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Efficiency, Share Tenancy, and Allocative Behavior in Peasant Farming:

A Safety-First Approach*

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The resource allocation behavior of peasant farmers is explored in a safety-first model in which farmers may be owner-cultivators, owners-cum-sharecroppers, or pure sharecroppers. Both the risk effect and the incentive effect influence resource allocation decisions. Unlike the results in a simple model with certainty, sharecroppers may use land more or less intensively than owners-cum-sharecroppers. Comparisons are made among the three classes of farmers in terms of the relative intensity of land use. Finally, the implications of gambling-type behavior arising from disaster avoidance are explored.

I. Introduction

In analyzing peasant decision-making under risk, security-based or safety-first models have received considerable attention (Roy; Kataoka; Roumasset; Moscardi and de Janvry; and Kunreuther and Wright). In the paper, a safety-first model of farmer behavior is developed to analyze allocative behavior under which land is cultivated more intensively in owner-farming as

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compared to sharecropping tenancy are explored. As in the simple model with certainty, the safety-first model can lead to the prediction that sharecroppers will use land less intensively than owner-cultivators. Unlike the certainty model, however, in the safety-first model, sharecroppers may use land more intensively than owners-cum-sharecroppers. The risk effect can more than compensate for the incentive effect of the share contract. This is an important result and demonstrates that both the status of the cultivator and the form of contract can importantly influence resource allocation behavior.

In Section II of the paper, the structure of the safety-first model is outlined and the efficiency (first-order) conditions are derived. Based on the cultivator's efficiency conditions, a comparative analysis of resource allocation behavior among three categories of cultivators is made in Section III. The focus is on the determination of what effects risk and contract form will have on the resource allocation behavior; the model is not meant to be and is not a complete model of resource allocation under share tenancy. Concluding observations are made in Section IV.

II. A Safety-Fisrt Model of Farmer Behavior

The proposed model is based on Roy's Safety Principle in which resources are allocated so that the farm family minimizes the probability of disaster. The farm family has in mind some notion of a 'disaster' level of income, d, the critical level below which they face starvation or bankruptcy. Furthermore, they behave so as to minimize the probability of falling below that disaster level. The farm household possesses a set of resources (land, capital, family labor and purchased inputs) which can be used in a set of production processes, each of which has an uncertain outcome. The randomness of expected net income can be attributed to both production as well as price uncertainty (for convenience input price uncertainty will be ignored).

We identify three important categories of farm households in our model — owner-cultivator (whose entire cultivated holding is composed of owned land), owner-cum-sharecropper (part of whose holding is composed of land rented-in under sharecropping tenancy) and pure sharecropper (whose entire holding is composed of land rented-in under sharecropping tenancy). Contract choice is not endogenous; the model does not attempt to explain the choices among wage, fixed-rent, and share-rent contracts. Instead the model focuses on the effects of the type of contract on the resource allocation decisions. In particular the model is incomplete because the behavior of the landlord is omitted from the analysis.

Because of the potential for differential resource-use patterns in rented-in land, the relation between inputs and output is represented by the following two sets of production functions (using two crops and three inputs to illustrate the model).

$$(1)\ Q_1 = g(L_1, X_1, Y_1)\, u_1$$

$$(2)\ Q_2 = h(L_2, X_2, Y_2)\, u_2$$

$$(3)\ \overline{Q}_1 = \overline{g}(\overline{L}_1, \overline{X}_1, \overline{Y}_1)\, u_1$$

$$(4)\ \overline{Q}_2 = \overline{h}(\overline{L}_2, \overline{X}_2, \overline{Y}_2)\, u_2$$

where Q_i represents the physical output of crop i in owned land, $\overline{Q}_i$ represents the physical output of crop i in rented-in land, L_i, X_i and Y_i represent the amount of land and of the two other variable inputs used in cultivation, and u_i represents the random component associated with crop production. Similarly, the output prices have random components (for convenience we assume that the random disturbances that affect prices have no effect on outputs and vice versa).

