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EXPLAINING DIVERSITY IN AGRICULTURAL ORGANIZATION: AN AGENCY PERSPECTIVE

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Explaining Diversity in Agricultural Organization:
An Agency Perspective

by James Roumasset

Introduction

The economics of internal organization [*e.g.* Spence (1975), Williamson, Wachter and Harris (1975), Stiglitz (1975), Mirrlees (1975), the New Institutional Economics (Williamson ,1985) and the New Classical Microeconimics (Yang and Ng, 1993) provide a dynamic new approach to industrial organization. Long standing dissatisfaction with representing the firm as nothing more than a production function has led to exciting investigations into organizational matters such as contractual form, methods of compensation, hierarchy, and vertical integration. Our purpose here is to synthesize this theory as it applies to labor contracts and the nature of the agricultural firm, illustrate how the theory can be used to explain empirical patterns in the employment relation, and extend the theory to explain particular patterns in agricultural labor contracts. Our primary objective is to demonstrate the utility of the theory for explaining agricultural organization and to suggest a methodology for empirical investigation.

1.1 Piece Rates, Time Rates and Teams

This section illustrates how the economics of internal organization can be used to explain patterns in agricultural labor contracts. Piece rates tend to be chosen over time rates for tasks where shirking is easy monitor by *ex post* inspection. The incidence of piece rates is also higher where the work force is more heterogeneous, where high opportunity wages prevail and where some agricultural operations are done by specialized teams. These relationships are implied by the proposition that contracts minimize excess burden in the face of enforcement and information costs.

1.1.1 Information costs and the theory of labor contracts

The competitive theory of contracts [Cheung (1969), Newbery (1974), Reid (1976), Roumasset (1979)] may be paraphrased as follows: if contracting costs are small and the numbers of economic agents of all types are large, then no contracting solution which does not approximate a competitive equilibrium can be an equilibrium solution [see also Arrow (1969) and Hildebrand (1977)]. This theory has been used to explain the *terms* of contracts, for example, cross-sectional and temporal differences in the percentage shares going to various parties in share contracts [Roumasset and James (1979)]. The theory is not useful, however, for explaining the choice among alternative *forms* of contracts and methods of organizing production. For the latter, we need a comparative institutions framework [Coase (1960), Demsetz (1969)].

An institution is a system of rules which delineates guidelines of interaction among members of a social system [Roberts and Holdren (1972), Ruttan (1978, p. 329)]. A contract is a specific type of institution. The economic function of institutions is to economize on transactions costs, in particular, enforcement and information costs [Roumasset (1974), Anderson and Hill (1975), North (1977), Williamson (1980)]. Thus the competitive theory of contracts, which abstracts from transaction costs, is inadequate to explain institutional form. An alternative theory is that institutions evolve so as to minimize excess burden [Demsetz (1972), Roumasset (1978 and 1979)].

Stiglitz implicitly applies the latter principle to the choice of piece rates versus time rates [see also Lucas (1979)]. Time rates are alleged to induce "effort shirking," which can be mitigated by supervision. Piece rates are thought to avoid effort shirking but permit "quality shirking." Where quality shirking is easy to detect, it can be limited by a modest amount of supervision.

Stiglitz also showed that piece rates can be used to screen out less productive workers when the quality of workers is variable and unknown. It is possible to set piece

rates sufficiently low that only the most skilled workers will receive their opportunity wage and accept the job.

For some tasks, it will be difficult to set the piece rate to equate the marginal product of labor with the implicit wage, even if the ability of the worker is unknown. The loss in such cases of setting the piece rate too high is roughly equal to the difference between the implicit and opportunity wages times the quantity of labor employed. The disadvantage of setting the rate too low is that workers will not accept work or they will quit once they learn the implicit wage. Time rates will therefore tend to be chosen in such situations.

In order to predict and/or explain empirical patterns concerning the choice between piece rates and time rates, we need a model which incorporates the considerations above. Our model should integrate the problem of comparing the excess burden of alternate contracts with the problem of investing in the optimal amounts of monitoring and screening activities.[1] It wold not be appropriate to compare, for example, piece and time rates where information was assumed to be identical in both cases. Rather a piece rate contract, with its own optimal amount of enforcement and information, must be compared to a time rate contract with its optimal amount of enforcement and information.

There has been some confusion about the source of shirking. Alchian and Demsetz (1972) held that it is the difficulty of knowing each worker's contribution to total output which led to the problem. Other authors [*e.g.*, Mirrlees (1975)] have correctly observed that it is only necessary to know the inputs of workers to be able to pay workers their marginal products.

It is instructive here to view workers as producing intermediate products (*e.g.*, sugarcane planted or harvested, weeds removed) which in turn are inputs to the final product (sugarcane). The problem now is to estimate the quantity of intermediate inputs.

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[1]Stiglitz (1975) discusses both problems, but not in a unified framework.

Represent output, Q, as function of a vector of intermediate inputs, X, and the state of the world, q. X in turn is produced as a function of labor quantity, N, average quality, ß, and effort, e. Summarizing,

(1) $$Q=Q(q,X),$$

(2) $$X=f(b,e,N)$$

Management seeks to estimate X. The better the estimate, the closer management can come to paying workers their marginal products and avoiding shirking. Management's optimization problem is to select a reward function and a level of supervision/monitoring so as to maximize profits.

Piece rates and time rates, each combined with its own standards and penalties, are examples of reward functions. For both payment systems, reward depends on estimated X. In the case of piece rates, X is estimated by directly observing the result of a worker's effort, *e.g.*, planted cane standing in a field. Standards, *e.g.*, about the uniformity of planted cane, and penalties are also related to direct observation of X. To the extent that standards and penalties are associated with discrete categories, workers will have an incentive to perform close to the minimum that is required to be classified in a particular category. More generally, the reward function does not pay the worker the full increase in profits associated with improvements in the quality of his work. For example, if a worker allows a small enough variation in the uniformity of planted cane, his reward will not be diminished. As a result, piece rates are associated with "quality shirking."

In the case of time rates, X is estimated indirectly via estimates of ß, e, and N and the function f(ß,e,N). Penalties are associated with standards and observations relating to e. Since the employer's estimate of e depends partially on factors out of the worker's control (*e.g.*, past performance, race, age, sex), the reward function does not provide the worker with the full increase in profits associated with an increase in effort. We call this "effort shirking."

We can now view labor contracts or reward functions as determined according to the following model. The employer chooses the quantity of labor, N, expenditures on supervision, S, and the reward function, R_i, in order to

(3) $$\underset{N,S,R_i}{Max}\ E(\pi) = \int_0^1 PQ_i(\theta, X)P(\theta)d\theta - C(N,S,i),$$

where q is a random variable on the 0-1 interval, with density function p(q), P is output price, and C is the cost function. The worker chooses effort and some aspects of work quality (*e.g.*, diligence, care) so as to maximize utility, *i.e.*.,

(4) $$\underset{e,\beta}{Max}\ U = U\left[R_i(X'), e, \beta\right]$$

where X' = g(S,β,e) is the employer's estimate of the laborer's product X.

Conditions 3 and 4 combined with the condition that the employer must pay the worker his opportunity utility level [see Stiglitz (1975), Newbery and Stiglitz (1979)], give rise to a determinate contract.

By making additional assumptions, e.g, that there is a fixed penalty for being caught shirking under time rates and that the probability of being caught is a concave function of supervision [see, *e.g.*, Calvo and Wellisz (1979)], we get the natural implication that supervision increases effort but with a decreasing marginal product. That is,

(5) $$e = e_i(S_i), \quad \frac{de}{dS} > 0, \quad \frac{d^2e}{dS^2} < 0,$$

for the ith reward function.[2]

One may similarly associate "quality shirking" with the quality variable, ß, so that under piece rates,

(6) $$\beta = \beta_i(S), \quad \frac{d\beta}{dS} > 0, \quad \frac{d\beta}{dS^2} < 0.$$

To facilitate the graphical exposition below, we further assume that there is no effort shirking under piece rates and no quality shirking under wage rates. In terms of our model, this follows from the more basic assumptions that

[2]Alternatively, following Lucas, one can treat condition 5 as a self-evident assumption.

(7) $$\frac{\partial g_P}{\partial e} = \frac{\partial f}{\partial e}$$

and

(8) $$\frac{\partial g_t}{\partial \beta} = \frac{\partial f}{\partial \beta},$$

where g_p and g_t are the functions for estimating X for piece rates and time rates respectively.

Also note that maximizing profits is the same as minimizing the difference between what profits would be if contracts could be perfectly and costlessly enforced and profits under costly supervision and information. This difference between "first-best" and "second-best" profits may be called excess burden, borrowing the name of the same concept from the optimal taxation literature.[3] More formally, define excess burden of the ith reward function as

$$EB_i = \dot{\pi}_{1i} - \dot{\pi}_{2i}$$

where $\dot{\pi}_{1i}$ and $\dot{\pi}_{2i}$ are the first- and second-best profit maxima. That is, $\dot{\pi}_{2i}$ is the solution of eq. (3) and $\dot{\pi}_{1i}$ is the profit maximum given by

(9) $$\underset{N,S,R_i}{Max}\ E(\pi) = \int_0^1 PQ_i(\theta, X)P(\theta)d\theta - C(N,i),$$

where X is costlessly observed.[4] For graphical convenience, we further define shirking cost as

(10) $$C_i = EB_i - S_i,$$

or

$$EB_i = C_i + S_i$$

recalling that S_i is expenditure on supervision for the ith reward function.

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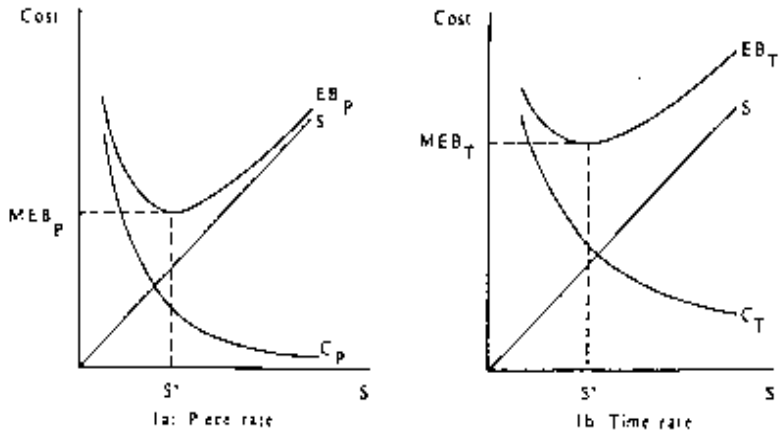
[3]As in optimal taxation, one should not take "excess" in the literal sense of implying the feasibility of reducing the burden. This poses a problem in optimal semantics. "Excess burden" is an imprecise term for a precise concept. While changing the term may have ceratin pedagogical advantages, there would be sizeable transaction costs of doing so. (This footnote is dedicated to Armen Alchian.)

