ECONOMIC ANALYSIS OF LAND AND LABOR MARKET PARTICIPATION IN RURAL INDIA: AN APPLICATION OF THE MULTINOMIAL LOGIT MODEL

by

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ABSTRACT

PEREIRA, MONTGOMERY P.A. Economic Analysis of Land and Labor Market Participation in Rural India: An Application of the Multinomial Logit Model. (Under the direction of LOREN A. IHNEN and DANIEL A. SUMNER.)

This research investigated the determinants of the participation decisions in the land and labor markets of rural India using a constrained production consumption model of the farm household.

The broad objectives of this study were as follows: (1) to model simultaneously the land and labor market participation decisions -- specifically the choice to supply labor, to hire in labor on the farm, to lease out land and to lease in land; (2) to test empirically the hypothesis that tenancy is a response to non-tradeability of farm resources such as farm experience, oxen and farm equipment; (3) to test for the presence of "spillover" effects from the labor market on the land lease decisions; and (4) use the estimated model to simulate the impact of selected policy instruments on the participation behavior in these markets.

The specified economic model was the standard neoclassical farm household production consumption model subject to two types of inequality constraints: (2) lower bounds and (2) upper bounds.

The first order conditions from this model were used to define the corner solutions with respect to the input decisions under

investigation. These conditions were then utilized to make inferences on individual propensity to participate in the market due to changes in the characteristics of the household head, due to changes in household and farm endowments and due to changes in market related constraints.

The economic model was also used to obtain comparative static results to generate hypotheses on the presence of "spillover" effects from potentially binding constraints in the labor market on the land lease decisions. These comparative static results are similar to those of Tobin-Houthaker and in static disequilibrium macro-economic literature.

A multinomial logit model was estimated for the set of four simultaneous decisions and consisting of 16 choices. The Nerlove and Press representation of the deterministic component was adopted.

The estimated results supported the hypothesis that the land market and the labor market decisions are simultaneous. It was also found that the demanders of land are adjusting to different constraints than the suppliers of land and, hence, treatment of one of the decisions as inverse of the other is likely to result in biased estimates.

The evidence on the presence of caste discrimination in the land lease market was very weak. A likelihood ratio test conducted to test this hypothesis was rejected at 20 percent level of significance. Further, the number of oxen owned by the household was not an

important determinant of the decision to lease out land but significantly influenced the decision to lease in land. This result indicates that the decision to lease in land and not the decision to lease out land is an adjustment to inelastic supply of farm power.

Most suppliers of land are small owners of land while most demanders of land are medium owners of land. The unequal distribution of farm equipment among these two classes seems to be an important determinant of the land allocation decisions. The estimated results suggest that inadequate rental markets for farm equipment reduces the marginal product of own farm land, especially for the small owners of land, while it raises the marginal product of hired land for the medium class.

Land ownership was positively related to the decision to lease out land while it was negatively related to the decision to lease in land. Simulation results showed that a land redistribution policy without intervention in the other factor markets wouuld increase the proportion of households supplying land in the small class by nearly nine percent. It would also decrease the proportion leasing in land both in the small and medium class but increase it in the large class.

An increase in average value of land increased the probability of supplying land consistent with Cheung's hypothesis. On the presence of potentially binding constraints in the labor market, the likelihood ratio test was statistically significant at less than five percent level indicating that the presence of constraints in the

labor market has significant spillover effects on the land lease decisions in these villages. Specifically, separate tests by sex indicated potentially binding constraints on female labor supply than on male labor supply. No evidence was detected on the presence of the 'supervision' constraint in these villages. Likelihood ratio test, however, provided strong evidence to the hypothesis that tenancy is an adjustment to more efficient utilization of farm resources, especially farm experience, number of oxen owned and farm equipment.

Finally, from the estimated responses by landholding classes, one could conclude that the male heads of household from the medium class are the most likely to seek adjustments to changing resource position through participation as suppliers of labor as compared to the other two classes. It is the small landholding households that are most likely to enter and exit as hirers of labor. In the land market, the small farmers are the most active participants as suppliers of land, while it is the medium class that is active as demanders of land. Thus, a ban on tenancy is most likely to have adverse effects on the earnings of these two classes instead of the large landholding class.