Total net income of the owner-cultivator in the two-crop model is represented by (5), and the net income of the owner-cum-sharecropper and the sharecropper (assuming that the cultivator receives a crop-share of θ from the output of his rented-in land) are represented by (6) and (7), respectively.

$$(5)\ r = P_{Q_1} Q_1 + P_{Q_2} - \{w_x(X_1 + X_2) + w_y(Y_1 + Y_2)\}$$

$$(6)\ r^* = P_{Q_1} Q_1 + P_{Q_2} Q_2 + \theta(P_{Q_1} \overline{Q}_1 + P_{Q_2} \overline{Q}_2) - \{w_x(X_1 + X_2 + \overline{X}_1 + \overline{X}_2) + w_y(Y_1 + Y_2 + \overline{Y}_1 + \overline{Y}_2)\}$$

$$(7)\ r^{**} = \theta(P_{Q_1} \overline{Q}_1 + P_{Q_2} \overline{Q}_2) - \{w_x (\overline{X}_1 + \overline{X}_2) + w_y(\overline{Y}_1 + \overline{Y}_2)\}$$

where w_x and w_y represent the prices of variable inputs X and Y.

Under the assumption of stochastic independence of the output and price disturbances, the mean and variance of net income for each of the three categories of farm households can be derived. Also, there are additional constraints imposed by the total availability of land to the farm households in each of the three categories.

As observed earlier, in the safety-first model of resource allocation, the farm family is motivated by disaster-avoidance and, therefore, allocates resources to various crops to minimize the probability of disaster. The certainty equivalent of the probability of disaster, $P(r < \bar{d})$, can be derived, following Pyle and Turnovsky, by assuming that the distribution of random variable, r, can be fully described by its two parameters, mean and variance, μ_r and σ_r. Minimization of the probability of disaster is thus equivalent to minimizing the expression, $((\bar{d} - \mu_r)/\sigma_r)$, subject, of course, to the constraints imposed by the production functions and the amount of land. Therefore, minimizing $((\bar{d} - \mu_r)/\sigma_r)$, with respect to the relevant constraints for each type of cultivator yields a set of first-order conditions for the decision variables, L_i, X_i and Y_i (see Table 1).

In equations (8) through (10), the left hand side in each case represents the expected value of marginal product of the inputs, L, X, and Y in the production of crop i. On the right hand side, the input price or the opportunity cost of the respective input is compounded by a risk factor, ϕ_{Q_1}, associated with the use of that input in the production of crop i. The risk factor reflects not only the uncertainty of net income, but also the characteristics of the cultivator, particularly his subsistence needs relative to his income-earning potential. It is evident, therefore, that the right hand side represents the farmer's perceived cost for each input which he equates to the expected value of its marginal product to arrive at the allocation of resources which is optimal, given both production as well as price uncertainty. Equations (11) through (16) may be interpreted similarly.

III. Allocative Behavior under Sharecropping Tenancy

Based on the first-order conditions presented in Table 1, four

Table 1

FIRST-ORDER CONDITIONS BY TYPE OF CONTRACT

First-Order Conditions for Owner-Cultivator

$$(8)\quad E(VMP_{L_i}) = \lambda\sigma_r[\{(\bar{d}-\mu_r)/\sigma_r^2\}E(P_{Q_i})E(Q_i)\sigma^2_{u_iv_i} + \{(\bar{d}-\mu_r)/\sigma_r^2\}E(P_{Q_j})E(Q_j)\sigma_{12}+1]^{-1}.$$

$$(9)\quad E(VMP_{X_i}) = w_x[\{(\bar{d}-\mu_r)/\sigma_r^2\}E(P_{Q_i})E(Q_i)\sigma^2_{u_iv_i} + \{(\bar{d}-\mu_r)/\sigma_r^2\}E(P_{Q_j})E(Q_j)\sigma_{12}+1]^{-1}.$$

$$(10)\quad E(VMP_{Y_i}) = w_y[\{(\bar{d}-\mu_r)/\sigma_r^2\}E(P_{Q_i})E(Q_i)\sigma^2_{u_iv_i} + \{(\bar{d}-\mu_r)/\sigma_r^2\}E(P_{Q_j})E(Q_j)\sigma_{12}+1]^{-1}.$$