[4]Formally, $\lim_{S \to \infty} X' = X$, where s is the quantity of supervision/information and $S = P_S S$. Now for costless information, $P_S = 0$, the employer can be regarded as knowing X. Both piece and time rates are capable of achieving the first-best optimum.

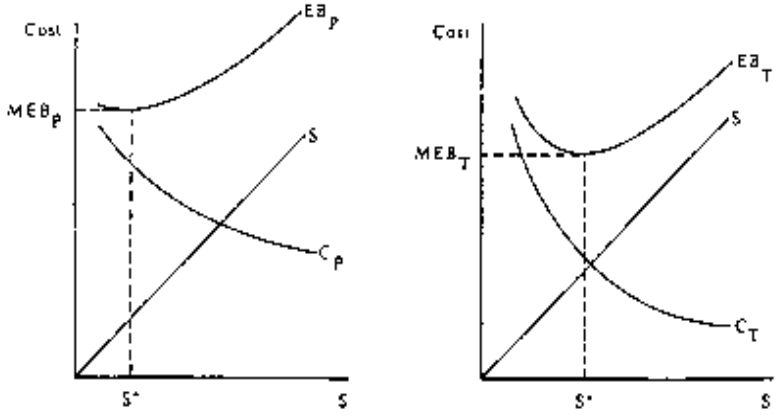
We can now graph excess burden as the sum of supervision expenditures and shirking costs. In fig. 1, we use excess burden graphs to illustrate the hypothesis that the incidence of piece rate contracts is inversely related to the difficulty of monitoring quality shirking. Fig. 1a represents a task for which quality shirking is easy to monitor so that quality shirking is less costly than effort shirking. This is reflected by the rapid decline of C_p and its relatively low position with a small amount of supervision.

Case I: Quality shirking easy to monitor



1a: Piece rate 1b Time rate

Case II: Quality shirking hard to monitor



1c Piece rate 1d. Time rate

Fig. 1. Effect of monitoring difficulty on choice of contract.

Figs. 1c and 1d represent a task for which quality shirking is harder to detect. Accordingly, C_p in fig. 1c is substantially higher than in 1a. On the other hand, C_t in fig. 1d is unaffected by the difficulty of monitoring quality shirking, reflecting the assumption in eq. (8). Also note that C_p is relatively flat in figs. 1a and 1c at higher levels of supervision. This captures the assumption that the marginal product of supervision at high levels of supervision is relatively low under piece rates.

Since supervision is measured in monetary units, the cost of supervision is a 45 degree line.[5] Excess burden, EB, is the sum of S and C. Profit-maximizing supervision, S*, occurs where EB is at a minimum. Comparing the top two diagrams we see that fig. 1a has the least minimum excess burden. That is, where quality shirking is "easy" to monitor, our theory predicts that piece rates will be chosen.

Fig. 1c illustrates the proposition that as the difficulty of monitoring quality shirking increases, the cost of shirking rises for a given amount of supervision. It follows then that if difficulty is increased "enough," that the minimum excess burden of piece rates will rise above that of time rates and time rates will be preferred.

Fig. 1 has been constructed to illustrate the optimality of piece rates for the "easy-to-monitor" case. Clearly the curves could have been drawn so that piece rates (or time rates) dominate in both cases. The critical point is that piece rates reduce effort shirking and that quality shirking is more responsive to monitoring for tasks which are easy to monitor. This leads to the comparative statics proposition that the greater the difficulty of detecting quality shirking, the less will be the incidence of piece rates.[6]

A similar analysis can be applied where there is difficulty in setting the appropriate piece rate. In such cases, there is an additional source of excess burden. In terms of fig.

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[5]Since supervision is a composite of several activities, we assume that any expenditure, S, will be spent in the most effective way.

[6]If we extend Stiglitz's framework to cover this case, the result is that as monitoring quality shirking becomes more difficult, the proportion of the worker's reward coming from the "incentive payment" (piece rate) becomes larger.

1, we can imagine curve C_p rising as the uncertainty about the appropriate piece rate rises. Clearly it is possible that curve C_p will rise enough so that time rates will be preferred.

The quality variable, ß, is affected both by factors controlled by the worker and by factors out of his control in the short run. In the discussion of quality shirking, we have dealt with the former. We now investigate the case where workers differ according to inherent quality, *i.e.*, skill. By investing in knowledge about worker quality, the employer can decrease the probability that a worker's quality will differ from the predicted value by more than some arbitrary e. That is, knowledge "squeezes" the probability distribution of worker quality about the true quality. To the extent that the frequency distributions of workers are characterized by large variances, the employer will tend to lose profits in the selection process. For example, if wages are set higher than the opportunity cost of the desired employee, then wages will be unnecessarily high. If the wage is set too low, however, the desired employees will not accept work and the marginal product of attracted workers will be lower than anticipated. Thus, the employer faces a tradeoff between collecting information about worker quality or suffering a loss of profits due to his inability to equate wage with marginal product and to select appropriate workers.

Piece rates, however, can economize on the cost of collecting information about workers. It is possible, for example, that piece rates can be set sufficiently low that only workers who are "fast" at a particular task will accept the job. Others will find that their implicit wage is lower than their opportunity wage [Stiglitz (1975)]. This sorting function is called "screening by self-selection."[7] Thus one would except, *ceteris paribus*, that a greater degree of worker heterogeneity would lead to a greater incidence of piece rate contracts.

In summary, we expect the incidence of piece rates to be higher the easier it is to monitor quality shirking, the easier it is to set piece rates to equate the implicit wage with

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[7]Hallagan (1977, 1978) and Newbery and Stiglitz (1979) develop this argument for the case of rent, wage, and share contracts. See also Salop and Salop (1976).

the opportunity wage, and the greater the heterogeneity of the work force. These tendencies hold even when information and enforcement are choice variables to the firm.

1.2 An Application to Philippine Sugarcane Farms

This section illustrates how the theory developed above can be used to document and explain actual patterns found in labor arrangements. The application uses empirical evidence on labor contracts used by selected sugarcane farms in the Philippines. The sample was chosen in order to obtain substantial contrast regarding certain agroeconomic characteristics like land quality, wage rates and farm sizes, given the preliminary hypothesis that these factors play an important role in determining choice of contracts. Data was gathered from four provinces: Batangas, Tarlac, Laguna, and Negros Occidental. Three municipalities were picked out from each province for a total of twelve survey areas. The farm was the unit of analysis and five farms were chosen from each municipality for a total of 60 respondents. In the choice of survey areas, the purposive sampling technique was used and was geared towards attaining the maximum contrast among the prevailing contractual arrangements [see Uy (1979) for additional details].

A variety of arrangements were noted among the sample farms. Table 1 presents the incidence of piece and wage contracts for various tasks.[8] "Pakyaw" is a type of piece rate wherein workers are paid according to the land area covered. "Pakyaw" dominates land preparation, weeding and cultivation. Labor hired for cutting canepoints and harvesting is paid almost exclusively by piece rates. Chemical application tends toward the use of time rates.

[8]Respondents which utilized only family labor for certain tasks and those which did not perform certain operations are also indicated. Sample farms which had only ratoon crops for the surveyed crop year, 1977-1978, for instance, did not have land preparation and planting operations.

Table 1

Frequency distribution of payment systems across chosen tasks.[a]

	Number of observations (percentages in parentheses)					
	No operation	Time rate	*Pakyaw*	Piece rate	Family labor	Total ($n = 60$)
Plowing	10	—	—	—	—	60
	(16.7)	—	—	—	—	(100)
Tractor rented	—	—	29	—	—	—
			(48.3)	—	—	—
Tractor owned	—	15	2	—	—	—
	—	(25.0)	(3.3)	—	—	—
Plow rented	—	3	—	—	—	—
		(5.0)	—	—	—	—
Plow owned	—	1	—	—	—	—
	—	(1.7)	—	—	—	—
Cutting canepoints	13	2	—	42	3	60
	(21.7)	(3.3)	—	(70.0)	(5.0)	(100)
Planting	11	20	2	20	7	60
	(18.3)	(33.3)	(3.3)	(33.3)	(11.7)	(100)
Replanting	5	29	—	13	13	60
	(8.3)	(48.3)	—	(21.7)	(21.7)	(100)
Fertilization	—	26	5	15	14	60
	—	(43.3)	(8.3)	(25.0)	(23.3)	(100)
Chemical application	50	9	—	—	1	60
	(83.3)	(15.0)	—	—	(1.7)	(100)
Weeding	5	30	17	—	8	60
	(8.3)	(50.0)	(28.3)	—	(13.3)	(100)
Cultivating	—	19	16	—	25	60
	—	(31.7)	(26.6)	—	(41.7)	(100)
Harvesting	—	—	—	60	—	60
	—	—	—	(100)	—	(100)
Stubble shaving	15	15	10	—	20	60
	(25.0)	(25.0)	(16.7)	—	(33.3)	(100)
Trash burning	28	6	5	—	21	60
	(46.7)	(10.0)	(8.3)	—	(35.0)	(100)

[a]*Source*: Uy (1979).

[b]Respondents which utilized only family labor for certain tasks and those which did not perform certain operations are also indicated. Sample farms which had only ratoon crops for the surveyed crop year, 1977–1978, for instance, did not have land preparation and planting operations.

A comparison of cross-task characteristics provides some explanation of the relative preference for piece rates for some tasks and time rates for others. In cutting canepoints, workers are normally paid according to the volume of canepoints cut (per 10,000 or 1,000 points). In harvesting, workers are paid according to the weight harvested or on a tonnage basis. The difficulty of completing these tasks is sufficiently easy to access so as to make both parties aware of the implicit wages of the workers. The quantity of the work done in canepoint cutting can easily be checked by observing the finished output and insuring that an accurate number of canepoints is reported.