BIOGRAPHY

The author was born on January 17, 1954, in Goa, India. In 1970, he was selected as a National Science Talent Scholar by the Indian Council of Agricultural Research, New Delhi, to pursue studies in agricultural sciences. In 1974, he received his Bachelor of Science degree with a major in Agricultural Economics from the University of Agricultural Sciences, Bangalore, India. In 1977, he completed his Master of Science degree in Agricultural Economics from the same university.

In 1976, the author accepted a position at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India. He joined the doctoral program at North Carolina State University, Raleigh, in the fall of 1978. In spring and summer of 1982, the author worked as a researcher at The World Bank, Washington, D.C., and in spring and fall of 1984, he was an instructor in the Department of Economics and Business at North Carolina State University. In January 1985, the author joined the staff of the Center for Forensic Economic Studies, Philadelphia, as a Senior Analyst.

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Besides the members of my committee, there are also others who have contributed to successful completion of this program. Among these I am indebted to Dr. Hans P. Binswanger for introducing me to the program, to this area of research and continued encouragement throughout the program. Also to be placed on the record are the endless hours of discussions with Dr. Jaime Quizon during my stay in Washington, D.C. I would like to thank him for the time spent both at the office and at home in helping me to focus my ideas on land and labor markets in India.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Why do some agricultural households supply labor to the market while others don't? Why do some lease in land while others lease out? Do households face potentially binding constraints in the labor market and do these influence the land lease decisions? Will reallocation of land from large to small farmers decrease the demand for tenancies and increase the demand for hired labor? This research investigates the determinants of participation decisions in the land and labor markets of rural India using a multinomial logit model. The maintained hypothesis in this study is that an individual's decision to participate is the result of maximization of a function whose arguments are various characteristics of the individual, household and farm endowments and market related constraints.

An analysis of participation decisions is important because: (1) Participation represents entry into or exit from the market and hence reflects an increase or a decrease in input demand or supplies. Understanding the causes of such shifts increases the available set of policy instruments to alter the existing wage and employment levels, whereas, predicting such shifts helps to obtain better measures of potential input demands and supplies.

(2) Often, the objective of agricultural policies is to change the qualitative behavior of individuals. For example, if farming produces a higher income than work as a hired laborer in the labor market and thereby improves the welfare of the landless, labor households, then the only way that the these households can undertake farming, given the constraints in the credit market, is through leasing in land. A knowledge of the determinants of these participation decisions thus would enable promotion of the desired changes. (3) Since participation decisions represent market exit or entry as a response to change in the resource position of the household, a microeconomic analysis would help in designing appropriate economic policies to promote efficiency in resource allocation on the farm. Inappropriate policies, for example the efforts to ban share tenancy on the grounds that it leads to exploitation of the weak tenant, may do more harm than good. In recent literature on tenancy the institution of share tenancy is viewed as efficiency enhancing rather than efficiency inhibiting and the empirical evidence available, though far from satisfactory, also indicates that tenancy is a response to absent or poorly developed markets for land, insurance and other factors such as a managerial talent. Thus, a policy banning tenancy could, in the absence of intervention in the other markets, make tenant households worse off, even though the policy was designed to promote the welfare of the tenants. (4) Household's market entry or exit may also reflect accumulation of assets or human capital and eventually specialization

into certain trade or occupation. Thus investigating the participation behavior could be expected to aid our understanding of issues such as the underlying nature of complementarity and substitution between farm assets which are fixed in the short run and lifecycle adjustments through discrete behavior. (5) Market entry or exit represents diversification of risks associated with different markets and also reflects entrepreneurial nature of the household heads, so analyzing such behavior can throw light on these relatively neglected issues in the development literature.

