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# On the Existence of Sharecropping

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# *Abstract*

*When tenancy contracts are subject to ex-post limited liability, it is optimal for the landlord to offer the tenant the entire crop share since full incentive leads to higher production even in the bad state of the nature, which can be appropriated in the form of fixed rental payments. We show, in a simple model of incentive contracts where the tenant carries out multiple tasks, that effort substitution effect helps explain share tenancy even if there is limited liability in the ex-post sense.*

# *Resumen*

*Hasta hace tiempo se creía que los contratos de arrendamiento óptimos sujetos a restricción de liquidez ex-post serían sólo de renta fija porque para el terrateniente es óptimo ofrecerle al arrendatario todo el incentivo (toda la cosecha) para que haga esfuerzo alto y que lo lleve a alta producción incluso en el peor estado de la naturaleza. Sin embargo, este documento demuestra, con un modelo de riesgo moral donde el arrendatario realiza múltiples tareas, que el efecto de sustitución de esfuerzo ayuda a explicar renta compartida incluso con restricción de liquidez ex-post.*

# On the existence of sharecropping[☆]

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## Abstract

When tenancy contracts are subject to ex-post limited liability, it is optimal for the landlord to offer the tenant the entire crop share since full incentive leads to higher production even in the bad state of the nature, which can be appropriated in the form of fixed rental payments. We show, in a simple model of incentive contracts where the tenant carries out multiple tasks, that effort substitution effect helps explain share tenancy even if there is limited liability in the ex-post sense.

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## 1. Introduction

For more than a century, sharecropping has been one of the popular contractual arrangements in agrarian economies.[1] Since the seminal work of Cheung (1969), many attempts have been made to explain the existence of this widely prevalent institution. Sharecropping may emerge from pure risk-sharing motives (e.g. Stiglitz, 1974; Newbery, 1977), or the presence of moral hazard and limited liability (e.g. Eswaran and Kotwal, 1985; Shetty, 1988; Basu, 1992; Laffont and Matoussi, 1995; Sengupta, 1997; Ghatak and Pandey, 2000; Ray and Singh, 2001). Shetty's (1988) work was among one of the earlier works that stresses the role of the tenant's limited liability in explaining share tenancy. His contribution lies in recognizing the role of the tenant's ex-post limited liability constraint, i.e., when the tenant cannot meet his rental obligations when output realizations are sufficiently adverse. Ray and Singh (2001) later show that under ex-post limited liability, share tenancy does not appear as an optimal contractual structure. They introduce the notion of ex-ante limited liability – the rental payments to the landlord cannot exceed the tenant's initial wealth – which explains the existence of sharecropping.

The main objective of our paper is to show that sharecropping may emerge as an optimal tenancy contract even in the presence of limited liability in the ex-post sense. We analyze a stylized model of multitask moral hazard as in Hölmstrom and Milgrom (1991). The economy consists of one landlord and one tenant. The landlord owns two heterogeneous plots and the tenant is hired to work in both plots. The effort cost function of the tenant depends on the efforts exerted in both plots, and is in general not separable. We first show that when the efforts exerted in different plots are independent of each other, ex-post limited liability alone fails to explain the emergence of share tenancy. If the tenant is given the entire share of output in each plot, then it induces him to exert the highest incentive compatible efforts. Thus even for the realizations of adverse productivity shocks in both plots, the landlord can be paid back a higher rent, a result similar to the one obtained in Ray and Singh (2001). Then we show that when the tenant's cost function is not separable in efforts, i.e., there is the so-called *effort substitution* effect, then share tenancy emerges as an optimal contractual agreement. In particular, the landlord and the tenant share the crop produced in the plot in which the low realizations of output are less likely. The intuition behind such result is similar to multitask agency models. High incentive in one task dampens the incentive to exert high effort in the other since an additional unit of effort in one task increases the marginal effort cost in the other task.