Quality shirking is relatively easy to control for both harvesting and canepoint cutting by observing labor's intermediate product. In harvesting, inspection of the output and the harvested land will indicate the thoroughness of the completed work. Cane that has not been cut sufficiently close to the ground will be readily detected. That is, harvesting fits the "easy-to-monitor" case in fig. 1 and the diagram therefore explains the preference for piece rates in harvesting. Application of chemicals (including fertilization) fits the "hard-to-monitor" case since it is difficult to determine whether or not the chemicals have been uniformly applied. As expected, chemical application is usually done on a wage basis.

The highly seasonal character and high labor requirements of harvesting lead to comparatively high costs of recruiting and gathering information about prospective workers. The harvesting season comes almost simultaneously to all sugarcane farms within a given area and results in extensive use of migrant workers. The farm operator is faced with the problem of screening the workers or assessing the relative abilities of each of the workers. Since piece rates allow workers to select themselves on the basis of their expected performance, piece rates offer an additional advantage in harvesting.

Table 1 also shows that when the farm operator owns a tractor, he pays the tractor operator with time rates. If the tractor is rented, piece rates are used. We should add, however, that it is the tractor which is being hired on a piece rate basis. The tractor

operator is paid by the tractor owner on a wage basis. We presume that tractor operators are paid by wages because of possible capital maintenance problems associated with piece rates. Just as a piece rate worker will not be motivated to maintain high standards of quality, he will also not be motivated to avoid abuse of the equipment and tools of his job.

1.3 Piece Rates with Teams: Decentralization, Specialization and Inventing-by-Doing

In the preceding sections, we have synthesized the theory of labor contracts developed within the field of industrial organization and applied it to labor contracts in sugar production. In this section, we extend the theory to incorporate an additional institution—piece rates with teams.

The economic function of teams is to reduce excess burden associated with centralized management. The Marschak-Radner concept of establishing a network of autonomous but coordinated decision makers is just one function of teams. The functions of selection, enforcement, and internal organization are included in a broader conceptualization. Complementarity of inputs, the issue stressed by Alchian and Demsetz is not critical to the teams. One can exploit complementary inputs without teams, and teams may be useful even if inputs are not complementary.

Piece rates with teams motivate decentralization of three types. First, there is an incentive for decentralization of supervision. Effort shirking would reduce the team's payment. Quality shirking would impair the team contractor's reputation. Since the team leader knows the members, he can presumably supervise more efficiently than an outsider.

Teams also facilitate decentralization of decision making about internal organization. The team can establish its own specialization, internal supervision, and system of rewards. Since teams do similar jobs for many employers, workers continue to perform similar tasks in similar production systems across several employers. This

facilitates not only learning-by-doing but encourages "inventing-by-doing" as well. As Adam Smith (1937, p. 14) noted,

> "Men are much more likely to discover easier and readier methods of attaining any object, when the whole attention of their minds is directed towards that single object...."

Organization by teams may also economize on information about the quality of workers. By selecting their own members, each team can take advantage of its own information about a small part of the work force. That is, where information is diffuse, decentralization economizes on information costs. Since piece rates reward the team according to its total productivity, they will have the incentive to select workers who are appropriate for the various tasks.

In summary, piece rates in combination with teams provide an additional institution whereby the excess burden associated with information and enforcement costs can be reduced. Specifically, the combination facilitates decentralization of three types. Decentralization of supervision economizes on supervision costs by making it worthwhile for workers to monitor themselves. Decentralization of selection makes efficient use of the team's own knowledge of a small part of the work force (friends, relatives, townmates, etc.). Decentralization of organization similarly makes efficient use of a team's own information about the comparative advantages of the team members.

Piece rates paid to teams was a common arrangement for harvesting sugarcane on our sample farms. Harvesting teams usually service numerous farms in an area. For large *haciendas*, teams typically work the whole season for one employer. Employers often deal with the same contractor year-after-year. This maintains an incentive to limit quality shirking.

In our sample, teams generally divided the proceeds equally among team members. The exception was the team leader who received a 10% surcharge above the piece rate. This suggests that contractors are successful in selecting harvesters with roughly equal

ability. Since the screening function of piece rates still applies with teams, we would expect these workers to be comparatively proficient.

1.4 Explaining Patterns Involving Factor Prices, Land Quality, and Size of Enterprise

The purpose of this section is to incorporate determinants of labor contracts which are likely to be important in agricultural settings wherein factor markets are not necessarily highly developed. These determinants include factor prices, land quality, and farm size.

In highly integrated market economies, there is a tendency towards factor price equalization. This may explain why the economics of internal organization has neglected the role that factor prices play in organizational form. In rural areas of developing countries, however, factor immobilities, transportation costs and other barriers to trade allow substantial variation in factor prices from one location to another.

Wage rates as a reflection of labor scarcity are likely to be of particular importance not only for the terms but for the forms of labor contracts. Fig. 2 illustrates the specific hypothesis that the incidence of piece rates tends to increase with higher wages. Figs. 2a and 2b illustrate a high wage case wherein piece rates dominate wage rates. Roughly speaking, the cost of effort shirking outweighs the cost of quality shirking. For the low wage case, however, the cost of effort shirking can be reduced substantially by substituting relatively cheap labor for the time lost at a given level of supervision. This is illustrated by the curve, C_T, in fig. 2d, which lies substantially below that in fig. 2b.

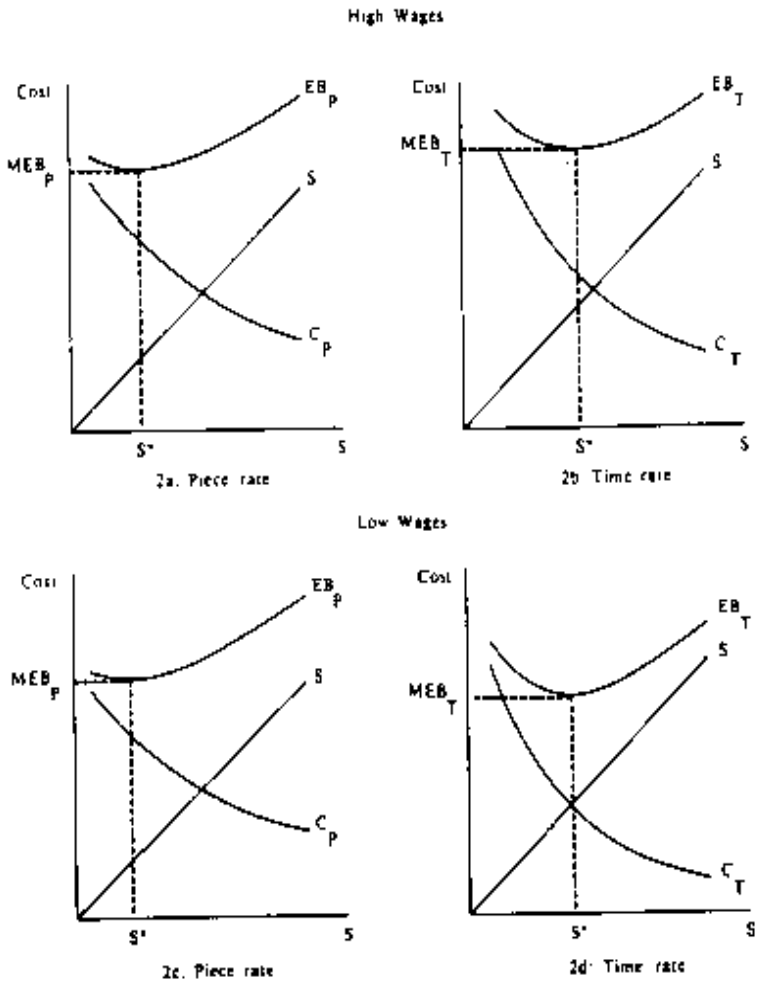


Fig. 2. Effect of variable wage levels on choice of contract.

In contrast, curve C_p in fig. 2c lies only slightly below that in 2a. This reflects the assumption that labor quantity is not a good substitute for labor quality. To some extent, it may be worthwhile with cheap labor to repair some of the losses associated with quality shirking, but this method will be more costly than doing the task carefully in the first place. As a result, the advantage of piece rates over time rates will decline as wages fall.

The graphs embody the additional assumption that the wages or opportunity costs of supervisors rise with the general wage level. This effect is represented by a parallel rightward shift of the shirking cost curves and a corresponding upward shift of the excess burden curves along a 45 degree diagonal line. This has no effect on the relative positions of EB_p and EB_T nor on contract choice. It only raises equilibrium expenditures on supervision.

The analysis is more ambiguous in the case of variations in land quality. First, note that higher land quality implies a higher profit maximizing level of labor per hectare. With more workers, time rates will lead to higher effort shirking for high land quality at each level of supervision. For piece rates, not only does higher labor intensity lead to greater (quality) shirking but a given level of shirking will presumably lead to a higher loss in yield for highly productive land. This would not be an important factor, however, where quality shirking is easy to monitor. In summary, better land quality will lead to higher levels of supervision but may not be a major factor in the choice of wage versus piece rates.

Farm size is expected to be a positive force in the selection of piece rates. This is due to the tendency for piece rate workers to be hired through middlemen and employed in teams. Wage workers are more often contracted on a direct hire basis. A small farmer may be able to rely on acquaintances to satisfy his demand for workers whereas a larger operation would benefit from the services of middlemen. Moreover, the use of piece work with teams is subject to economies-of-scale up to the point where the optimum team size is reached. To the extent that higher land quality leads to more workers per hectare, the

economies-of-scale advantages of piece rates may also play a role in the higher land quality areas.

The role of wages, land quality, and farm size for the sample of Philippine sugarcane farms is shown in table 2. Probit analysis was used to regress a dummy variable for choice of contract (1 if piece rate; 0 if time rate) on a wage index (average daily wage), an index of land quality (implicit rent)[9] and farm size.

[9]Implicit rent was defined as value of yield less value of all inputs [see Uy (1979) for additional details].

