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ABSTRACT

Two categories of Thai sharecroppers are observed to be efficient: those under high poverty and high risk, and those in a long-term relation of gift exchange with their landlord. Econometric estimates show that use of variable factors by these sharecroppers is insignificantly different from that by owner-operators and significantly higher than that by generic sharecroppers. Interpretations for this behavior are provided by models of sharecropping under safety-first and of repeated contracts with gift exchange.

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I. Introduction

Share tenancy contracts are widely observed in developing countries. For this reason, many scholars have been searching to identify the causes of their prevalence and permanence. The key issue in answering this question has been to establish under what conditions share tenancy is more desirable for the landlord, in his character of principal, than alternative tenancy contracts. It is well known, however, that sharecropping is usually a source of inefficiencies associated with the disincentive which output sharing implies for the tenant. We will show in this paper that, based on observations from two villages in Thailand, there exist conditions which make a sharecropping contract efficient in resource use. By efficient, we mean that the intensity of resource use under sharecropping is not inferior to that of the opportunity fixed-rent contract. If sharecropping can be both landlord optimum <u>and</u> efficient relative to other contracts, under widely observed structural conditions, its prevalence and permanence should, indeed, be expected.

There exists a large body of literature that attempts to identify conditions under which share tenancy is superior to fixed-rent or wage contracts.[1] Alternative theories invoke its usefulness in risk sharing when insurance markets fail (Cheung, 1969; Stiglitz, 1974; Newbery, 1975; Allen, 1985), in screening workers of different qualities (Hallagan, 1978; Newbery and Stiglitz, 1979), in overcoming market imperfections for inputs other than land (Reid, 1976; Bardhan, 1980; Eswaran and Kotwal, 1985), and more recently, in providing an insurance against defaulting and compensating for risk-taking behavior by tenants with limited liability (Shetty, 1988; Basu, 1992). These theories all admit potential losses from incentive bias and predict that the eventual dominance of sharecropping will depend on the trade-off between these incentive losses and the gains from the specific features on which they focus.

There exist, however, three possibilities for sharecropping to be efficient in spite of its inherent incentive bias. The first is when the landlord can enforce the efficient level of work effort. Enforcing efficiency requires that all the variables specified in the contract be not only observable by the two parties but also verifiable by a third party who can punish those (or legitimate the punishment of those) who have violated the terms of the contract agreed upon ex ante. Otherwise, the strategic behaviors of the two parties will lead them to ex post disagreement. Key for this is the design of mechanisms for indirect observation of the tenant's behavior given the random characteristic of the weather (Radner, 1981).

The second possibility is when the tenant's objective function contains some feature that makes him behave efficiently in spite of the incentive bias created by a standard sharecropping contract. As we will see, this is what applies to the poorest tenants in one village, Village N. Highly unstable yields, lack of income diversification, and extreme poverty induce them to give first priority to securing a minimum level of farm income, pushing them to work efficiently.

The third possibility to achieve efficient sharecropping is to modify the standard contract in order to add features that reward efficient behavior. We analyze such a case when the contract is repeated over time and includes gift giving if the tenant behaves cooperatively in working efficiently. In this case, the contract becomes self-enforceable and efficiency is achieved. This is what we observe in the second village, Village Bo, for a subset of the sharecroppers who hold long-term contracts and practice reciprocal gift exchange.

The focus of this paper is on exploring empirically and theoretically these last two instances of efficient sharecropping. In part II, a description of the villages shows the various conditions under which share tenancy applies. In part III, we test for the efficiency of sharecropping contracts, and find that a subset is efficient in each village: the poorest sharecroppers in Village N and those receiving gifts in Village Bo. In part IV, the empirical findings are conceptualized in two different types of share contract models: a model where the tenant makes decisions regarding labor supply based on the safety-first principle for Village N, and a repeated game characterized by gift reciprocity between landlord and tenant, and use of trigger strategies for Village Bo. The safety-first model does not assume observability of labor effort, and efficiency is ensured directly by the tenant's optimal strategy. In the repeated game model, on the other hand, ex post inference of the labor effort is assumed but not direct enforceability, and the thrust of the contract is to design a mechanism of enforcement for the two partners.

II. Share Tenancy Systems in Two Thai Villages

Farm household surveys were conducted in two Thai villages in 1984-85.

Village N is characterized by high risk and widespread poverty. It is located in a rain-fed area approximately 100 kilometers northwest of Bangkok. Farmers usually grow rice in the rainy season in the wetter areas and sugarcane in the drier areas. Rice yields in a good year are about 1.8 to 1.9 tons per hectare, but yields are so unpredictable that farmers experienced severe droughts and almost no harvest as often as seven times in the last 10 years.

While land tenure is dominated by owner operators who manage 58% of farms in the village, tenancy contracts are important with 19% sharecroppers, 19% fixed-rents, and the rest mixed owner-share tenancies. Of the share tenancy contracts, 41% are among relatives. Yet, the landlords usually live outside the village and do not interfere with the tenants' farm management practices. In share contracts, one-third of the harvested output is usually paid as land rent, and the tenant has to pay for all production costs other than land.