There are two works close in spirit to the present one. Luporini and Parigi (1996) analyze a multitask agency model where the tenant grows a subsistence crop and a cash crop. Because of the spillovers between the two crops, sharecropping is unable to efficiently reallocate the labor input to take full advantage of the the external shocks. Ray (2005) consider a model of sharecropping in which the tenant undertakes two actions: labor input to grow crop and investment to maintain the land quality in the long run. Ray shows that a higher crop share for the tenant induces him to exert higher effort that immediately increases the output, but reduces his incentive to invest in land, and hence to optimally allocate effort in two tasks it is necessary to reduce the tenant's crop share. These authors use dynamic models where share tenancy is used as an instrument for the intertemporal allocation of effort between multiple tasks, while we use a static model of multitasking to explain the emergence of sharecropping.

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[1] See Ackerberg and Botticini (2000) for evidence of share tenancy in the fifteenth century Tuscany.

## 2. The Model

We consider a simple multitask agency model as in Hölmstrom and Milgrom (1991). The economy consists of two risk-neutral individuals: one landlord ($L$) and one tenant ($T$). The landlord has two plots of land which differ in quality. The production function of plot $i = 1, 2$ is given by $Q_i = \theta_i e_i$, where $\theta_i \in [\underline{\theta}_i, \overline{\theta}_i]$ with $0 < \underline{\theta}_i < \overline{\theta}_i$ represents the productivity of plot $i$, and $e_i$ is the labor input or effort required in plot $i$. Let the joint probability distribution of $\theta_1$ and $\theta_2$ be given by $F(\theta_1, \theta_2)$, and $F_1(\theta_1)$ and $F_2(\theta_2)$ be the respective marginal distributions. We assume that the true realizations of productivity are independent across plots, i.e, $F(\theta_1, \theta_2) = F_1(\theta_1)F_2(\theta_2)$. The tenant has no initial wealth,[2] and incurs cost of efforts which is given by:

$$\psi(e_1, e_2) = \frac{1}{2}\left(c_1 e_1^2 + c_2 e_2^2\right) + \delta e_1 e_2,$$

with $\psi_{ii} = c_i > 0$ for $i = 1, 2$, and $\psi_{12} = \delta \in [0, \sqrt{c_1 c_2})$, which represents the degree of *effort substitution*. If $\delta = 0$, then the efforts in different tasks are independent. Tenant's efforts $(e_1, e_2)$ are not verifiable, and hence there are potential moral hazard problems in effort choice. We normalize the tenant's outside option to 0.

A contract $\gamma = (\alpha_1, \alpha_2, R)$ specifies the tenant's share $\alpha_i$ of output from plot $i$ and the rental payment $R$ to be made to the landlord. We assume that a minimum production of $\hat{\theta} e_i$ for at least one $i$ is sufficient to cover the tenant's rental obligations. When $\alpha_i = 1$ for $i = 1, 2$ and $R > 0$, then the contract is a *pure rent* contract. On the other hand, share contract emerges when $\alpha_i < 1$ for at least one $i$. Given a contract $\gamma$, the expected payoffs of the landlord and the tenant are respectively given by:

$$\begin{aligned} E[U_L] = {} & [1 - F_1(\hat{\theta})](1 - \alpha_1)e_1 E[\theta_1 \mid \theta_1 \geq \hat{\theta}] + [1 - F_2(\hat{\theta})](1 - \alpha_2)e_2 E[\theta_2 \mid \theta_2 \geq \hat{\theta}] \\ & + F_1(\hat{\theta})e_1 E[\theta_1 \mid \theta_1 < \hat{\theta}] + F_2(\hat{\theta})e_2 E[\theta_2 \mid \theta_2 < \hat{\theta}] + [1 - F_1(\hat{\theta})F_2(\hat{\theta})]R, \end{aligned}$$

$$\begin{aligned} E[V_T] = {} & [1 - F_1(\hat{\theta})]\alpha_1 e_1 E[\theta_1 \mid \theta_1 \geq \hat{\theta}] + [1 - F_2(\hat{\theta})]\alpha_2 e_2 E[\theta_2 \mid \theta_2 \geq \hat{\theta}] - [1 - F_1(\hat{\theta})F_2(\hat{\theta})]R \\ & - \psi(e_1, e_2). \end{aligned}$$

The above expressions are derived in the Appendix, which take into account the (ex-post) limited liability constraint of the tenant. When both plots have realizations of the productivity parameter less than $\hat{\theta}$, the tenant is unable to meet his rental obligation, and the total output of the two plots plus his initial wealth are taken away by the landlord.