First-Order Conditions for Owner-cum Sharecropper

$$(11)\quad E(VMP_{L_i})^* = \lambda_1\sigma_{r*}[\{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}E(P_{Q_i})E(Q_i)\sigma^2_{u_iv_i} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}\theta E(P_{Q_i})E(\bar{Q}_i)\sigma^2_{u_iv_i} + \{(\bar{d}-\mu_{r*})/\sigma_{r*}^2\}E(P_{Q_j})E(Q_j)\sigma_{12} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}\theta E(P_{Q_j})E(\bar{Q}_j)\sigma_{12}+1]^{-1}.$$

$$(12)\quad \theta E(VMP_{\bar{L}_i})^* = \lambda_2\sigma_{r*}[\{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}E(P_{Q_i})E(Q_i)\sigma^2_{u_iv_i} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}\theta(P_{Q_i})E(\bar{Q}_i)\sigma^2_{u_iv_i} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}E(P_{Q_j})E(Q_j)\sigma_{12} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}\theta E(P_{Q_j})E(\bar{Q}_j)\sigma_{12}+1]^{-1}.$$

$$(13)\quad E(VMP_{X_i})^* = w_x[\{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}E(P_{Q_i})E(Q_i)\sigma^2_{u_iv_i} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}\theta E(P_{Q_i})E(\bar{Q}_i)\sigma^2_{u_iv_i} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}E(P_{Q_j})E(Q_j)\sigma_{12} + \{(\bar{d}^*-\mu_{r*})/\sigma_{r*}^2\}\theta E(P_{Q_j})E(\bar{Q}_j)\sigma_{12}+1]^{-1}.$$

Table 1 (continued)

$$(14)\quad \theta E(VMP_{\overline{X}_i})^* = w_x[\{(\bar{d}^*-\mu_{r^*})/\sigma^2_{r^*}\}E(P_{Q_i})E(Q_i)\sigma^2_{u_iv_i} + \{(\bar{d}^*-\mu_{r^*})/\sigma^2_{r^*}\}\theta E(P_{Q_i})E(\overline{Q}_i)\sigma^2_{u_iv_i} + \{(\bar{d}^*-\mu_{r^*})/\sigma^2_{r^*}\}E(P_{Q_j})E(Q_j)\sigma_{12} + \{(\bar{d}^*-\mu_{r^*})/\sigma^2_{r^*}\}\theta E(P_{Q_j})E(\overline{Q}_j)\sigma_{12}+1]^{1}.$$

First-Order Conditions for Sharecropper

$$(15)\quad \theta E(VMP_{\overline{L}_i})^{**} = \lambda\sigma_{r^{**}}[\{(\bar{d}^{**}-\mu_{r^{**}})/\sigma^2_{r^{**}}\}\theta E(P_{Q_i})E(\overline{Q}_i)\sigma^2_{u_iv_i} + \{(\bar{d}^{**}-\mu_{r^{**}})/\sigma^2_{r^{**}}\}\theta E(P_{Q_j})E(\overline{Q}_j)\sigma_{12}+1]^{-1}$$

$$(16)\quad \theta E(VMP_{\overline{X}_i})^{**} = w_x[\{(\bar{d}^{**}-\mu_{r^{**}})\sigma^2_{r^{**}}\}\theta E(P_{Q_i})E(\overline{Q}_i)\sigma^2_{u_iv_i} + \{(\bar{d}^{**}-\mu_{r^{**}})/\sigma^2_{r^{**}}\}\theta E(P_{Q_j})E(\overline{Q}_j)\sigma_{12}+1]^{1}.$$