Table 2

Choice of labor arrangement vs. land quality, wage index and farm size: Probit analysis (standard errors in parentheses)[a]

Dependent variables	Independent variables: Constant	Land quality index	Wage index	Farm size	$\chi^{2\,b}$
Contract (Y)					
0 if time rate					
1 if piece rate					
Planting contracts					
Y_1	−5.59485	0.00038	0.59075	0.00005	13.8950
	(2.29874)*	(0.000122)**	(0.23321)*	(0.00188)	
Weeding contracts					
Y_2	10.8386	0.00029	1.16921	0.00345	15.5004
	(6.56327)***	(0.000431)	(0.67241)**	(0.00224)***	

[a] The following levels of significance are based on asymptotic t-ratios: *significant at 0.01 level, **significant at 0.05 level, *** significant at 0.10 level

[b] The values in this column represent −2 log likelihood ratio which tests the hypothesis that all coefficients are equal to zero. The values are asymptotically distributed chi-squared, with k degrees of freedom where k is the number of independent variables. All the values reported are statistically significant at the 0.01 level

As expected, the wage variable was significant and positively related to the choice of piece rates. The land quality variable was positive and significant for the planting operation, and farm size was positive and significant for weeding. These findings are consistent with the economies-of-scale advantages of piece work with teams.

These results are only intended to be illustrative of the role of factor scarcity, factor quality, and economies-of-scale in contract choice. Larger and more carefully designed samples, better specification of the functional relationships, and measurement of additional variables are needed for more conclusive results. As an example of the econometric problems, Uy (1979) reported a complex causal relationship between land quality and farm size. For family farms, an inverse relationship between farm size and land quality was observed, but for plantations, the relationship was positive. Further studies should also investigate the importance of the size of the labor force in the area and level of labor market development.

1.5 Summary and Implications

The purpose of section 7.1 has been to synthesize, apply, and extend the theory of the employment relation to facilitate explanations of agricultural organization, especially in areas without highly developed labor markets. The theory developed in 7.1.1 differs from other treatments in two respects. First, the firm's investment in supervision and information is treated as endogenous. Second, labor is viewed as producing an intermediate product which itself is an input in the final production function.

The profit-maximizing labor contract is the one which minimizes the excess burden associated with the costs of monitoring plus the profits lost from "shirking" at a particular supervision level. Where the worker's intermediate product can be directly observed, piece rates provide a device for paying the worker according to the marginal product of the intermediate product he has produced. Where the quality of the worker's intermediate

product can be readily assessed, piece rates avoid effort shirking and will not induce substantial "quality shirking."

The theory also predicts that the incidence of piece rates will increase with heterogeneity of the work force because piece rates facilitate "screening by self-selection." Piece rates will tend not to be used, however, where it is difficult to set the rate to equate marginal product with the opportunity wage. Since this problem can be ameliorated by collecting information about the time it takes to complete a particular task, it is now time rates that economize on information costs.

Section 7.1.2 illustrates how the theory can be applied by documenting and explaining patterns in the employment relation. For the Philippine application, the hypothesis about quality shirking proved to be the most useful. For harvesting and canepoint cutting, where quality shirking can be easily detected by visual inspection when work has been completed, piece rates are chosen in almost 100% of the cases.

Section 7.1.3 extended the theory of labor contracts to include piece rate with teams. When the employer pays piece rates directly to a team, there are a number of additional potential advantages. For one, production teams which specialize in specific tasks (*e.g.*, harvesting cane) are able to evolve more efficient systems of internal organization within the team. In addition, since teams recruit their own members, adverse selection problems are reduced. Finally, quality shirking is reduced due to the necessity for the team to maintain a good reputation.

Section 7.1.4 extends the theory to incorporate some determinants of agricultural organization which have been omitted from the industrial organization literature. The role of factor prices, which may vary widely in rural economies, was stressed. In particular, low wages favor time rates since cheap labor can be more readily substituted for time lost in effort shirking than it can be for quality shirking. The Philippine evidence supported this hypothesis.

There was also weak evidence that economies-of-scale favor piece rates. This follows from the tendency to use piece rates with teams. Thus, larger farms may favor piece rates as may better quality farms, since the latter use more labor per hectare.

While the analysis has not been intended to provide a direct test of the efficiency of employment contracts, some preliminary policy conclusions emerge. It has been popular, especially in the agricultural development literature, to blame falling rural wages on inefficient institutions or to blame the slow adoption of modern technology on "institutional constraints." As we have demonstrated here, however, the wide variation in observed contracts is not only consistent with efficiency, but the patterns observed are predicted by efficiency principles. This conclusion is sufficient to reject *a priori* conclusions that agricultural institutions are exploitative and inefficient.

The theory of contract selection developed here can also be used to clarify the theory of induced institutional change [Demsetz (1969), Davis and North (1971), Ruttan (1978)] according to which institutions will change when the benefits of the change exceed the costs. The latter theory is incomplete without a definition of what are the benefits and costs of institutional change. The concept of excess burden fills this void. We can now specify that the theory of institutional change predicts that an institution will be replaced if its associated excess burden can be reduced by switching to another institution. For the case of labor contracts, excess burden can be defined as the difference between maximum profits with costless information/enforcement and maximum profits with costly supervision.

Given the limited evidence presented, the various patterns and explanations discussed are best regarded as hypotheses. Indeed our main purpose has not been to formulate "laws" of agricultural contracts but to illustrate what we believe to be a fruitful methodology. As additional stylized facts of contracts and other institutions are documented, we will undoubtedly learn more, in an inductive fashion, about the forces which determine resource allocation in the face of incomplete markets.

2.0 Agency Costs and the Agricultural Firm

2.1 The Theory of Share Tenancy: Why All the Fuss?

In their recent review and synthesis of the economics of agricultural contracts, Hayami and Otsuka list more than 300 articles dealing with share tenancy, and their list is far from exhaustive. The reason for this level of attention, in spite of its limited empirical importance, is that share tenancy holds the key (or at least one of the keys) to the general economics of rural organization.

Joe Stiglitz's (1974) article was particularly seminal, spawning not only the New Industrial Organization based on principal agency theory but the Economics Rural Organization (Hoff, et.al., 1993) as well. As a theory of share tenancy, however, Stiglitz's model is somewhat misleading. He assumes that share tenancy is an employment contract and that share tenancy as well as alternative employment contracts can be represented by the worker's pay off function: $Y = aQ + b$, where a is the worker's percentage share of output, Q, and b is a fixed payment -- negative in the case of wage contracts and positive for rental contracts. The theory is graphically depicted in Figure 3. The principal (landowner) chooses the a that minimizes the sum of labor-shirking costs and risk-bearing costs. Labor-shirking costs decline to zero as the worker's share approaches one. Risk-bearing costs are assumed to increase with the worker's share because workers are assumed to be more risk averse than landowners. If the shirking costs are as illustrated, the optimal share will be roughly one-half, thus accounting for the alleged universality of the tenant share equalling one-half (Hayami and Otsuka, 1993).

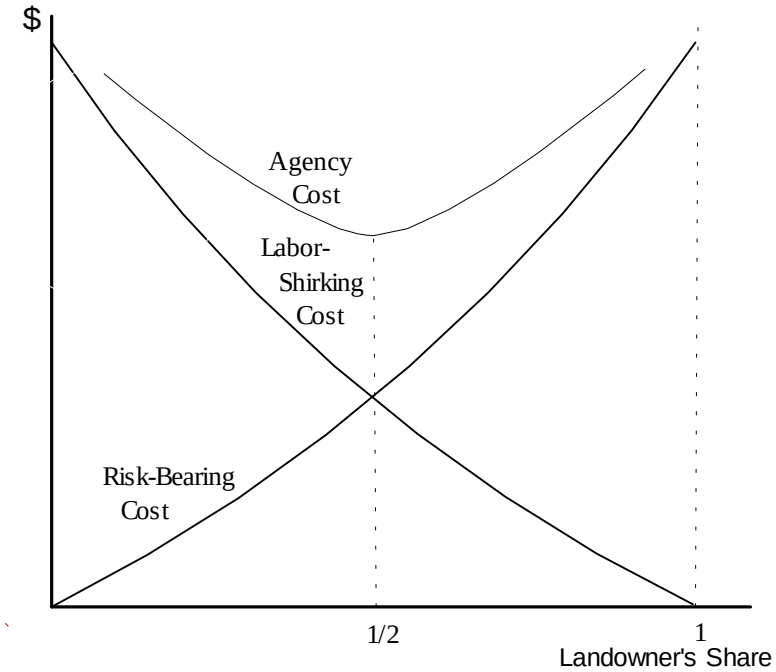


Figure 3: The Emergence of Pure Share Tenancy as the Result of Symmetrical Labor-Shirking and Risk-Bearing Costs

However, no evidence whatsoever has been offered to suggest that the tenant-landowner risk-aversion differential is anywhere near large enough to offset the labor incentive advantages of rent contracts. Figure 4 provides an alternative depiction of the costs of risk-bearing. The configuration shown reflects the assumptions that risk-bearing costs of owner-operators are positive but less than that of renters and that the total risk bearing costs under share tenancy are intermediate but closer to that of owner-operators.

Share tenancy reduces the costs of risk-bearing relative to renting by first sharing the risk between landowner and tenant, which reduces risk-bearing cost born by each by more than the percentage born by the other agent (Arrow and Lind, 1970). Second, share tenancy increases the proportion of risk born by the agent with a lower marginal risk premium. Since the first source of reduction is maximized at a share of • , the total risk-bearing curve is kinked at that point. As a result of these assumptions the total agency cost reaches a local maximum at α = • , but plausibly reaches a global maximum at $\alpha = 1$. In addition, income of owner operators in many parts of the world is not significantly greater than that of tenants. Even if landowner incomes are higher, risk aversion is not strongly, if at all, related to income (Binswanger, 1980, 1981). Moreover, agricultural households in countries such as the Philippines have numerous opportunities for reducing marginal risk premium, including farm enterprise diversification, family income diversification, and asset-liability management (including credit). These factors increase the likelihood that labor shirking costs dominate risk-bearing costs as shown in Figure 4.

In reality, however, both owner-operator and share tenancy contracts are more frequently observed than rental contracts. There must be an additional disadvantage of rental contracts.