## 3. Optimality of share tenancy

Since efforts are not contractible, the landlord-tenant relationship faces an incentive compatibility constraint which implies that the efforts $(e_1, e_2)$ exerted in both plots must maximize the tenant's expected payoff $E[V_T]$, given a contract $c$. Strict concavity of $E[V_T]$ with respect to effort implies the

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[2] Since our objective is not to study the wealth effects of the tenant's crop share as in Shetty (1988), we normalize his wealth endowment to zero.

following incentive constraints:

$$[1-F_i(\hat{\theta})]\alpha_i E[\theta_i \mid \theta_i \geq \hat{\theta}] = \psi_i(e_i, e_j) = c_i e_i + \delta e_j \text{ for } i,\, j = 1, 2, \text{ and } i \neq j. \tag{$IC_i$}$$

The second constraint is the participation constraint which is given by:

$$E[V_T] \geq 0, \tag{$PC$}$$

i.e., the tenant's expected payoff must be no less than his outside option. It is easy to show that the constraint ($PC$) must be satisfied with equality.[3] Finally, feasibility requires that the tenant's share of output from each plot cannot be higher than 1, i.e.,[4]

$$\alpha_i \leq 1 \text{ for } i = 1, 2. \tag{$F_i$}$$

After substituting for $\alpha_i$ from ($IC_i$) for $i = 1, 2$ and for $R$ from the binding participation constraint ($PC$) into the expressions of the expected payoffs, and in the constraints ($F_i$), and using the fact that

$$[1-F_i(\hat{\theta})]E[\theta_i \mid \theta_i \geq \hat{\theta}] + F_i(\hat{\theta})]E[\theta_i \mid \theta_i < \hat{\theta}] = E[\theta_i] \text{ for } i = 1, 2, \tag{1}$$

the landlord's maximization problem reduces to

$$\max_{\{e_1, e_2\}} e_1 E[\theta_1] + e_2 E[\theta_2] - \frac{1}{2}\left(c_1 e_1^2 + c_2 e_2^2\right) - \delta e_1 e_2$$
$$\text{subject to } [1-F_i(\hat{\theta})]E[\theta_i \mid \theta_i \geq \hat{\theta}] - (c_i e_i + \delta e_j) \geq 0 \text{ for } i,\, j = 1, 2, \text{ and } i \neq j. \tag{$F_i'$}$$

Let $\lambda_i$ for $i = 1, 2$ be the Lagrange multiplier associated with the above constraints. The first-order condition with respect to $e_i$ is given by:

$$E[\theta_i] - (c_i e_i + \delta e_j) - \lambda_i c_i - \lambda_j \delta = 0 \text{ for } i,\, j = 1, 2, \text{ and } i \neq j. \tag{2}$$

First, we show that sharecropping does not emerge if there is no effort substitution, i.e., if $\delta = 0$. Suppose that, for some $i$, $\alpha_i < 1$, i.e., the feasibility constraint associated with $\alpha_i$ does not bind, then the Kuhn-Tucker conditions imply that $\lambda_i = 0$. Then from the above equation it must be the case that $c_i e_i + \delta e_j = E[\theta_i]$. From the incentive constraint ($IC_i$) we then have

$$\alpha_i = \frac{E[\theta_i]}{[1-F_i(\hat{\theta})]E[\theta_i \mid \theta_i \geq \hat{\theta}]} = 1 + \frac{F_i(\hat{\theta})E[\theta_i \mid \theta_i < \hat{\theta}]}{[1-F_i(\hat{\theta})]E[\theta_i \mid \theta_i \geq \hat{\theta}]} > 1,$$

which is a contradiction. Therefore, the optimal values of the tenant's shares are given by $\alpha_1 = \alpha_2 = 1$. In other words,

**Lemma 1** *In the absence of effort substitution, the tenant gets full share of output from each plot.*

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[3] Otherwise, the landlord may increase her expected payoff by increasing the rental payment a bit, and the contract would still be accepted.