Among sharecroppers, there are sharp differences in productive assets ownership, and that group is split between rich and poor in Table 1. For comparison purposes, the group of owners is also split with the same criterion. Sharecroppers with low assets face a serious problem of extreme poverty and insecurity. Their average income level is only 33% of that of rich sharecroppers and 61% of owners with similar productive assets. Their sources of farm household income show little diversification and extreme reliance on rice, with rice accounting for 97% of their gross agricultural income compared to 65% for poor owners and 88% for rich sharecroppers. For this village, off-farm incomes mainly derived from wage labor and employment opportunities are extremely limited. As a result, the share of off-farm income in total cash income is low, and even though it is higher for the poor sharecroppers, it only reaches 39% of their total cash income. For them, insurance is not available through either consumption credit or migration: local money lenders do not make loans to tenants due to the high default risk, and there is no migration to sugarcane plantations because it would not cover the household's minimum income needs. As a consequence, annual fluctuations in rice yields have a crucial effect on the poor tenants' labor decisions as they need to self-insure against disaster in rice production itself.

Family labor is the dominant source of farm work, and there are no great differences among tenure types. However, poor farmers are clearly disadvantaged by lack of fixed capital (productive assets and tractor per farm size) and they make up for this difference by a more intense use of labor and variable inputs.

Village Bo is located 20 kilometers east of Chiang Mai City and is famous for wood carving and a thriving textile cottage industry. This area has the least rain in Chiang Mai Province and, in the dry season, rice farming is impossible. The annual yield of rice depends crucially on rainfall, but income insurance is provided by high diversification in non-farm activities which account for 74% of the total farm households cash income (Table 1). Consequently, even though rice accounts on average for 87% of agricultural gross income, the instability of rice production is not as crucial to the lives of these farmers as it is in Village N.

Tenancy contracts are pervasive as 45% of the farm households are pure tenants and 47.5% owner-operators, with the rest holding mixed owner-share tenancies. Of the share tenancy contracts, 83% are between relatives, and these contracts are in general repeated over a long period of time. The common rental rate is 50%. However, in 61% of the contracts, all of which are among relatives, the rent paid is below the level stipulated by contract. This is caused by the fact that landlords make discontinuous after-harvest gifts of grain to their tenants in exchange for hard work, naturally defined as the level of work effort which the tenant would produce were he the owner. For this reason, sharecroppers in this village were divided in Table 1 between those with and without gift exchange. The observed average duration of current contracts with gift exchange was nine years.

By contrast to Village N, non-family labor is an important source of work. Indicators of performance suggest that sharecroppers with gift exchange are not very different from owners in terms of labor use per area in rice and yields achieved.

III. Tests of Sharecropping Efficiency

Based on the observed performance of sharecroppers in the Thai villages, we postulate the following two hypotheses: (1) In Village N, high income risk and extreme poverty, when there is no alternative insurance available but self-insurance through rice production, motivate the poorest sharecroppers to work as efficiently as owners in rice production; (2) In Village Bo, gift giving by landlords in exchange for hard work, in the context of a long-term contracts, induces the gift-receiving sharecroppers to work efficiently.

These hypotheses do not negate the Marshallian disincentive effects of sharecropping of which Bell (1977) and Shaban (1987) gave convincing empirical evidence. Thus, all sharecroppers should be more inefficient than owner-operators. However, for the poor sharecroppers in Village N and the gift-receiving sharecroppers in Village Bo, the motivation which these circumstances create compensates for the Marshallian effect and they reach a level of efficiency comparable to that of owner-operators. To develop a strong test of these hypotheses, we proceed as follows:

i) In Village N, we contrast the behavior of assets rich sharecroppers against that of assets rich owner-operators, and find them inefficient; we contrast the behavior of assets poor sharecroppers against that of assets poor owner-operators, and find them no less efficient.

ii) In Village Bo, we contrast the behavior of all sharecroppers against owner-operators, and find them inefficient; we contrast the behavior of gift-receiving (Bo) sharecroppers against owner-operators, and find them no less efficient.

The endogenous variable used is the total value of variable factors per unit of area, calculated as the sum of total labor and variable inputs (valued at market prices) used in rice production divided by the rice area[2]. To test the above two hypotheses, dummy variables are introduced for the different categories of sharecroppers defined and, in Village N, for low assets in general. Other exogenous variables included were a vast array of characteristics of the household and the farm; we report in Table 2 only those that remained with significant coefficients. Both Villages N and Bo are rainfed, but an important difference between households is the availability of pumps for irrigation in Bo. Since transactions costs in access to factors of production tend to be proportional to farm size (Feder, 1985; Eswaran and Kotwal, 1986), we control for farm size in all cases. Also fundamental in determining transactions costs is the share of family labor in total labor used. The small area under rice in each village implies that differences in soil quality are likely to be secondary. Local varieties, by contrast, are 100% adopted in Village Bo, but not in Village N, and they create important differences in factor intensity between adopters and nonadopters. Similarly, the level of fixed factors differs markedly across farms and this is controlled by a tractor/farm size variable and availability of family labor (measured by number of family workers per farm size).

The results for Village N (Table 2) show that sharecroppers with high assets ownership are indeed inefficient compared to owner-operators of similar assets ownership, but this difference of behavior between sharecroppers and owners disappears for the poorest farmers. Among other exogenous variables, we find that availability of family labor and a higher share of family in total labor, which both lower the effective price of labor, lead to higher variable factor use; use of local as opposed to high yielding rice varieties lowers factor use; and a higher stock of machinery also lowers variable factor use (the overall influence of the tractor ownership dummy and the log tractor per farm size variable is negative for all observations).