The most often cited disadvantage of rental contracts other than misallocation of risk-bearing is land shirking (also called asset shirking). Land-shirking has not been formally modelled in the context because of its inherently dynamic character. The idea is that renters cannot be effectively bound to long-term contracts and execute an "end move" and "mine" the land in the last period before quitting the contract.

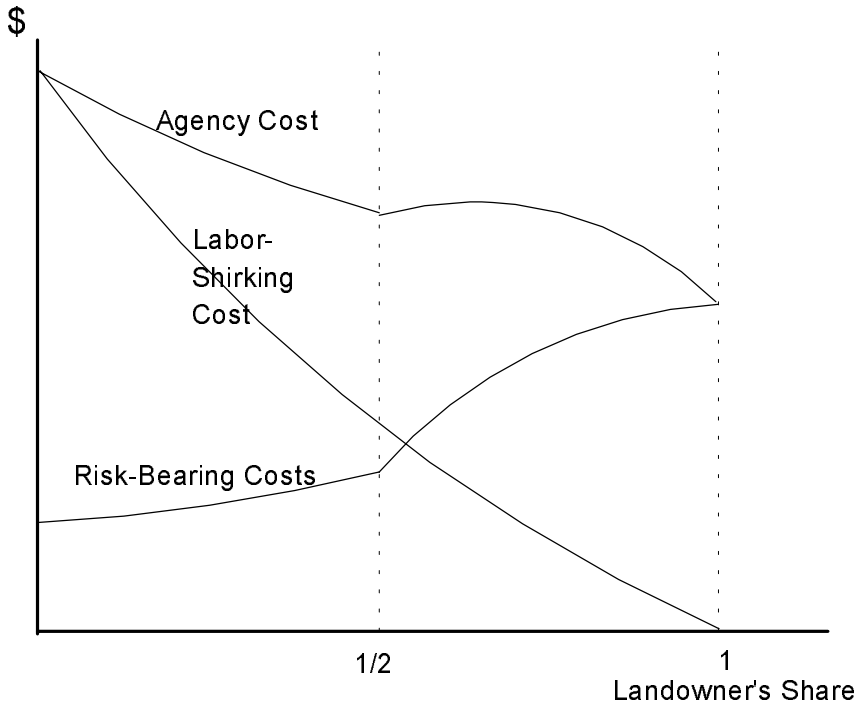


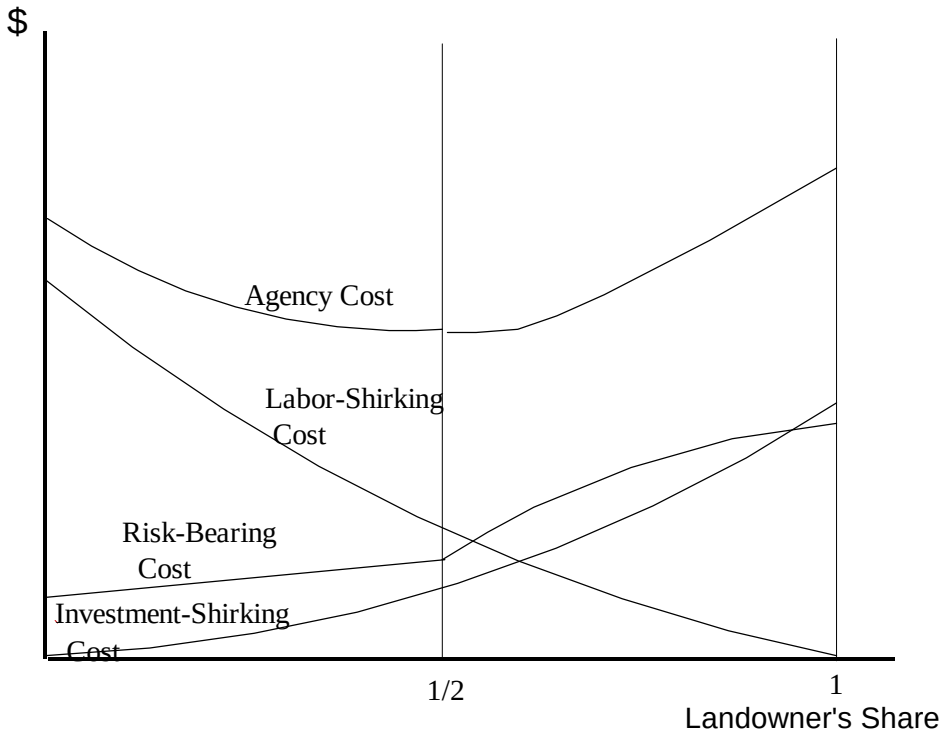
Figure 4: Rent Contracts Eliminate Labor-Shirking Costs
Without Creating Overwhelming Risk-Bearing Costs

More generally, the problem is binding the renters to an optimal program of investment, including cropping pattern, maintenance, and land improvements. Just as renters may breach multiple period rent contracts and exploit short-run strategies that decrease the land's productive capacity, landowners may breach promises not to raise the rent and expropriate investments made by the leasee.

Government possibilities against investment-shirking are discussed in subsequent sections. For now, it is sufficient to note that the agency costs of investment increase with a. Adding investment-shirking costs, Figure 5 shows how share tenancy can emerge as an optimal contract.

Hayami and Otsuka (1993) argue that the costs of asset abuse are minimal because in the longer run, reputation serves as an effective governance mechanism. Figure 5 allows that reputation mitigates investment-shirking but does not eliminate it. First, if reputation were completely effective as a governance mechanism, a formal justice system would be unnecessary. Second, for reasons detailed by Williamson (1985) and Barzel ( ), first-best optimal investment would require an elaborate system of contingency contracting and monitoring, both of which are constrained by information costs.

Figure 5 also illustrates how agency theory can solve what Otsuka and Hayami assert is the "major remaining puzzle" about share tenancy, namely that the tenant's share is almost universally one-half." As discussed in Chapter 6, there is substantial variation of landowner shares due to land quality (including required land improvement such as planting coconut trees in order to grow coconuts), the labor intensity of the crop, and relative factor prices. Nonetheless landowner shares are usually either 1/2, 1/3, 2/3, as Stiglitz (1989) reports, i.e., there is notable "bunching" of landowner shares Singh (1989), and 1/2 is the most common share. One reason for "bunching" at $\alpha = 1/2$ is the kink in the risk-bearing cost curve (explained above in conjunction with Figure 4).



Fgure 5: An Electric Theory of Share Tenancy

2.2 A Taxonomy of Agricultural Firms

The principal agency theory of share tenancy that emerged in the 1970s (Stiglitz, 1974; Holmstrom, 1979; Shavell, 1979) was, as mentioned above, a theory of the employment relation between landowner and worker. Hayami and Otsuka (1993), by suppressing the role of hired labor, used the same risk-bearing vs. labor-shirking theory to explain the existence of share tenancy as a relation between landowner and farm manager. They also called for an integrated theory of agricultural contracts that explains the interrelated contracts for both management and labor and other interlinked contracts such as credit. One approach to a more general theory of interlinked agricultural contracts is to adopt the perspective of the firm as a nexus of contracts (Jensen and Meckling, 1976; Aoki, et.al., 1990; and Yang and Ng, 1993). Accordingly, the following sections explore the nature and causes of the agricultural firm.

In the spirit of Frank Knight and Ronald Coase (1937), the firm can be viewed as an alternative to market organization. Both Knight and Coase stressed the role of the entrepreneur as a coordinator of resources. Knight portrayed the firm as an entrepreneur with an authority relationship over the other factors. Coase extended this view by stressing the cost of using the market, *i.e.*, of contracting the other factors from outside the firm. In the words of Douglas North (1981),

> According to Coase, the advantage of the firm over transacting in the market is a gain as a result of a reduction in transaction costs...(presumably at least partly in consequence of the authority).

Several authors have elaborated on this theme, focusing on the nature and sources of the transaction costs of using the market. Barzel (1982) stresses the measurement costs involved in monitoring contract performance. Williamson (1975) and Klein, Crawford, and Alchian (1978) discuss the role of opportunism in increasing the costs of contract enforcement. Arrow (1974) discusses conditions under which abandoning the invisible fist

of authority may reduce the costs of communicating decisions and coordinating production.

These observations help explain the existence of firms. They also contain the rudiments of a theory of the boundaries of the firm, *i.e.*, of what will be purchased from the market and what activities will be coordinated within the firm. What is inside and what is outside the firm depends on the relative advantages of the specialization afforded by markets vs. the reduction in transaction costs, facilitated by relationships among the firm's principals. These relationships are governed both by bonding or "F-connections" (cf. Ben-Porath 1980) and by an explicit or implicit agreement among principals that can be characterized as a contract prescribing rights and duties of the parties, decision-making mechanisms, and rewards and/or sanctions for good and bad citizenship. This "constitution" and the institutions for prescribing and enforcing future activities constitute the governance structure of the organization (Williamson 1985).[10]

In agricultural organization, share contracts can be classified according to whether they are essentially labor contracts or relationships among firm principals. There are two distinct types of share contracts in agriculture. One is primarily a labor contract such as *gama* or *ceblokan* arrangements in Asian rice production whereby the worker receives a small share of the output for harvesting and other specified tasks.[11] The other is more of a partnership wherein the tenant receives a larger share, typically 1/3 to 2/3, for assuming the responsibility for most of the work (including supervision) and day-to-day decision-making (*e.g.*, about the composition and timing of inputs). Most of the principal-agency literature, by modelling share tenancy as an employment contract, fails to make this distinction. Eswaran and Kotwal (1985) model share tenancy as a partnership, but, unlike

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[10]See also Goldberg (1979) for a discussion of "relational exchange."