Note: To save space the first-order conditions for input Y_i are omitted for the owner-cum sharecropper and sharecropper contracts. E is the expectation operator, $\overline{L}$ is the owner cultivator's operational holding of rented-in land, $\overline{L}^*$ is the owner-cum sharecropper's operational holding, $\overline{L}^{**}$ is the sharecropper's operational holding, u_i is the stochastic component of output for crop i, v_i is the random component of price of crop i, $\sigma^2_{u_iv_i}$ is the variance of disturbances affecting farmer's income from crop i, and σ_{12} is the covariance of disturbances affecting income from crop 1 and crop 2.

cases with important implications for resource allocation behavior in peasant farming under conditions of uncertainty are examined.

Case 1

The first case to be examined is the resources allocation behavior of owner-cum-sharecropper, both on his owned and on his rented-in land. The relevant first-order conditions, (13) and (14), yield the following efficiency conditions for the use of variable input X on his owned land and rented-in land, respectively.

$$(17)\ E(VMP_{X_i})^* = w_x \phi^*_{Q_i}$$

$$(18)\ \theta E(VMP_{X_i})^* = w_x \phi^*_{\bar{Q}_i}$$

From (17) and (18), we get

$$(19)\ E(VMP_{\bar{X}_i})^* = (\phi^*_{\bar{Q}_i}/\phi^*_{Q_i})\ (1/\theta)\ E(VMP_{x_i})^*$$

By assumption $\phi^*_{Q_i} = \phi^*_{\bar{Q}_i}$, the riskiness associated with the cultivation of crop Q_i on both owned and rented-in land is the same. Thus, for $0<\theta<1$, $E(VMP_{\bar{X}})^* > E(VMP_X)^*$, which means that there is an incentive on the part of the owner-cum-sharecropper to restrict resource-use on rented-in land as compared to owned land. It is also quite evident that the tendency to cultivate the sharecropped land less intensively will be stronger, the lower the value of crop-share, θ the farmer receives. The result is analogous to the results obtained in what Cheung calls the "tax equivalent approach." It is not being argued here that the result is one which we would observe with much frequency in the real world, because as Cheung and others have pointed out, the landlord will often take steps to ameliorate the disincentive effects of the share contract.

Case 2

In case two the differences in the resource use of an owner-cultivator and an owner-cum-sharecropper are explored. The relevant first-order conditions, (9) and (13), yield the following efficiency conditions for the use of variable input X in the cultivation of crop Q_i by an owner-cultivator, and by an owner-cum-sharecropper on his owned land, respectively.

$$(20)\ E(VMP_{X_i}) = w_x \phi_{Q_i}$$

$$(21)\ E(VMP_{x_i})^* = w_x \phi^*_{Q_i}$$

Using (20) and (21), we obtain:

$$(22)\ E(VMP_{X_i}) \gtrless E(VMP_{X_i})^* \text{ as } \phi_{Q_i} \gtrless \phi^*_{Q_i}$$

Thus, it follows that the owner-cultivator's use of the variable input X in his cultivated land differs (unless, of course, $\phi_{Q_i} = \phi^*_{Q_i}$) from that of an owner-cum-sharecropper on his owned land. The extent of divergence depends on the difference in the two risk factors, ϕ_{Q_i} and $\phi^*_{Q_i}$. The fact that part of his cultivated holding is composed of rented-in land affects the resource allocation decision on his owned land as well. The status of the cultivator and not just the characteristics of the contract has an impact on resource allocation behavior.

A closer examination of the two risk factors shows that for $\bar{d} < \mu_r$ (and $\sigma_{12} > 0$) i.e., for the farm family whose expected income-earning capacity is adequate to meet its subsistence requirements, $\phi^*_{Q_i} > \phi_{Q_i}$ which leads to $E(VMP_{X_i})^* > E(VMP_{X_i})$. Therefore, under such circumstances, the farmer's use of his owned land will be less intensive if he decides to augment his cultivated holdings through renting-in land under sharecropping tenancy.