As the share of family in total labor may be considered endogenous, we performed on that variable the test of exogeneity proposed by Nakamura and Nakamura (1981). This is done by regressing the share of family in total labor on instrumental variables (family labor, owned area, owned tractor, off-farm income, assets, age, and belonging to a cooperative). The residual of this regression is then introduced jointly with the observed variable in the model. Exogeneity of the regressor implies that the coefficient of the residual is not significantly different from 0. The reported t-statistics of 0.9 on the coefficient of the residual indicates that exogeneity of the share of family labor cannot be rejected.

In Village Bo, the sharecropper effect is negative but not significant. However, those who receive gifts are significantly more productive than those who do not. This brings them to a level of efficiency superior to but not significantly different from that of the owner-operators. Efficient sharecropping is thus observed for that category. Among other exogenous variables, we find that the inverse relation between factor intensity and area holds (we tested that exogeneity of area in rice cannot be rejected) and that availability of irrigation pumps induces a significantly higher level of variable factor use.

Empirical tests thus suggest that there are situations under which sharecropping can be as efficient as owner-operated farms. The two mechanisms which we identified as producing this result were high risk *cum* poverty and gift exchange. Factor use by these two categories of sharecroppers are insignificantly different from that by owners and significantly higher than that by generic sharecroppers. In the following section, we proceed to formalize two models of sharecropping behavior under these conditions, deriving from them the conditions under which efficient behavior would indeed result.

IV. Models of Efficient Share Tenancy

The general model of sharecropping under uncertainty and risk aversion in the principal-agent expected utility framework gives the well-known results that the choice of the optimal contract and its efficiency vary with the level of risk aversion of the two partners and the condition of enforceability of the tenant's work effort (Otsuka and Hayami, 1988). In the case of nonenforceability, the fixed-rent contract is optimal for a risk neutral tenant, and a pure share or mixed share-rent contract is optimal, although not efficient, for a risk averse tenant.

For the case of Village N, we propose in Section A a principal agent model where the tenant's activity is based on the safety-first principle. This type of behavior is induced by conditions such as those observed in Village N (Lipton, 1968): highly risky income, extreme levels of poverty, and lack of insurance through, for instance, access to off-farm employment or consumption credit. In this case, share tenancy is an essential source of insurance, and safety-first behavior can lead, under conditions that we will establish, to efficiency, despite the non-observability of the work effort by the landlord.

In the safety-first contract, efficiency is obtained by the conditions prevailing within a single period of time and, although the contract may be repeated over the years, this is not an essential condition for efficiency to obtain. By contrast, the model developed in Section B for Village Bo insures efficiency through a repeated game with strategic behavior encompassing gifts and threats. It is based on the assumptions of observability but nonenforceability of the tenant's effort by the landlord. We know from standard game theory results that the efficient cooperative solution can prevail if the contract is infinitely repeated. What we propose instead is the design of a long-term but finite contract that, under certain conditions which we establish, will be both superior for the landlord and efficient in labor use.

A. Village N: Safety-First, Expected-Utility Model

We start with the general formulation of a linear tenancy contract, of which fixed-rent and pure-sharecropping contracts are special cases. A contract is defined by (r, R), where r $(0 \leq r < 1)$ is the landlord's share of output and R $(R>0)$ a fixed payment per acre. Assuming constant returns to scale, the problem is written for a unit of area, with output depending on the tenant's effort (A) and on the realization of the random variable $\theta \sim (1, \sigma)$. If $f(A)\theta$ is the output at harvest time, the tenant's income will be $Y = (1 - r)\, f(A)\theta - R$. The fixed-rent contract is thus obtained with $(r = 0, R>0)$, and the pure sharecropping contract with $(r>0, R=0)$. We assume a principal-agent framework in which the landlord maximizes the expected utility of his income (Z) with respect to the terms of the contract, and subject to the tenant's work behavior and reservation utility $\overline{W}$.

The safety-first model is defined, following Roy, as the behavior which minimizes the upper limit of probability that the tenant's income will be less or equal to a disaster level d, i.e., $\min_{A} \Pr(Y \leq d)$. Bushena and Zilberman (1991) have shown that this formulation can be derived from a general model of expected utility under discrete status levels. In this framework, serious disaster and normal times are conceptualized as two different discrete status, such as death and life, or solvency and bankrupty. The tenant's utility level is assumed to depend on both income and status, where the probability of occurrence of the status also depends on income. If the utility curve in a state of disaster is sufficiently lower than the curve in normal circumstances, and if there exists a level d under which the tenant is in the disaster status with certainty, then maximization of expected utility is equivalent to the safety rule given above. Returning to Roy's formulation, there exists a certainty equivalent to this statement that corresponds to $\max_A (EY - d) / \sigma_Y$, where $Y \sim (EY, \sigma_Y)$; i.e., the behavior which maximizes the number of standard deviations of income above the disaster level (Pyle and Turnovsky, 1970).