[11]*Gama* or *Ilani*, as practiced in the Philippines, is an arrangement whereby the worker contracts to weed and harvest a specified parcel for typically 1/6 of the rice harvested for that parcel; *ceblokan*, practiced in Indonesia, typically requires transplanting, in addition to harvesting and weeding, for the same 1/6 share (Roumasset 1978; Hayami and Kikuchi 1981). Remarkably, a similar arrangement was documented in *The Constitution of Athens* almost 3,000 years ago. Workers contracted under a sharing arrangement in ancient Greece were called *Hectomori* or "sixth partners."

previous partnership interpretations (Reid 1976, 1978; Hallagan 1978; Murrel 1983), they abstract from decision-making by the tenant. In what follows, we reserve the term "share-tenancy" for medium or long-term relationships where the tenant is a principal in the agricultural firm and participates in decision-making, as well as worker supervision. Short-term contracts wherein workers are paid a percentage of the gross are viewed as labor hiring arrangements similar to piece rate labor contracts.[12]

In their "Separation of Ownership and Control," Fama and Jensen (1983b) propose "a spectrum of organizations" distinguished by the degree of separation of management and risk-bearing functions. They emphasize that separation of management (the initiation and implementation of decisions) does not imply a loss of control (the ratification and monitoring functions). Reminiscent of Coase, Fama and Jensen note that the benefit of "separate" management is the greater degree of specialization that it affords. While such specialization comes at greater agency costs, these costs are mitigated by the control mechanisms retained by the principals.

In agriculture, separation of the management and labor functions is a more useful characteristic for distinguishing common types of agricultural firms. Figure 1 illustrates a spectrum of agricultural firms with separation of work, management, and control increasing from left to right. The most unspecialized organization is the owner worker-manager firm, wherein both labor and management come from the owner's household. If the owner hires all the labor and provides only land and management, we call the arrangement an owner-managed firm. Clearly intermediate cases are possible, with part of the labor being hired. The conventional use of the "owner-operated" firm obscures these differences in specialization. Sometimes part of the management, including worker supervision and day-to-day operational decisions, is also hired. This form is represented at the far right of Figure 1 and is commonly practiced in plantation agriculture (Uy 1979).

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[12]For a discussion of the advantages and disadvantages of piece rates vs. wage contracts, see Stiglitz (1974) and Roumasset and Uy (1980).

The hired-manager form facilitates specialization between both labor and management and between management and control.

Lease arrangements may be similarly arrayed from the worker-manager form to owner-manager form wherein most of the labor is hired. The location of lease contracts in Figure 6 reflects less variability in the degree of specialization among leasehold than in owner-operated forms. The lease worker-manager reflects greater specialization than the owner worker-manager since the landowner in leasehold arrangements retains some control over land use decisions. The lease-manager form is less specialized than the owner-manager form however since lease managers do some of the labor.

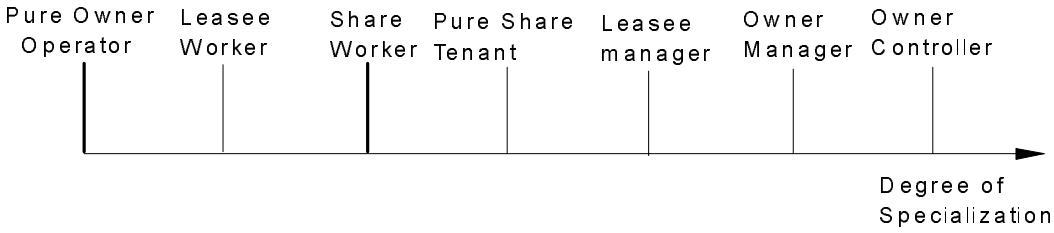

Figure 6: A Spetrum of Agricultural Firms

Figure 6 also distinguishes the two predominant forms of share tenancy. We define pure share tenant arrangement as one in which the landowner and tenant share in both the decision-making and control aspects of management and in the costs of productive inputs as well as outputs. This arrangement resembles a true partnership.[13] Share worker-manager refers to an arrangement where the tenant shoulders all of the input costs and most of the management. As Figure 1 suggests, this arrangement is intermediate between pure share tenancy and the lease worker-manager arrangement.

Since management receives the residual payment, the percentage of the residual going to management alone will increase, moving towards the right of Figure 1, as management is increasingly separated from labor. The quantity and quality of managerial inputs will therefore be enhanced by the separation of functions.

The advantage of separation of functions is the specialization that it affords. The disadvantage is the disincentive effects created when some of the firm participants do not receive the full value of their marginal product.[14] The additional transaction costs of separate management will be accepted only when they are outweighed by the benefits of specialized management. Specialized management will be increasingly important the greater is the potential value added of management.

The residual payment also includes rent paid to organization-specific assets.[15] The hired-manager arrangement gives the residual to the asset control functions of management and therefore gives the maximum incentive to efficient asset control. In share-tenancy partnerships, the tenant's share of the residual compensates him only for his labor, supervision, and production decisions but also for his equity in the land,[16] draft

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[13]Another partnership not dealt with here is the part-owner firm in which one of the partners plays a more active role in management and owns up to one-half of the equity of the operation.

[14]The source of the incentive problem is the moral hazard that arises in the face of uncertainty when inputs cannot be directly measured or indirectly inferred from outputs (Lewis 1980).

[15]Organization-specific assets include fixed plant and equipment, institutionalized procedures, skills and other assets that have lower value to other organizations (Fama and Jensen 1983b, 31).

[16]In the Philippines, for example, tenants can sell cultivation rights for as much as 50 percent of the market value of the land (Hayami and Kikuchi 1981).

animals, and some farm equipment. His share provides partial incentive for investment and maintenance of these assets.

(b) Patterns, Synthesis, and a Preliminary Hypothesis

Despite the large literature on tenancy, there is little agreement about the stylized facts of tenure choice under different environments that a theory should be expected to explain. In this section we attempt to combine apparently diverse observations about the incidence and forms of share tenancy across land types of varying productivity to suggest a possible relationship between the extent of specialization in the agricultural firm and the value added by land and management. We do this neither to place inordinate emphasis on land quality nor on technological determinism but to illustrate how describing and explaining general relationships between contracts and the environment may help to elucidate the determinants of economic organization.

We begin with the observation that the incidence of share tenancy relative to the owner-worker increases with land productivity. In the Bicol region of the Philippines, the two predominant types of agricultural firms at the beginning of the Green Revolution (*i.e.*, up to at least 1970) were share tenancy and owner-operated family farms with little or no hired labor. The Bicol region is comprised of three "rice-bowl" provinces containing the Bicol River Basin, two island provinces with severe weather problems, poor soil quality, and high transportation costs, and one "intermediate" province contiguous with the rice bowl but with uneven topography and a relatively high proportion of upland rice. Statistics on tenure form show a strikingly higher incidence of share tenancy in the more productive areas. In the rice-bowl provinces, 56% of the sample farms were operated by share tenants vs. 22% owner-operated family farms. In the intermediate province, there were 24% owner-operated family farms. In the intermediate province, there were 24%

share tenants and 25% owner operators, and in the island provinces there were less than 5% share tenants and 72% owner-operated family farms.[17]

On the other hand, there is evidence to suggest that the incidence of share tenancy decreases with land quality relative to the owner-managed firm, which relies on hired labor. For example, Datta et al. (1986) found, in a large sample of farms in India, that the incidence of wage contracts relative to share contracts increased with irrigation. This suggests the importance of distinguishing different types of owner operator, lease, and share arrangements. Since owner-operated farms can be more or less specialized than tenanted farms, depending on the degree of separation between management and labor, the search for general patterns regarding the relative incidence of share tenanted and owner operated farms may be a futile one.

In an extensive analysis of Indian data, Bardhan (1984) also finds that the incidence of share tenancy relative to owner-operated family farms increases with land quality factors, such as irrigation and rainfall. His statistics also suggest a rough correlation between the ratio of share tenancy to lease-worker tenancy and indicators of land productivity, with share tenancy dominating in the eastern and northwestern parts of India and fixed-rent tenancy predominant in the southern states. While this evidence is consistent with the land productivity-specialization hypothesis, better proxies for land quality and an indicator of specialization within forms of fixed-lease tenancy would be useful.

More direct evidence on the land quality-specialization hypothesis is available on the different forms of share tenancy. Several previous studies have shown that locational differences appear to affect both the terms and form of share-tenancy arrangements.[18]

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[17]These statistics were computed from the 1970 Bureau of Agricultural Economics Integrated Agricultural Survey of 1013 Bicol farms as reported in Roumasset (1976). Only 13 sample farms were operated on leasehold arrangements. Most of the remaining sample farms were operated by part-owners.

[18]Several authors have regarded the constancy of tenant shares, typically said to equal 50 percent, as one of the stylized facts of share tenancy (Bell and Zusman 1976; Hurwicz and Shapiro 1978; Newbery and Stiglitz 1979; Allen 1985; Eswaran and Kotwal 1985). These authors have failed to recognize the great variations in tenancy shares across space, time, and crop (Cheung 1969; Roumasset 1981; Datta et al. 1984; Bardhan 1984).

Roumasset (1976) found that a sample of rice farms in Laguna, Philippines, with high rents per hectare and favorable soil conditions, were typically operated under a "supportive" contract ("pure share tenant" in Figure 1) where the landlords received 50 percent of the gross harvest and paid 50 percent of the cost of seeds and fertilizer. For the sample farms in Albay province, where soil and weather conditions are worse, share-lease or "nonsupportive" contracts were used under which landowners received only 1/3 of the harvest but did not share in the costs.[19] These findings were later generalized for both rice and nonrice tenants. Both output and input shares of landowners were found to be positively correlated with land quality in the Philippines, Java (Indonesia), and Bangladesh (Roumasset and James 1979; Roumasset 1981; Hayami and Kikuchi 1981; Ali 1979). Bardhan (1984) also found a strong association between the cost sharing by the landowner and the landowner's share and between landowner's share and land quality.

Both the landlord and the tenant do more management in pure share tenancy (supportive) arrangements. At least in the Philippine case, there also appeared to be substantially more hired labor under pure share tenancy, with the tenant providing supervision, input decisions, and day-to-day management. In summary, relatively unspecialized share worker-management arrangements tend to be more common on poorer quality land; on better land the share tenant specializes more on management, and cost sharing is used to help induce efficient input use.

Thus a number of disparate observations about the incidence and forms of share tenancy are suggestive of an overall relationship between land productivity and specialization in agricultural organization. In the next sections we explore a possible theoretical explanation for this relationship and then illustrate a more direct method of verification.

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[19]In share-worker arrangements, such as the sharecropper in the post-bellum American South, landowners commonly received more than 50 percent but also provided the inputs and made most of the production decisions. These arrangements are relatively rare in Asian agriculture.

