owners of land plots with vines might be hesitant to sign contracts with strong incentives for current production (i.e., fixed-rent contracts).

- Both the multitasking and risk-sharing effects of vines suggest similar outcomes:
  - – fixed-rent contracts should be less likely with vines.
- As including the crop type alone is not a conclusive test of the risk-sharing hypothesis, we also consider the tenant's wealth as a potential proxy for his risk aversion.
  - – If risk aversion is an important determinant of contract form and wealth is a valid proxy for risk aversion,
    - ○ wealthier tenants should be more likely to engage in fixed-rent contracts.

Summary Statistics:

- The four cross tabulations in Table 2 illustrate three interesting correlations.
  - Land plots with vines (and other perennial crops) appear to be associated with share contracts, whereas land plots with cereals (and other annual crops) were most often leased out under fixed-rent contracts.
  - As one looks across contracts for a given crop type, the mean tenant's wealth is higher under fixed-rent contracts than under share contracts.
  - Poorer tenants primarily cultivated land plots with vines only or farms with vines and cereals, whereas wealthier tenants mainly cultivated plots with cereals only.
    - This last correlation is suggestive of matching between landlords and tenants:
      - tenants with certain characteristics appear to be matched with specific crops.

- The distribution of land types was very different across towns.
  - In Pescia, 75% of land plots had cereals only, very few had both cereals and vines, and the rest (20%) were plots with vines only.
  - In San Gimignano, 85% of land plots had both cereals and vines, 10% had cereals only, and 5% had vines only.
  - Florence was somewhat in between, with 55% of the plots containing mixed crops, 38% only, and 8% vines only.
- These differences in land distributions give exogenous variation in crop type that can help control for endogenous matching.

Empirical Results: Naive Contract Choice Equations

- Their first econometric take on the data is to estimate simple contract choice equations, ignoring the possibility of matching and subsequent endogeneity problems.

- Column 1 of Table 3 presents results of a linear probability regression of contract choice ($0 =$ share, $1 =$ fixed rent) on town dummies, tenant's wealth, and crop (0 if cereals, 0.5 if mixed, and 1 if vines).
  - The results confirm the casual evidence of Table 2:
    - moving from cereals to mixed crops to vines appears to decrease the probability of fixed-rent contracts, whereas increases in tenants' wealth raise the likelihood of fixed-rent contracts.

- These results are consistent across various specifications: linear probability, probit and fixed effects models.

- The negative coefficient on crop might either
  - suggest that vines were riskier and more likely to be leased under share contracts
  - support a multitasking argument that landlords were hesitant to use incentive-laden contracts on perennial crops.
- If wealth is a good proxy for risk aversion, the positive coefficient would seem to lend some support to the risk-sharing hypothesis.

Empirical Results: Matching Equations

- Now consider the possibility of endogenous principal-agent matching.
  - Here particular concern arises from the realization that tenant's wealth is probably not a perfect proxy for tenant's risk aversion.
  - If tenants match with landlords on the basis of an unobserved component of risk aversion, the coefficients in Table 3 on both crop and wealth will be biased.
- A first step toward assessing potential matching problems is to examine correlations between observable principal and agent characteristics.
- Column 1 of Table 4 addresses this question by regressing crop on town dummies and tenant's wealth.
  - The results confirm the correlations in Table 2 in that they show a very strong, significant, negative relation between the two variables.
    - It is the less wealthy tenants that appear to end up with vines.

- At the very least, this regression suggests that there is matching between principals and agents, although it does not tell us why there is such matching.
  - On the one hand, if risk effects were very important and vines were considerably riskier than cereals, one might expect the reverse relationship, that is, less risk-averse tenants ending up on riskier crops.
  - On the other hand, a multitasking story (with little or no difference in the riskiness of crops) might suggest that more risk-averse tenants end up with vines.
    - The intuition is that, all else equal, both landlords owning vines and very risk-averse tenants relatively prefer share contracts.

Empirical Results: Linear Instrumental Variable Models

- Ackerberg and Botticini (2002) use instruments that affect the matching equation that describes how tenants are matched with crops but do not affect the contractual choice equations.
  - The three towns differ in terms of the importance of crop type.
    - If the effect of risk aversion on contracts and the effect of wealth on tenant's risk aversion are similar across these towns, then using town dummies as instruments for vines provides "exogenous" variation in crop type.
    - Exogenous supply side variation in land suitable for different types of crops puts similar tenants (in terms of risk aversion) on different types of land just because they happened to be in a given area (assumption: there is little migration).
  - Hence the effect of crop is identified correctly.

- A comparison of the instrumental variable results in Table 4 to the corresponding OLS results in Table 3 shows a number of differences.
  - In all cases the crop coefficient becomes smaller and considerably less significant.
  - Similarly, in all cases the wealth coefficient increases in magnitude.
- This suggests that the OLS estimates overestimate the effect of crop and underestimate the effect of wealth, in both value and statistical significance.
- Hence we can conclude that both risk-sharing and multi-tasking are important considerations for choice of sharecropping.

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