Taking into account the disutility of work, the tenant's problem is to choose A that maximizes his utility, W(Y, A), where, assuming separability between income and leisure[3]:

$$W(Y, A) = \frac{b}{\sigma_Y}(EY - d) - U(A),$$
$$\text{with } b > 0, U' > 0, U'' \geq 0, U(0) = 0,$$
$$EY = (1 - r) f(A) - R, \text{ and } \sigma_Y = (1 - r) f(A) \sigma.$$

The landlord's optimization behavior is thus written as:

$$\max_{r,R} Z = EV(r f(A)\theta + R), \tag{1}$$

subject to

$$A = \arg\max W(Y,A) \tag{2}$$

and

$$\max W = \overline{W}. \tag{3}$$

The tenant's first order condition (2) can be written as:

$$0=\frac{b}{\sigma_Y}(1-r)f'(A)-\frac{b}{\sigma_Y^2}(EY-d)(1-r)f'(A)\sigma-U'(A)$$

$$=\frac{b}{\sigma_Y}(1-r)f'(A)\left[1-\frac{(EY-d)}{\sigma_Y}\sigma\right]-U'(A)$$

in which constraint (3) can be substituted to give:

$$0=\frac{b}{\sigma_Y}(1-r)f'(A)\left[1-\frac{\overline{W}+U(A)}{b}\sigma\right]-U'(A) \qquad (2')$$

$$=\frac{b}{f(A)\sigma}f'(A)\left[1-\frac{\overline{W}+U(A)}{b}\sigma\right]-U'(A). \qquad (2'')$$

This last expression shows that, when the tenant's risk attitude follows the safety-first criterion and rental rates are adjusted to maintain him at a fixed opportunity level, A is independent of r and R. Hence all contracts are equally efficient.

A mathematical intuition of this result can be obtained by remarking that W can also be written as:

$$W(Y,A)=-\left(\frac{b}{\sigma}\frac{R+d}{1-r}\right)\frac{1}{f(A)}+\frac{b}{\sigma}-U(A)=-\frac{g(r,R)}{f(A)}+\frac{b}{\sigma}-U(A).$$

This shows that, when the tenant's objective function is to maximize the number of standard deviations of income, r and R only enter jointly as g(r,R) in the objective function, which is, in a sense, equivalent to reducing the contract to only one parameter g(r,R). The two constraints (2) and (3) thus give a system in two variables A and g, independently of the particular values of r and R in g. This is in contrast to the usual expected utility specification where the landlord can use the two parameters of the contract, r and R, to achieve the desired levels of both efficiency and welfare.

Another interpretation of this result is as follows: From the initial definition of W, one can interpret b/σ_Y as a risk discounting factor on expected income. Note that this discounting factor is inversely proportional to σ_Y and thus to (1 - r). In expression (2'), the first term b/σ_Y accounts for the disincentive due to risk aversion, $(1 - r)$ is the standard disincentive effect of sharecropping, and the term in square brackets, [.], comes from variation of the risk factor with effort, $d\sigma_Y/dA$. The fact that this latter term is independent of the terms of the contract is related to the proportionality between σ_Y and the variable income $(1 - r)f(A)$, which gives $d\sigma_Y/dA = dEY/dA$. What (2') shows is that, under safety-first behavior, the risk factor and the sharecropping disincentive exactly compensate each other; as the tenant's share increases, incentive to work due to output sharing rises and disincentive to work due to risk aversion also rises. As a result, the labor decision is the same for all r.

This equivalence in efficiency between sharecropping and fixed-rent contracts is the fundamental result of the model, which corresponds to the empirical analysis of the previous section. We may, however, want to go further and see which contract is optimal for the landlord. This is what we now turn to.

Once A is defined, solving the reservation utility constraint (3) gives R as:

$$R = -d + (1-r)f(A)[1-\sigma(U+\overline{W})/b]. \tag{3'}$$

With equations (2") and (3') jointly determining $A(\overline{W})$ and $R(r;\overline{W},d)$, the landlord's problem is thus reduced to:

$$\underset{0\le r<1}{\text{Max}}\ EV\left[r\,f(A)\,\theta - d + (1-r)\,f(A)\left(1-\sigma(U+\overline{W})/b\right)\right].$$

Therefore, the landlord's income is a linear function in r, and the optimum is a corner solution (i.e., a sharecropping contract (R = 0) if $dEV/dr > 0$, a fixed-rent contract (r = 0) if $dEV/dr < 0$, and any mixed contract if $dEV/dr = 0$).

However, $$\frac{d}{dr}EV = f(A)\,EV'\left[\frac{EV'\theta}{EV'} - \left(1-\sigma(U+\overline{W})/b\right)\right].$$

Taking a Taylor expansion of V around $\theta = 1$, and denoting $\tilde{V} = V(\theta = 1)$, we obtain:

$$EV' \cong \tilde{V}' \text{ , } EV'\theta \cong \tilde{V}' + \sigma^2 r\, f(A)\, \tilde{V}'' \text{ , and}$$

$$\frac{d}{dr} EV \cong f(A)\, EV'\, \sigma\left[-\sigma\, r\, f(A)\, R_L + (U + \overline{W})/b\right]$$

where $R_L = -\tilde{V}''/\tilde{V}'$ is the landlord's measure of risk aversion.