[4] It is reasonable to assume that $\alpha_i \leq 1$ for some $i = 1, 2$. See Ray and Singh (2001) for a detailed discussion on this issue.

The intuition behind the above result is fairly simple. When the marginal cost of effort in one plot does not depend on the effort exerted in the other plot, it is optimal for the landlord to offer full incentives, i.e., $\alpha_1 = \alpha_2 = 1$. As a consequence, the tenant exerts the highest incentive compatible levels of effort in both plots. Hence, even for low realizations of productivity (less than $\hat{\theta}$) the landlord can extract a high rental payment. This situation is equivalent to employing two identical tenants, one in each plot.[5]

Next we show that sharecropping may emerge when $\delta > 0$, i.e., there is effort substitution. Notice first that sharecropping in both plots, i.e., $\alpha_i < 1$ for $i = 1, 2$ cannot be optimum. If it were the case, then one must have $\lambda_1 = \lambda_2 = 0$. Equations ($IC_i$) and (2) together imply that

$$\alpha_i = \frac{E[\theta_i]}{[1 - F_i(\hat{\theta})]E[\theta_i \mid \theta_i \geq \hat{\theta}]} > 1,$$

a contradiction. We now analyze situations where the landlord and the tenant will share the output produced in one of the two plots. Suppose this occurs in plot $i$, i.e., $\alpha_i < 1$, while $\alpha_j = 1$. In this case $\lambda_i = 0$, and the first-order conditions (2) become

$$\begin{aligned} E[\theta_i] - (c_i e_i + \delta e_j) &= \delta \lambda_j, \\ E[\theta_j] - (c_j e_j + \delta e_i) &= c_j \lambda_j. \end{aligned}$$

And the feasibility condition associated with $\alpha_j$, which is binding at the optimum, implies

$$c_j e_j + \delta e_i = [1 - F_j(\hat{\theta})]E[\theta_j \mid \theta_j \geq \hat{\theta}].$$

The last three equations are used to solve for three unknowns, namely $e_i$, $e_j$ and $\lambda_j$. Substituting these optimal values into the incentive constraint ($IC_j$), we get

$$\alpha_i = \frac{c_j E[\theta_i] - \delta F_j(\hat{\theta})E[\theta_j \mid \theta_j < \hat{\theta}]}{c_j[1 - F_i(\hat{\theta})]E[\theta_i \mid \theta_i \geq \hat{\theta}]}.$$

For $\alpha_i$ to be strictly less than 1, it must be the case that

$$\frac{F_i(\hat{\theta})E[\theta_i \mid \theta_i < \hat{\theta}]}{F_j(\hat{\theta})E[\theta_j \mid \theta_j < \hat{\theta}]} < \frac{\delta}{c_j} \quad \text{for } i, j = 1, 2 \text{ and } i \neq j. \qquad (\star)$$

In the following proposition, we state our main result.

**Proposition 1** *Sharecropping emerges in the presence of effort substitution effect. Given that condition ($\star$) holds, the tenant receives full share from plot $j$, and the landlord shares the crop of plot $i$ with the tenant.*

When there is effort substitution, higher effort in one plot makes it more costly for the tenant to exert an additional unit of effort in the other plot. When low realizations of productivity is less likely in plot $i$, i.e., condition ($\star$) holds, it is not necessary to offer full incentive to the tenant in this plot. This is because higher effort in plot $i$ may reduce that in plot $j$ since $\delta > 0$. Hence, the tenant gets the entire crop share

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[5] Similar result is also obtained by (Ray and Singh, 2001, Proposition 2) for an economy where the landlord owns a single plot.

where high realizations of productivity is less likely.[6] The following example clarifies the point.