3.0 Conceptual Framework and Theoretical Development of the Hypothesis

3.1 A Principal-Agency Approach to Positive Agency Theory

In this section, we attempt to model efficient contract choice in the presence of information and enforcement costs of input use. Most of the principal-agency literature in economics has focused on labor shirking. But investments in land improvements may also be "shirked" by "mining" the land or, more generally, by failing to maintain the optimal level of fertility and productive capacity. Managerial inputs, both for decision-making and supervision, may also be shirked.

The model that follows uses the principal agency framework to make explicit use just what is being optimized but borrows from positive agency theory the notion that more than one input is susceptible to shirking. This allows the optimal organizational form to vary according to the environment without requiring large differences in risk-bearing abilities. The model also incorporates an important disadvantage of fixed lease contracts that helps to explain the unpopularity of such contracts in many environments.

We first extend the principal-agency model (see, *e.g.*, Stiglitz 1974; Newbery and Stiglitz 1979; and Lewis 1980) to allow for two sources of shirking. Represent the value of output, D, as a function of both labor, x, and land maintenance/improvement, z. For simplicity assume two periods such that the present value of output can be expressed as:

(11) $$D = D_1(x_1, \theta_1) + D_2(x_1, z, \theta_2, r)$$

where D_1 and D_2 are the discounted value of output functions for periods 1 and 2, q_1 and q_2 are the two stochastic variables and r is the real discount rate. Investment in land, z, is made in the first period and increases output in the second period. Positive investments such as improving or maintaining the irrigation ditches increase z. Negative investments, *e.g.*, allowing noxious weeds to propagate or intensive cultivation practices that "mine"

the soil fertility, decrease z. In order to clarify the meaning of efficient contract choice, we abstract from "managerial shirking" in the mathematical version of the model.

The agent (*e.g.*, tenant) chooses the level of investment in land and labor in the two periods so as to maximize the expected utility, U. The principal (landowner) chooses a payment schedule, P_i, which relates the agent's income to D and the principal's (imperfect) monitoring of the inputs. The agent's income can thus be expressed as $P = P_i(D,x_1,x_2,z)$ where the principal chooses i from the set of possible contracts, C, and the principal's income as V = D - P - m, where m is monitoring costs. The principal's profit maximization problem is

$$\underset{i \varepsilon C, m}{Max}\ V_i = D - P - m$$

(12) $$\text{subject to } U > \overline{U}$$

$$\text{where } U = \underset{x_1, x_2, z}{Max}\ U(P, X_1, X_2, Z)$$

and where *m* is monitoring expenditures by the principal and *U* is the utility level available to the agent in his best alternative.

The principal agency formulation provides a convenient measure of the efficiency of contracts. Define maximum unconstrained[20] expected profits as:

(13) $$\pi^* = (\pi^*{}_{1\pi}, \pi^*{}_{2\pi}, z^*)$$

where $\pi^*{}_{1\pi}, \pi^*{}_{2\pi}$ and z^* are optimum inputs under the assumption of costless measurement and enforcement of input levels.

The inefficiency or agency cost of the ith contract can be expressed as:

(14) $$A_i = \pi_i - V_i$$

where V_i is the solution of (12) for a given *i*. Since π^* is a constant, finding the highest V_i yields the same contract as solving for the lowest A_j, *i.e.*,

(5) $$\{i | V = V_i\} = \{j | A^* = A_j\}$$

[20]The terms "constrained" and "unconstrained" are used here, in the sense of constrained Pareto optimality (*e.g.*, Newbery and Stiglitz 1979), to distinguish models that incorporate transaction costs from models that abstract from transaction costs. Unconstrained profits are also equivalent to "first-best" profits and constrained profits are equivalent to "second-best" profits in the sense of Lewis (1980).

where V = $\underset{i \varepsilon C}{Max}\, V_i$ *and* $A^* = \underset{j \varepsilon C}{Min}\, A_j$.

Equations (11-14) provide a sense in which the assumption of positive agency theory, that contracts evolve so as to minimize agency costs, is equivalent to the assumption of principal agency theory, that equilibrium contracts maximize the constrained objective function of the principal.[21] The framework also provides a clarification of the meaning of agency costs, defined by Fama and Jensen (1984) as:

> Agency costs include the costs of structuring, monitoring, and bonding a set of contracts among agents with conflicting interests, plus a residual loss incurred because the cost of full enforcement of contracts exceeds the benefits.

In the principal agency framework, the costs of structuring, monitoring, and bonding are represented by m_i^*, and the residual loss is $\pi^* - (D_i^* - P_i^*)$ where $D_i^* - P_i^*$ is the maximum constrained profits to the principal, before accounting for m_i^*.

The proposition that "efficient" contracts minimize "agency costs" obscures a 3-level hierarchy of optimization problems. Since "minimize" refers to the choice across contracts, "agency costs" must be interpreted to mean the *least* cost combination of measurement and enforcement activities associated with a particular contract, *i.e.*, m_i^*. Moreover, the optimal m is chosen subject to *optimal* shirking by the agent. These levels of optimization are transparent in the graphical exposition of agency theory employed below (Figure 7).

[21]To maintain this correspondence where the principal is not risk neutral, then V must be defined to be net of a risk premium.

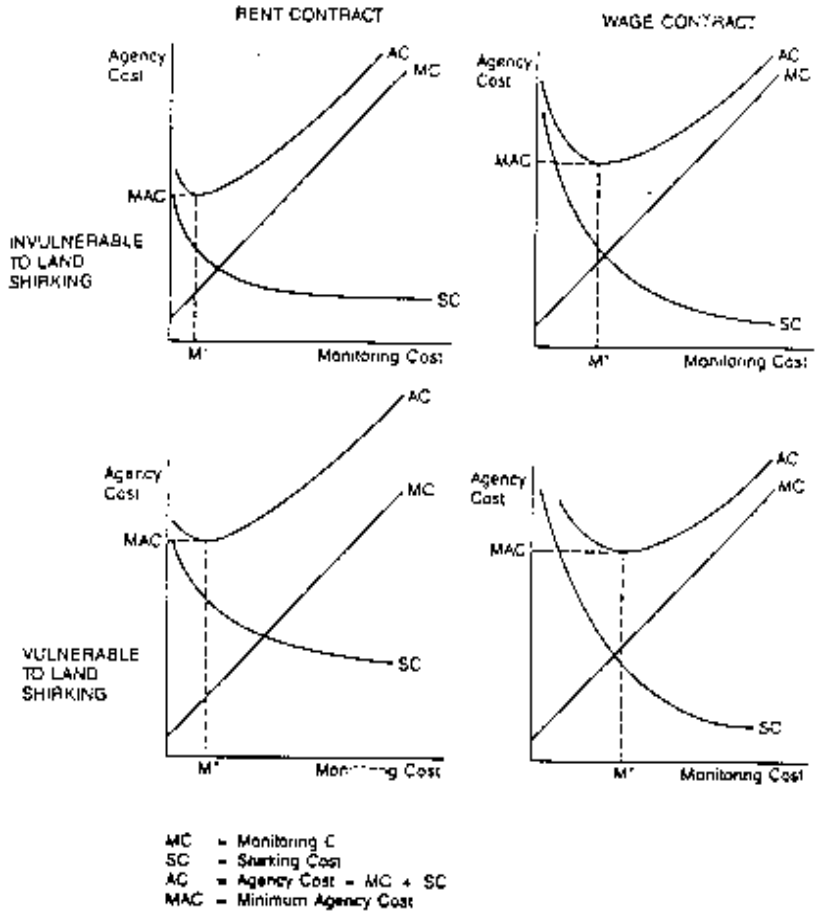

FIGURE 2
CONTRACTUAL CHOICE IN TWO ENVIRONMENTS

3.2 A Theory of Specialization and Tenure Choice

We can now use the agency cost framework to explain the apparent association between land productivity and the degree of specialization in the agricultural firm. In particular, we wish to illustrate why a landowner might employ a tenant on a fixed lease basis to provide the labor and supervision for land of low productivity but would be more likely to hire wage workers if there were substantial potential benefits from investing in land maintenance and improvements. Following Eswaran and Kotwal, since we wish to develop alternative explanations for agricultural contracts to the conventional moral hazard theory, we abstract from differences in ability to bear risk between landlord and worker.

The advantage of lease arrangements is well known. By paying labor the residual, incentives for labor shirking are eliminated. An important disadvantage of fixed-rent tenancy, aside from possible risk-bearing problems, is the possibility of "mining the land" (Marshall) or "land shirking." If the fixed-lease contract is only for one period or if enforcement costs make collection of period 2 rent difficult, the tenant may choose to deplete the productivity of the farm in period 1 and abandon the farm in period 7. That is, if farming techniques are available that sufficiently enhance first period output at the expense of maintaining the productive value of the land, then the utility maximizing strategy may be to maximize his income in the first period break (or not renew) his lease and rejoin the labor force in the second period.[22] This model clearly has relevance beyond two periods. So long as the landowner's rights to collect future rents are attenuated (*e.g.*, by flight of the tenant or the threat of land reform laws by the state), then the tenant's incentive to stint land improvement inputs will discourage landowners from renting their land out on a fixed fee basis. Moreover, since the prospects of technological change and

[22]We assume that there is sufficient labor mobility that period 1 performance will not markedly affect the wage received in period 2. Alternatively, the second period wage penalty for poor performance in period one may be incorporated into the enforcement technology for the lease contract.

other forces outside the control of the contracting parties render the competitive rental value of land uncertain in the future, fixed-rent contracts will tend to be of limited duration.

The cost of land shirking will depend primarily on the marginal efficiency of investment in land maintenance and land improvement. Land with low natural productivity and artificial improvements tends to be less vulnerable to depreciation than land with high natural productivity (*e.g.*, fertility and low pest population) and improvements (*e.g.*, land levelling, terracing, irrigation). While land shirking may be a minimal problem in some environments, in others it may be the predominant determinant of agricultural organization. In contrast, labor shirking is less environmentally determined and more related to the amount of monitoring. It is therefore plausible that in environments with little predisposition for land shirking, contracts will be chosen to mitigate labor shirking and thereby save on costly monitoring. Where land shirking is potentially a major problem, however, contracts may be chosen for their incentive for investment. In these cases, direct monitoring of labor can be used to manage labor shirking.