The sign of $(U + \overline{W})$ is the same as that of EY - d (i.e., of the tenant's expected income relative to disaster). Thus, if EY < d, the optimal contract is a fixed-rent contract. This somewhat perverse result comes from the fact that maximization of the ratio $(EY - d)/\sigma_Y$ implies maximization of the variability of income, and this is in order to enable the very poor peasant, who is on average below the catastrophic level of income, to more often reach an income above this minimum level d. If EY > d and the landlord's level of risk aversion is low, the optimal contract is a pure sharecropping contract with:

$$R = 0, \quad 0 < r = 1 - \frac{d}{f(A)\left(1 - \sigma(U + \overline{W})/b\right)} < 1.$$

The intuition for this result is that the (risk neutral) landlord wants to minimize the tenant's income level at a given ratio $\frac{EY - d}{\sigma_Y} = \overline{W} + U$. This is done by selecting the highest possible r in order to minimize σ_Y, thus inducing the highly risk averse tenant to substitute income security for income level.

B. Village Bo: Reciprocal Gift Exchange Model

To develop the strategic game underlying the contracts with gift in Village Bo, we extend the one-period model of sharecropping under risk into a multiperiod model with nonenforceability. We use the standard framework of a principal-agent model, with expected utility objective for both partners and a reservation level for the tenant's welfare.

Two contracts serve as references in designing the gift exchange contract. The first contract $(\overline{A}, \overline{r}, \overline{R})$ is the efficient contract that would require cooperation or enforceability, in which the landlord obtains the maximum utility that he could ever achieve. The other contract is the noncooperative, nonenforceable Nash equilibrium

(r^*, R^*) that leads to inefficiency as the tenant's work effort is $A^* < \overline{A}$. In the principal-agent framework, the tenant is at the same reservation utility in both cases. The efficient contract cannot be sustained since it is not incentive compatible, even in a repeated game. Thus, we look into one specific scheme of sharing the benefits of cooperation, a discrete gift G given by the landlord in exchange for an efficient level of effort $\overline{A}$ by the tenant. This gift exchange contract is written $(\hat{A} = \overline{A}, \hat{r} = \bar{r}, \hat{R} = \overline{R} - G)$.

The theory of repeated games tells us that the cooperative outcome $(\hat{A}, \hat{r}, \hat{R})$ will not in general prevail in a full information repeated game with a finite horizon. However, the cooperative outcome is an equilibrium if the game is infinitely repeated and the discount rates of the two partners are sufficiently low, or if the time horizon is finite but uncertain and the probability that the game continues is sufficiently high[4]. In a similar framework, and for games that are finite with a known termination date, Radner invokes a case of asymmetry that prevents one partner from defaulting, and then specifies an approximate equilibrium concept that leads the finite game to be cooperative. Clearly, in all these cases, many such contracts $(\hat{A}, \hat{r}, \hat{R})$ are superior to the noncooperative solution.

We apply this general approach to the design of the contract by the landlord. To do this we take the discount rates of the two partners as given and determine the conditions on the contract itself, i.e., on G, for $(\hat{A}, \hat{r}, \hat{R})$ to be an equilibrium (Section b). We also apply the concept of approximate equilibrium to the case where both partners could default but behave with bounded rationality (Section c).

Before we leap into the mathematical presentation of the game itself, one more issue has to be addressed which is linked to the time frame of the decision process of this particular landlord tenant contract. The sequential decision-making process that we consider here is dictated by the intertemporal characteristic of the production process, with the principal announcing his strategy (a reward G if the tenant behaves cooperatively), the tenant choosing an action (the efficient effort $\overline{A}$ or the level of A that maximize his instantaneous welfare), the principal executing his announcement, and repetition of this pattern over time. Two problems will generally arise in the implementation of the third phase of this contract. One originates in the nonobservability of the tenant's action and the other in the incentive for the landlord not to honor his announcement even when the tenant chooses $\overline{A}$. Radner addresses the first question, while assuming that the landlord is bound to respect his announcement, and that both the noncooperative Nash equilibrium and the cooperative Pareto optimal solution are predetermined. He constructs a statistical method for the landlord to detect cheating by the tenant.[5] We adapt this informational structure to the conditions of sharecropping by assuming that the landlord can take the initiative of defaulting if this is his choice, but that the tenant's behavior is observable by the landlord. Regarding the latter point, arguments have been made that in a stable environment, the landlord should be able to ascertain the effect of weather ex post and to estimate reasonably well the tenant's labor effort from his knowledge of the production function. This deducted information is, however, not verifiable by third parties. This particular feature precludes the landlord from using withdrawal of the gift for punishment of the tenant's failure to cooperate within the same period. Any such nonpayment of the gift would be interpreted by third parties as unilateral defaulting. In other words, the landlord can observe the tenant's behavior and use this information for further periods, but any non-preannounced withdrawal of the gift is considered by others as defaulting on his part. Since the landlord thus cannot retaliate within the period, this is equivalent to saying that the two partners are playing simultaneously, with either or both partners allowed to default independently.