**Example 1** Let both $\theta_1$ and $\theta_2$ are uniformly distributed over the supports $[1, 4]$ and $[2, 3]$, respectively. The parameters of the effort cost function are given by $c_1 = c_2 = \delta = 1$. Hence, condition $(\star)$ is satisfied for $\hat{\theta}^2 > 5.5$. In this case, the optimal shares are given by:

$$\alpha_1 = \frac{27 - 3\hat{\theta}^2}{16 - \hat{\theta}^2} < 1, \quad \text{and} \quad \alpha_2 = 1.$$

Notice that at the optimum we cannot have $(\alpha_1 = 1, \alpha_2 = 1)$ or $(\alpha_1 = 1, \alpha_2 < 1)$ since the necessary conditions of the maximization problem are satisfied over three mutually exclusive sets of parameter values. Here, the distribution of $\theta_1$ is a mean preserving spread of that of $\theta_2$, and hence plot 1 is riskier than plot 2. It is quite intuitive, under limited liability, that the output from the plot with greater variance is shared between the landlord and the tenant. □

## 4. Concluding remarks

When a landlord-tenant relationship faces ex-post limited liability, share contracts in general do not appear to be optimal. The present paper has made an attempt to explain the existence of share tenancy in the presence of ex-post limited liability when the tenant works in more than one plot. We have shown that when the joint effort cost function is not separable in efforts, i.e., there is effort substitution effect, share cropping emerges in equilibrium. When there is no effort substitution effect, the situation is equivalent to hiring two identical tenant, one for each plot. The situation under non-separability of the joint cost of efforts should not literally be interpreted as one tenant working simultaneously in two plots. Consider a situation of family farming where the landlord hires two tenants from the same family. Higher working hours by one family member may then imply that the other tenant needs to spend more time outside his workplace. Our landlord-tenant economy can also be interpreted as a firm-worker economy where a firm produces two different products, and incentive in each task is given in terms of share of the profit. Irrespective of the different interpretations that can be given to the present model, we show that a multitask agency model helps explain share contracts in the presence of ex-post limited liability.

## Appendix

We derive the final expressions for the expected payoffs of the landlord and the tenant. First consider

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[6] The Kuhn-Tucker first-order conditions of the landlord's maximization problem imply three regions for the parameter values in which the candidate solutions are optimal. First, $\alpha_1 < 1$ and $\alpha_2 = 1$ are optimal only if $F_1(\hat{\theta})E[\theta_1 \mid \theta_1 < \hat{\theta}]/F_2(\hat{\theta})E[\theta_2 \mid \theta_2 < \hat{\theta}] < \delta/c_2$. Second, $\alpha_2 < 1$ and $\alpha_1 = 1$ are optimal only if $F_1(\hat{\theta})E[\theta_1 \mid \theta_1 < \hat{\theta}]/F_2(\hat{\theta})E[\theta_2 \mid \theta_2 < \hat{\theta}] > c_1/\delta$. And finally, $\alpha_1 = \alpha_2 = 1$ are optimal solutions only if $\delta/c_2 \leq F_1(\hat{\theta})E[\theta_1 \mid \theta_1 < \hat{\theta}]/F_2(\hat{\theta})E[\theta_2 \mid \theta_2 < \hat{\theta}] \leq c_1/\delta$. The inequalities in the first two cases are nothing but the restatements of Condition $(\star)$.

the expected payoffs of the landlord, given a contract $\gamma = (\alpha_1, \alpha_2, R)$, which is given by:

$$
\begin{aligned}
E[U_L] = & \int_{\hat{\theta}}^{\bar{\theta}_1} \int_{\hat{\theta}}^{\bar{\theta}_2} [(1-\alpha_1)\theta_1 e_1 + (1-\alpha_2)\theta_2 e_2 + R] dF_1(\theta_1) dF_2(\theta_2) \\
& + \int_{\hat{\theta}}^{\bar{\theta}_1} \int_{\underline{\theta}_2}^{\hat{\theta}} [(1-\alpha_1)\theta_1 e_1 + \theta_2 e_2 + R] dF_1(\theta_1) dF_2(\theta_2) \\
& + \int_{\underline{\theta}_1}^{\hat{\theta}} \int_{\hat{\theta}}^{\bar{\theta}_2} [\theta_1 e_1 + (1-\alpha_2)\theta_2 e_2 + R] dF_1(\theta_1) dF_2(\theta_2) \\
& + \int_{\underline{\theta}_1}^{\hat{\theta}} \int_{\underline{\theta}_2}^{\hat{\theta}} [\theta_1 e_1 + \theta_2 e_2] dF_1(\theta_1) dF_2(\theta_2).
\end{aligned}
$$