Case 3

Perhaps the most interesting case is the comparison of the allocative behavior under pure sharecropping tenancy with that under owner-cultivation. Using the relevant first-order conditions, (9) and (16), we obtain:

$$(23)\ E(VMP_{X_i}) = w_x\, \phi_{Q_i}$$

$$(24)\ \theta E(VMP_{\bar{X}_i})^{**} = w_x\, \phi^{**}_{\bar{Q}_i}$$

Using (23) and (24),

$$(25)\ E(VMP_{\bar{X}_i})^{**}/E(VMP_{x_i}) = (\phi^{**}_{\bar{Q}_i}/\phi_{Q_i})(1/\theta)$$

Thus, in this case, whether $E(VMP_{\bar{X}_i})^{**} > E(VMP_{X_i})$ i.e., whether land is cultivated less intensively under sharecropping tenancy, depends on whether $\phi^{**}_{\bar{Q}_i} \geqslant \phi_{Q_i}$ given $0 < \theta < 1$. Even for $\phi^{**}_{\bar{Q}_i} < \phi_{Q_i}$, $E(VMP_{\bar{X}_i})^{**}$ exceeds $E(VMP_{X_i})$ as long as

$(\phi^{**}_{\bar{Q}_i} / \phi_{Q_i}) > \theta$. Only in a very special case of both $\phi^{**}_{\bar{Q}_i} < \phi_{Q_i}$ and $(\phi^{**}_{\bar{Q}} / \phi_Q) < \theta$ will $E(VMP_{\bar{X}_i})^{**}$ fall short of $E(VMP_{X_i})$. Although the out-come is an empirical matter, there would appear to be greater possibilities for less intensive land-use under sharecropping tenancy. This may be attributed to two distinct factors affecting resource use in peasant farming — the incentive and risk effects.

A. Incentive Effect

Because $\partial\{E(VMP_{X_i})^{**}/E(VMP_{X_i})\}/\partial\theta = -(\phi^{**}_{\bar{Q}}/\phi_Q)\ (1/\theta^2) < 0$, it follows that given the relative risk factors $(\phi^{**}_{\bar{Q}} / \phi_Q)$, the lower the valus of θ, i.e., the lower the crop-share that the sharecropper receives on his rented-in land, the stronger will be his tendency to cultivate the land less intensively as compared to that of an owner-cultivator (analogous to the results obtained in Case I).

B. Risk Effect

Again, since $\partial\{E(VMP_{\bar{X}_i})^{**}/E(VMP_{X_i})\}/\partial(\phi^{**}_{\bar{Q}}/\phi_Q) = (1/\theta) > 0$ it follows that for a given crop share, θ, the higher the value of $\phi^{**}_{\bar{Q}}/\phi_Q)$, i.e., the higher the 'risk' factor associated with crop-cultivation for a share-cropper relative to that for an owner-cultivator, the greater the tendency on the part of the former to cultivate his land less intensively as compared to the latter. Thus, both risk and incentive effects combine to induce a less intensive use of variable inputs on sharecropped land relative to that on an owner-operated holding.

Case 4

Finally, the allocative behavior of the pure sharecropper and that of an owner-cum-sharecropper in the cultivation of his *rented-in* land are examined. Using the relevant first-order conditions (14) and (16),

$$(26)\ \theta E(VMP_{\bar{X}_i})^{*} = w_x\,\phi^{*}_{\bar{Q}_i}$$

$$(27)\ \theta EE(VMP_{\bar{X}_i})^{**} = w_x\,\phi^{**}_{\bar{Q}_i}$$

From (26) and (27), it follows that

(28) $E(VMP_{\bar{X}_i})^* \gtreqless E(VMP_{\bar{X}_i})^{**}$ as $\phi^*_{\bar{Q}_i} \gtreqless \phi^{**}_{\bar{Q}_i}$