Given this particular informational structure, we now proceed to establish the conditions that insure that the cooperative agreement will be the equilibrium solution.

a) Definition of the Strategy

Let $\overline{W}$ and $\overline{Z} = EV[\overline{r}f(\overline{A})\theta + \overline{R}]$ be the levels of expected utility that would be achieved in the enforceable contract, and $W^* = \overline{W}$ and $Z^* < \overline{Z}$ in the noncooperative, nonenforceable Nash equilibrium. The landlord's objective is to design a noncooperative contract $(\hat{A}=\overline{A}, \hat{r}=\bar{r}, \hat{R}=\overline{R}-G)$ that will achieve efficiency by a self-enforcing mechanism and generate a higher utility for him than the noncooperative alternative Z^*. $(\hat{A}, \hat{r}, \hat{R})$ creates the following levels of utility:

Tenant: $\hat{W} = EU[(1-\bar{r})\, f(\overline{A})\, \theta - \overline{R} + G, \overline{A}] > \overline{W}$.

Landlord: $\hat{Z} = EV[\bar{r}\, f(\overline{A})\, \theta + \overline{R} - G] < \overline{Z}$.

The problem now is to determine the conditions on G under which a trigger strategy, designed around this contract, is effective in ensuring $(\hat{A}, \hat{r}, \hat{R})$ as the equilibrium contract.

The *trigger strategy* is composed of a reference strategy and of a retaliation procedure in case of default by the other partner. In the reference strategy, both partners conform to the efficient contract $(\hat{A}, \hat{r}, \hat{R})$ for $t < t^*$ and switch to the noncooperative Nash equilibrium (A^*, r^*, R^*) at $t = t^*$, where t^* has been defined by agreement. The retaliation procedure applied by each partner consists in switching to the noncooperative Nash strategy at $t^\circ + 1$ if the other partner defaults at $t^\circ \leq t^*$.

The default option for each of the two partners is defined as his best instantaneous reply to the other playing the reference strategy. If it is the tenant who defaults, he does so by working the quantity $\hat{A}'$ at that maximizes his expected utility in the contract $(\hat{r}, \hat{R})$, i.e.,

$$\hat{A}' = \arg\max EU[(1-\bar{r})\, f(A)\, \theta + \overline{R} - G, A]$$

which yields $\hat{W}' > \hat{W}$ for him but $\hat{Z}' < \hat{Z}$ for the landlord. As for the landlord, he defaults by withholding the gift, and the contract becomes, for that year, identical to the enforceable contract $(\overline{A}, \bar{r}, \overline{R})$ which yields $\hat{W}'' = \overline{W}$, $\hat{Z}'' = \overline{Z} > \hat{Z}$.

To establish the equilibrium strategy in this reciprocal gift exchange contract, we consider a finite T-period sequence of contracts where T is large. Clearly, if the trigger strategy is effective and the reference game prevails, the optimal strategy is to set $t^* = T$. We now need to determine under which conditions the trigger strategy is effective in deterring both partners from defaulting. This is done by considering successively the payoffs that the tenant and the landlord could derive from defaulting.

b) The Equilibrium Contract for t < T

(i) Payoffs from defaulting by the tenant. The landlord will clearly lose from any defaulting by the tenant. For the tenant, the present value of the payoffs from alternative strategies are:

Reference strategy: $$\sum_{t=0}^{t^*} \alpha^t \hat{W} + \sum_{t^*+1}^{T} \alpha^t W^*.$$

Tenant defaults at t°: $$\sum_{t=0}^{t^\circ-1} \alpha^t \hat{W} + \alpha^{t^\circ} \hat{W}' + \sum_{t^\circ+1}^{T} \alpha^t W^*,$$

where α is the tenant's discount factor.

From this, we see that the net gain from defaulting at $t^\circ = t^*$ is $\Delta W = \alpha^{t^*}(\hat{W}' - \hat{W}) > 0$, and the net gain from defaulting at $t^\circ < t^*$ is

$$\Delta W = \alpha^{t^\circ}(\hat{W}' - \hat{W}) - \sum_{t^\circ+1}^{t^*} \alpha^t(\hat{W} - W^*)$$
$$= \alpha^{t^\circ}\left[(\hat{W}' - \hat{W}) - (\hat{W} - W^*)\alpha\frac{1-\alpha^{t^*-t^\circ}}{1-\alpha}\right].$$

The tenant will default before t* if this net gain from defaulting is positive, i.e., if

$$\frac{\hat{W}' - \hat{W}}{\hat{W} - W^*} > \alpha\frac{1-\alpha^{t^\circ-t^\circ}}{1-\alpha}. \tag{4}$$

By differentiating $(\hat{W}' - \hat{W}) / (\hat{W} - W^*)$ with respect to G, one can show that it is a decreasing function h(G) of the gift G if

$$R_T(\hat{Y} - \hat{Y}') \leq \frac{\hat{W}' - \hat{W}}{\hat{W} - W^*} = h(G),$$

where $R_T = -U''/U'$ is a measure of the tenant's risk aversion This condition is more likely to hold the lower the degree R_T of risk aversion by the tenant. In this case, condition (4) gives:

- if $h(G) \geq \alpha/(1-\alpha)$, i.e., $G \leq h^{-1}(\alpha/(1-\alpha))$, the tenant defaults at $t^\circ = 0$;
- if $\alpha < h(G) < \alpha/(1-\alpha)$, i.e., $h^{-1}(\alpha/(1-\alpha)) < G < h^{-1}(\alpha)$, the tenant defaults at:

$$t^\circ = t^* - \frac{\ln[1-h(G)\alpha/(1-\alpha)]}{\ln\alpha};$$

- if $f(G) \leq \alpha$, i.e., $G \geq h^{-1}(\alpha)$, the tenant will not default.