Notice that, given the distribution function $F_i$ of a random variable $\theta_i$ over the support $[\underline{\theta}_i, \bar{\theta}_i]$, we have the following:

$$
E[\theta_i \mid \theta_i \geq \hat{\theta}] = \frac{1}{1-F_i(\hat{\theta})} \int_{\hat{\theta}}^{\bar{\theta}_i} \theta_i dF_i(\theta_i), \quad \text{and} \quad E[\theta_i \mid \theta_i < \hat{\theta}] = \frac{1}{F_i(\hat{\theta})} \int_{\underline{\theta}_i}^{\hat{\theta}} \theta_i dF_i(\theta_i). \tag{3}
$$

The term $E[\theta_i \mid \theta_i \geq \hat{\theta}]$ reads as the expectation of $\theta_i$ conditional on the event that $\theta_i \geq \hat{\theta}$. Using the above equations into the expression for $E[U_L]$ we get

$$
\begin{aligned}
E[U_L] = & [1-F_2(\hat{\theta})][1-F_1(\hat{\theta})](1-\alpha_1)e_1 E[\theta_1 \mid \theta_1 \geq \hat{\theta}] \\
& + [1-F_1(\hat{\theta})][1-F_2(\hat{\theta})](1-\alpha_2)e_2 E[\theta_2 \mid \theta_2 \geq \hat{\theta}] \\
& + [1-F_2(\hat{\theta})][1-F_1(\hat{\theta})]R + F_2(\hat{\theta})[1-F_1(\hat{\theta})](1-\alpha_1)e_1 E[\theta_1 \mid \theta_1 \geq \hat{\theta}] \\
& + [1-F_1(\hat{\theta})]F_2(\hat{\theta})e_2 E[\theta_2 \mid \theta_2 < \hat{\theta}] + [1-F_1(\hat{\theta})]F_2(\hat{\theta})R \\
& + [1-F_2(\hat{\theta})]F_1(\hat{\theta})e_1 E[\theta_1 \mid \theta_1 < \hat{\theta}] + F_1(\hat{\theta})[1-F_2(\hat{\theta})](1-\alpha_2)e_2 E[\theta_2 \mid \theta_2 \geq \hat{\theta}] \\
& + F_1(\hat{\theta})[1-F_2(\hat{\theta})]R + F_1(\hat{\theta})F_2(\hat{\theta})e_1 E[\theta_1 \mid \theta_1 < \hat{\theta}] + F_1(\hat{\theta})F_2(\hat{\theta})e_2 E[\theta_2 \mid \theta_2 < \hat{\theta}] \\
= & [1-F_1(\hat{\theta})](1-\alpha_1)e_1 E[\theta_1 \mid \theta_1 \geq \hat{\theta}] + [1-F_2(\hat{\theta})](1-\alpha_2)e_2 E[\theta_2 \mid \theta_2 \geq \hat{\theta}] \\
& + F_1(\hat{\theta})e_1 E[\theta_1 \mid \theta_1 < \hat{\theta}] + F_2(\hat{\theta})e_2 E[\theta_2 \mid \theta_2 < \hat{\theta}] + [1-F_1(\hat{\theta})F_2(\hat{\theta})]R.
\end{aligned}
$$

The expression for $E[V_T]$ can also be derived in a similar fashion.

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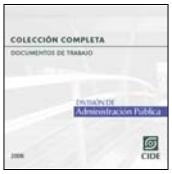

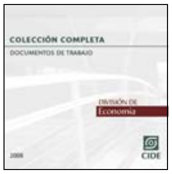

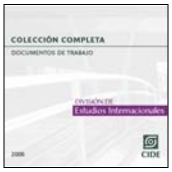

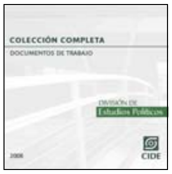

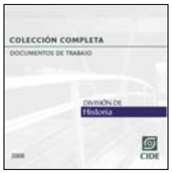

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