The theory of environmentally determined contractual choice sketched above is presented in terms of agency costs in Figure 2. In each of the four quadrants, agency costs (AC) are the sum of shirking costs (SC) and monitoring costs (MC). Each graph corresponds to a particular contract in a particular environment. The two graphs on the top represent "invulnerable" land and the bottom two represent "vulnerable" land. The graphs on the left correspond to rent contracts; those on the right, to wage contracts. Following the assumptions proposed in the previous paragraph, shirking costs under wage contracts are shown as being relatively responsive to monitoring and relatively unresponsive to the environment.

Relative contractual efficiency can be seen by comparing the point of minimum agency costs (MAC) for the two contracts under each environment. The assumptions

implicit in the shapes of the shirking curves imply that the relative efficiency of wage contracts increases with the vulnerability to land shirking. Figure 2 illustrates the case where in one type of land in sufficiently invulnerable to shirking such that rent contracts dominate and another type sufficiently vulnerable that wage contracts dominate. The graphs thus illustrate how different contracts may be preferred in different environments.

Factors other than the marginal efficiency of investment may also influence vulnerability. Greater attenuation of property rights and more uncertainty about equilibrium rents in future periods render the landowner vulnerable to losses in the value of land relative to the first-best optimum. Another determinant of agricultural organization is the share of value added attributable to land (including capital improvements), labor and management. Where management contributes a substantial proportion to value added, organizational forms that reward specialized management will tend to be favored. We hypothesize that management is relatively more important on better quality land. This provides a complementary explanation of the association between the degree of specialization and land productivity.

4.0 Statistical Verification: An Illustration

As we observed in section 2, most existing data is not suitable to provide direct verification of the specialization and land quality hypothesis. This section reports on a sample of Philippine sugarcane farms wherein the different forms of owner-operated farms are distinguished and ranked according to the degree of specialization. Philippine sugarcane farms show a large diversity in contractual forms—from the subsistence owner-operated to owner-controlled farms with hired labor and management. The sample of 60 sugarcane farms described below exhibits a wide range of contractual forms, facilitating a more complete illustration of how contracts respond to locational factors that affect the vulnerability of land and management to shirking.

Owner-managed farms seem to have better land, large farm sizes and more intensive application of cash inputs such as fertilizer and chemicals than share-tenants. A larger portion of their cultivation is also done by tractors. Owner-operated farms or subsistence farms tend to have poor land and less intensive application of fertilizers than share tenants. A ranking of contracts based on the extent of application of inputs shows a positive relationship between factor intensity and extent of specialization.

The more specialized forms of organization tend to predominate in the highly productive "sugar bowl" province. In the Laguna and Tarlac areas, which are less suitable for sugarcane production, share-tenancy and owner-operated farms are more common. Several leased farms were observed with hired agricultural workers and a lessee-manager. These contracts were classified as lease-manager arrangements.

The task of econometrically documenting the relationship between contractual choice and environmental characteristics is rather awkward. Both the environment and the contractual arrangement are multiattributed entities and most of the attributes defy accurate measurement. It is presumably these difficulties that largely account for the tendency to ignore the role of environment in contractual choice. But data problems do not constitute a sufficient justification for ignoring fundamental determinants of economic organization.

The theory developed above focuses on the degree of separation between labor and management as the primary characteristic of tenure choice. However, what we observe is not the degree of separation but the category of tenure choice. Accordingly, we rank tenure choice to the degree of specialization as shown in Table 3. Owner operators manage and cultivate their own farms,[23] and have the least specialization. Share tenanted farms are largely managed and partly cultivated by the tenants.[24] Harvesting the cane of share tenanted farms is done primarily by hired labor. In the owner-managed

[23]Specialization within the family is not considered here. The family is considered as one unit, rather than as a group of factor owners.

[24]Since all share tenants in the sample receive 50 percent of the output we do not distinguish here between share tenants and share manager.

farms in the sample, all labor is hired, *i.e.*, provided by separate agents thereby involving a greater degree of specialization than the share tenanted and lease-managed farms. On sugar plantations, even the plantation manager and the supervisory personnel are hired.

TABLE 1

AVERAGE FARM SIZE, AVERAGE YIELD PER HECTARE, AND AVERAGE INPUTS PER HECTARE BY TENURE STATUS

Tenure status	Specialization rank	# of Obs.	Average yield/ha. (piculs/ha.)		Average farm size (ha.)	Average fertilizer expense/ha. (pesos/ha.)		Average chemical expense/ha (pesos/ha.)	
			C*	R		C	R	C	R
Owner-operator	1	9	—	—	—	—	—	—	—
Share-tenancy	2	26	89	82	2.9	553	448	—	—
Lease-managed	3	3	85	112	16.0	710	470	23.3	0
Owner-managed	4	7	97	88	12.1	605	729	15.1	15.1
Owner-controlled (hired manager)	5	15	113	97	148.0	1,075	1,003	152.2	154.7

*C is cane crop, while R is ratoon crop

Source: Cy (1979)

One important characteristic of the farming environment is the vulnerability of the farms to what we have called land shirking. The more vulnerable lands are those with potential for fertility reduction and those that continually practice control of potentially destructive weeds, insects and diseases in order to keep the pest population low. Farms that continually cope with high pest populations (*e.g.*, because of high populations on nearby farms) and have inherently low fertility are less vulnerable to land shirking. High productivity farms are more prone to land shirking than low productivity lands that are incapable of generating high rents. Accordingly, a land quality index, measured as expected revenue per hectare minus production costs, is used as a proxy for vulnerability to land shirking.[25]

For simplicity, we have assumed a linear relationship between the true (but unobserved) specialization index and land quality. OLS regression of the observed specialization rank and the land quality index will not provide either unbiased or efficient estimates of the underlying relationship. The error terms of the linear model do not conform to Guass-Markov assumptions. Moreover, the OLS estimates of the ordinal dependent variable may fall outside the specified range. The alternative estimation procedure used here is the ordinal probit model developed by Mckelvey and Zavoina (1975; see also Madalla 1983, 46-9).

The results of the maximum likelihood estimation show a positive relationship between specialization rank and land quality. The land quality coefficient yielded a t-ratio of 2.45, which is significant at the 1 percent level (using a z-test). The conventional F-test to test the significance of the multiple correlation is not appropriate with the ordinal probit model. Significance of regression equation can be tested by computing minus twice the log likelihood ratio, in this case 6.10. This statistic is distributed as chi-square and is significant at the 5 percent level. Despite the rough nature of our proxy and the use of

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[25]See Roumasset and James (1979) for a discussion of the relationship between land quality and rent. Not only are rents higher on high quality land but, under profit maximization, the output elasticity of land is also higher, implying a higher landlord's share on tenant farms.

only one independent variable, the results are consistent with our hypothesis that the type of land has a significant influence on tenure choice. Where land quality is low and land shirking relatively unimportant, there is a tendency to give the residual payment to labor and thereby control labor shirking. Where land shirking is relatively important, labor shirking tends to be controlled directly by supervision; landowners retain most the residual, thus providing incentive for land maintenance.

The land quality/maintenance hypothesis was also tested for a sample of rice farms in Nepal and the results are even more striking, with 78 percent of the contractual arrangements being correctly predicted (Sharma 1984). Owner-management was ranked as the most specialized followed by share tenancy and fixed lease respectively. The specialization rank was then regressed on a measure of land quality and a number of control variables, again using the ordinal multinomial probit model. Similar evidence of the effect of land quality on tenure choice has been documented for India (Datta et al. 1986; Nugent et al. 1991).

5.0 Summary and Conclusions

Tenure arrangements are usually modelled as alternative modes of employment. We suggest an alternative view of agricultural organization in which agricultural firms are classified according to the degree of separation between labor, land, and management. While the conceptual framework used descends from positive agency theory (*e.g.*, Jensen and Meckling 1976; Fama and Jensen 1983a), we have shown how a principal agency framework can be used to clarify the meaning of "minimum agency cost."

The tenure choice literature to date has focused on three alternative arrangements—rent, share, and wage. Classifying agricultural firms by separation between labor and management requires a different and more detailed taxonomy. The "owner worker-manager" firm with no hired labor is completely unspecialized. The

"owner-manager" firm with hired labor is quite specialized and the "hired-manager" firm even more so, even though all three are commonly classified as owner-operator arrangements. Moreover, owner-managed firms should not be confused with wage contracts, as in the conventional taxonomy, because labor is often hired on a piece-rate or share basis. There are two main types of share tenancy, one with cost sharing and one without, where cost-sharing arrangements are combined with higher landowner shares. Employment contracts, where workers receive a small share of the output in return for performing particular tasks, *e.g.*, harvesting and weeding, are essentially piece rate arrangements for hiring labor and do not constitute share tenancy firms.

Once firms are arrayed according to the degree of separation and consequent specialization, a number of apparently diverse observations about tenure choice seem to fit a more general pattern—the higher the land productivity, the higher the degree of specialization. A method was developed for obtaining a more direct verification of this pattern and illustrated using a sample of sugarcane farms in the Philippines.

Two determinants of specialization were identified which are likely to be related to land quality—vulnerability to land shirking and the importance of management. Where land shirking is a potential problem and the scope for management errors large, then the firm's incentives are more likely to be oriented towards efficient management, with labor shirking controlled by direct monitoring. Where production decisions and asset management are less important, then organizations geared to minimizing labor shirking are more likely to be chosen.

The empirical results, while significant, do not prove that land productivity is inordinately influential in shaping agricultural organization. The results do help to illustrate, through the example of land quality, how relationships between environment and the mode of production may be statistically documented. Since production technique and tenure choice are determined simultaneously, it is misleading to attribute productivity

differences to tenure choice or other aspects of agricultural organization.[26] The comparative institutions view, in which the relative efficiency of alternative arrangements depends on the physical and economic environment, also highlights the possible danger of government efforts to "reform" agricultural institutions and to force farmers to conform to the "best" tenure arrangements. On the other hand, where government attempts to design better institutions are inevitable, *e.g.*, for some aspects of public land management, then the agency perspective may help planners to learn from the rich variety of indigenous institutions.[27]

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[26]For example, several authors have cited the inverse relationship between farm size and yield per hectare as evidence of dualism in the agricultural sector and have concluded that Robin Hood land reform would increase agricultural production.

[27]The agency or transaction cost approach is an integral part of the New Institutional Economics (Williamson 1975, 1985; Roumasset 1978).

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