This last condition establishes the minimum gift $h^{-1}(\alpha)$ that the landlord needs give to prevent the tenant from defaulting at $t^\circ < t^*$. This minimum gift is a decreasing function of α and an increasing function of the utility of leisure.

(ii) Payoffs from defaulting by the landlord. We proceed in the same fashion, comparing the present value of the payoffs that the landlord would obtain from alternative strategies:

Reference strategy: $\sum_{t=0}^{t^*} \beta^t \hat{Z} + \sum_{t^*+1}^{T} \beta^t Z^*.$

Landlord defaults at t°: $\sum_{t=0}^{t^\circ-1} \beta^t \hat{Z} + \beta^{t^\circ} \hat{Z}'' + \sum_{t^\circ+1}^{T} \beta^t Z^*,$

where β is the landlord's discount factor.

The net gain from defaulting at $t^\circ = t^*$ is $\Delta Z = \beta^{t^*}(\hat{Z}'' - \hat{Z}) > 0$. The net gain from defaulting at $t^\circ < t^*$ is

$$\Delta Z = \beta^{t^\circ}\left[(\hat{Z}'' - \hat{Z}) - (\hat{Z} - Z^*)\,\beta\frac{1-\beta^{t^*-t^\circ}}{1-\beta}\right],$$

where $\hat{Z}'' - \hat{Z} = G$ and $\hat{Z} - Z^* = \overline{Z} - Z^* - G$. Default will thus occur when

$$\frac{G}{\overline{Z}-Z^*-G} \geq \beta\frac{1-\beta^{t^*-t^\circ}}{1-\beta}.$$

There consequently exists a $t^\circ \leq t^* - 1$ at which the landlord has advantage to default if $G \geq (\overline{Z}-Z^*)\beta/(1+\beta)$. This establishes the maximum gift that the landlord can give without having an incentive to default at $t^\circ < t^*$.

In conclusion, the conditions for the contract $(\hat{A}, \hat{r}, \hat{R})$ to be an equilibrium up to time t^* are:

(i) the landlord has no incentive to default, i.e., if $G < (\overline{Z}-Z^*)\beta/(1+\beta) = G_{max}$,

(ii) the tenant has no incentive to default, i.e., if $G \geq h^{-1}(\alpha) = G_{min}$.

An efficient, cooperative-equivalent contract will, consequently, only be feasible if:

$$h^{-1}(\alpha) \leq (\overline{Z}-Z^*)\beta/(1+\beta). \qquad (5)$$

In a principal-agent framework, the gift will be set at the minimum necessary to achieve cooperation while, if bargaining occurs, any solution within this range is feasible.

c) Conditions for the Efficient Sharecropping Contract

We have established that when condition (5) is satisfied, there exists a level of gift such that there is no incentive for either partner to default at $t^\circ < t^* = T$. As is commonly known in a finite game, this is, however, not the case at $t^\circ = T$, since we have seen that both partners gain from defaulting in that year. The trigger strategy, consequently, fails at T. And, by backward induction, the cooperative scheme unravels, and the equilibrium strategy is the repetition of inefficient noncooperative Nash equilibria (A^*, r^*, R^*).

There are, however, three situations where the trigger strategy remains effective in inducing the efficient strategy $(\hat{A}, \hat{r}, \hat{R})$. The first is the well known situation where the contract either has an infinite duration, i.e., T tends toward infinity, or it has a finite but uncertain duration, i.e., at each time t the probability that the game continues is strictly positive. These two cases are mathematically equivalent with the probability of continuation and the discount factor playing the same role. In this situation, the trigger strategy is effective if the gift is between the minimum and maximum limits established above, and neither partner has an incentive to default.

The second is Radner's case where the landlord cannot default. In this case, the tenant's optimum response is to play $\hat{A}$ until T - 1 and to default at T. The tenant's gain from defaulting and the corresponding landlord's loss can both be made arbitrarily small by choosing T large enough. The trigger strategy with $G_{min} \leq G \leq G_{max}$ leads to an efficient sharecropping contract until the last period in which the inefficient Nash equilibrium will prevail. For T sufficiently large, this can be called an "epsilon-efficient" share contract.

We have, however, rejected the assumption that the landlord cannot default. Under this condition, the bounded rationality approach to modeling human behavior gives another interpretation of an epsilon-efficient share contract. Bounded rationality assumes that decisions may be taken which are not fully rational. Underlying this is the assumption that a fully rational behavior presumes that the decision makers possess large amounts of information which is costly to obtain. The alternatives then are either to explicitly incorporate these costs in the model and maintain full optimization or to use the bounded rationality approach which stipulates an admittedly approximate optimization whereby, in particular, no action will be taken to improve the objective function by less than a given small value.

Applying this approach to the share contract, we assume that even though both tenant and landlord are able to default, the option of defaulting will not be chosen by any partner if the present value of the expected gains are less than a minimum threshold ε. Recalling that the expected gain from defaulting at T is $\Delta W = \alpha^T(\hat{W}' - \hat{W})$ for the tenant and $\Delta Z = \beta^T(\hat{Z}'' - \hat{Z})$ for the landlord, there is for any discount factors α and β, a length of contract T which the landlord can choose to offer beyond which the expected gains from defaulting are negligible. We take this as the most likely explanation of epsilon-efficient sharecropping contracts.