However, a closer examination of the terms comprising the two risk factors shows that $\phi^*_{\bar{Q}_i} > \phi^{**}_{\bar{Q}_i}$ for $\bar{d}^* < \mu_{r*}$ and $\bar{d}^{**} > \mu_{r**}$, which leads to $E(VMP_{\bar{X}_i})^* > E(VMP_{\bar{X}_i})^{**}$. That the owner-cum-sharecropper may have a tendency to cultivate his rented-in land less intensively than the pure sharecropper appears to be counterintuitive in view of the relatively greater risk-bearing capacity of the former. The situation is, however, more complicated. The owner-cum-sharecropper confronted with successive crop failures, may be forced to sell his land and become a pure sharecropper relying entirely on rented-in land for cultivation purposes. Under such circumstances the sharecropper, in order to have any chance of meeting his subsistence requirements, may resort to 'gambling-type' behavior. In fact such behavior is sometimes observed among the poorer farmers in peasant agriculture (Roumasset; Kunreuther and Wright; Shahabuddin; and Shahabuddin, Stuart, and Feeny). With the income-earning capacity from farming activities sufficiently reduced so that the family is hardly able to cover its subsistence needs, the sharecropper has to take risks in order to have any chance of meeting his subsistence goals. Under such circumstances the sharecropper will in fact be using (with his $\bar{d}^{**} > \mu_{r**}$ and hence $\phi^{**}_{\bar{Q}} < 1$) more resources than called for under risk-neutral expected-profit maximization. (of course if $\bar{d}^* > \mu_{r*}$ and $\bar{d}^{**} < \mu_{r**}$ the results would be reversed).

IV. Summary and Conclusions

In peasant agriculture where the farms are extremely small and cultivation is dependent upon highly variable rainfall, the farm family may be preoccupied not with maximizing income, but with maximizing its chances of survival. Safety-first models of decision-making are based on this notion of disaster-avoidance; this study specifically employs Roy's Safety Principle. In particular, the conditions under which land is cultivated more intensively by owner-cultivators as compared to sharecroppers are delineated. Four interesting cases were examined.

In comparing the allocative behavior of a sharecropper with that of an owner-cum-sharecropper in the use of his rented-in land, it was noted that the sharecropper may cultivate his land more intensively as compared to the owner-cum-sharecropper. With income-earning capacity from farming activities barely sufficient to meet the subsistence needs of the farm family, the sharecropper resorts to 'gambling type' behavior in order to have the best chance of achieving his subsistence goals. Behavior of this sort has indeed been observed among the poorer farmers in peasant agriculture. Scandizzo and Dillon found in a sample of sharecroppers and small holders in a drought-prone area in Northeast Brazil that the latter tended to be more conservative that the former.

In most less developed countries sharecroppers generally have fewer assets than do land owners. Thus sharecroppers are more likely to be in the situation in which expected income is less than subsistence needs. There will, of course, also be land owners who are also forced to resort to gambling type behavior.

The paper has focused on the derivation of results concerning the relative intensity of land use under sharecropping as compared to owner cultivation. The results are in part analogous to the results obtained by Cheung in a model in which uncertainty is ignored. There is, however, an important difference between this safety-first model and what Cheung calls the "tax-equivalent approach." In the safety-first model land may be used more or less intensively under sharecropping, whereas in the certainty model, there is only an incentive effect and thus sharecropping necessarily leads to less intensive land use. In the safety-first model in which relative risk factors also affect resource allocation decisions, the relative intensity of land use rankings can be reversed.

Thus, in a safety-first model, sharecropping may lead to a higher or lower intensity of land use. The model is, however, like the "tax-equivalent approach" criticized by Cheung, incomplete. The landlord would be aware of the disincentives that may operate under the share contract and would, subject to transaction cost, take actions to enforce a higher level of variable input use. In the safety-first world of uncertainty, however, the disaster avoidance motive of the tenant may make the landlord's monitoring efforts unnecessary (or less necessary), a result that does not follow in the simple certainty model.

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