V. Conclusion

Through field work in Thailand, we observed two types of landlord-tenant situations in the context of production uncertainty where a sharecropping contract leads to efficiency in resource use compared to alternative tenancy contracts. Except for the Cheung-Newbery model, where the sharecropping contract can presumably be enforced with respect to the labor input, these situations are contrary to prior received knowledge where uncertain production was thought to justify sharecropping on the basis of risk sharing but at the cost of inefficiency in resource use. The two situations of efficient sharecropping under risk which we observed are quite prevalent in at least much of the Asian developing countries. They are:

1. Situations as in Village N, where the extreme level of poverty of the tenant household, the lack of off-farm income opportunities and consumption credit, and the very high level of risk associated with farm production lead the tenant to assume a safety-first behavior.

2. Situations as in Village Bo, where a long-term contract prevails between a landowner and a tenant that includes reciprocal gift exchange and preservation of the landlord's reputation.

If sharecropping is observed to be a highly prevalent and resilient form of contract in the developing countries, the fact that it is shown to be widely *efficient* in resource use relative to other contracts is an important addition to an explanation of this observation since an efficient institution should, indeed, be expected to prevail and remain.

FOOTNOTES

[1] For recent review articles, see Binswanger and Rosenzweig (1984, Chapter 1), Fukui (1984), Otsuka and Hayami (1988), and Singh (1989).

[2] We choose to perform the efficiency test of sharecropping on variable factor use as opposed to observed yield since the first is closer to decision making and less influenced by variables not controlled by the farmer.

[3] We abstract from the possibility of default on payment by the tenant. Specification of limited liability would affect the average income, its variance, and the attitude toward risk of the tenant (Basu, 1992).

[4] Another explanation of cooperation is imperfect information with reputation.

[5] His statistical method was later challenged and the design of alternative methods has given rise to several follow-up articles.

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Table 1. Village Statistics

	Village N Safety first				Village Bo Gift exchange		
	Owners		Sharecroppers		Owners	Sharecroppers	
	rich	poor	rich	poor		no gift	gift exchange
Land tenure							
Number of observations	36	6	6	8	19	8	10
Income by source (thousand bahts)							
Gross income from rice	21.2	10.3	20.7	10.0	16.8	12.7	24.1
Total gross agricultural income	28.2	15.9	23.4	10.3	19.7	14.7	27.2
Off farm income	8.0	3.3	10.9	3.4	39.1	17.5	25.8
Total cash income	28.1	14.5	27.4	8.8	51.4	24.9	37.2
Farm characteristics							
Farm size (rai)	28.5	11.3	27.2	13.6	10.4	9.7	17.5**
Family workers (numbers)	3.9	3.0	2.8	2.4	3.5	3.0	3.6
Productive assets (excl. tractor) (bahts)	3413	562	3132	640	1563	1644	1578
Tractor per farm size (bahts/rai)	148	0	120	0	184	715**	181
Availability of pump (% of farms)	0	0	0	0	26	0	13
Rice cultivation characteristics							
Area cultivated (rai)	25.1	8.3	26.0	1.3	10.4	9.7	17.5**
Share of family in total labor (%)	65.5	76.5	77.3	72.0	33.6	50.7**	36.4
Labor per area (bahts/rai)	447	716	334	492	316	269	338
Variable inputs per area (bahts/rai)	73	113	46	72.2*	120	99	100
Yield (tan/rai)	29.7	42.2	28.2	25.7**	58.3	55.3	55.8

All mixed tenancies and fixed rent contracts have been excluded.

Units of measurement: Currency: 1 baht = US$ 0.043; area: 1 rai = 0.16 hectare; weight: 1 tan = 10 kilogram.

* (**) significantly different from the mean value for the owners at the 90% (95%) confidence level with a two-tailed test.

Table 2. Levels of factor use by contract

Endogenous variable: Logarithm of expenditure on labor and variable inputs per unit of rice area

Village N: Safety-first behavior			**Village Bo: Gift exchange**		
Exogenous variables	Parameters	t-ratios	Exogenous variables	Parameters	t-ratios
Constant	5.9	11.0*	Constant	6.36	37.9*
Ln share family labor	0.26	2.2* [0.9]°	Ln area in rice	-0.18	2.3* [0.9]°
Ln family workers per farm size	0.34	4.8*			
Tractor ownership dummy	2.09	1.9*	—		
Ln tractor per farm size	-0.40	2.4*			
Local variety dummy	-0.24	2.8*	Pump dummy	0.25	1.8*
Low assets (a)	0.13	1.00			
High assets sharecropper	-0.24	1.85*	Sharecropper (a)	-0.06	0.51
Low assets sharecropper (b)	-0.13	0.81	Sharecropper with gift (b)	0.21	1.64*
Number of observations	56		Number of observations	37	
R-square	0.69		R-square	0.20	
Adjusted R-square	0.63		Adjusted R-square	0.10	
Total effect (a) + (b) Low assets sharecropper	0.005	0.04	Total effect (a) + (b) Sharecropper with gift	0.15	1.24

* Significant at the 95% confidence level with a one-tailed test

° t-statistics of the residual for the Nakamura and Nakamura test of exogeneity