The empirical importance of this study may be judged from the several facts: (1) Farmers make many qualitative choices and little research is done in this area with respect to the developing countries. (2) Nearly 70 percent of farmers do not participate in the land market. There are no studies in the literature that investigate the causes of such lumpy behavior. (3) Numerous articles hypothesize the presence of "spillover" effects from potentially binding constraints in the labor market on the land lease decisions. For example, the inability to hire desired amounts of labor from the market or problems related to supervision of hired labor is hypothesized to influence the decision to supply land (see Rao, 1971; Sen, 1981; and Stiglitz, 1974). Also, the presence of potentially binding constraints on labor supply or high unemployment rates are hypothesized to influence the extent of area under tenancy (Bardhan, 1979a). Few have satisfactorily modelled and empirically tested these assertions using micro data; (4) A priori, we would

set of participation decisions to be made simultaneously. None of the existing studies have taken this simultaneity into consideration. This study therefore differs from other studies in that it jointly estimates parameters for the land and labor market participation decisions using carefully collected micro data, namely the ICRISAT village level survey.[1] Thus, the empirical model specified is more general than that of Bardhan (1979a) or (1979b) and others. (6) Earlier studies have focused only on the leasing-in aspects of the household. (See, for example, Pant, 1981.) If the households that lease in land are adjusting to a different set of constraints than those that lease out land, then the set of paramter estimates would be different in the two cases. The asymmetry of the parameter estimates is tested in this study using a likelihood ratio test.

Some of the empirical studies that have investigated labor allocation issues in developing countries are by Sumner (1981), Rosenweig (1978, 1980), Bardhan (1979a) and Ryan and Ghodake (1979). Those dealing with tenancy are by Rao (1971), Bell (1977), Bliss and Stern (1982), Sen (1981), Bardhan (1979b), Jodha (1979) and Pant (1981). For an excellent review on this, see Binswanger and Rosenweig (1981).

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[1] ICRISAT is the acronym for International Crops Research Institute for the Semi-Arid Tropics located in Hyderabad, India. The village level survey contains longitudinal information on household, farm and other characteristics for 240 households spread across the semi-arid regions of South India.

The broad objectives of this study are: (1) to model simultaneously the land and labor market participation choices -- specifically the decision to hire out labor, to hire in labor on one's farm, to lease out land and to lease in land; (2) to empirically test the hypothesis that tenancy is a response to nontradeability of farm resources such as farm experience, oxen and farm equipment; (3) to test for the presence of "spillover" effects from the labor market on the land lease decisions; and (4) to use the model to simulate the impact of selected policy instruments on the participation behavior in these markets.

The plan for the rest of the thesis is as follows. In the next chapter, I discuss the economic model, which is a constrained farm household production-consumption model. The first order conditions are used to identify a set of feasible participation choices for the household head as well as to specify the empirical model. Here I also present comparative static results for a specific choice, namely an interior solution in the labor market and corner solution in the land market. These comparative static results are similar to those derived in the rationing literature by Tobin and Houthaker (1951) and are used to test for the presence of "spillover" effects.

The following chapter on the econometric aspects of the research contains a discussion on the multinomial logit model and the corresponding sample likelihood function. The fourth chapter deals with the empirical aspects of the research. Here I discuss the data, the definition of variables and the specification of the empirical

model, including a detailed discussion on the hypothesized determinants of the decisions as well as expected signs and the assumptions implied therein.

The fifth chapter presents the empirical results. Besides a discussion of the relative importance of the determinants of these decisions and tests of hypotheses, it contains predicted participation rates due to changes in selected explanatory variables.

The body of the thesis concludes with a chapter summarizing salient features of this research, limitations and suggestions for future research.

CHAPTER II

ECONOMIC MODEL

This chapter discusses the theoretical model underlying land and labor market choices of landowners. First, I discuss the objective function facing the individual.[2] The first order conditions from the constrained optimization are then used to investigate conditions under which an individual will be observed participating in the land and labor markets. This section is then followed by comparative static results for a specific choice. There I investigate the response on individual propensity to participate due to changes in some exogenous variables. Three types of effects are considered: (1) those due to changes in market rental rates, (2) those due to changes in attributes of the individual, and (3) those due to changes in market constraints to test for the presence of spillover effects on participation decisions arising from factor market "imperfections." "Imperfections" in the present study refer to the presence of transaction or adjustment costs or quantity constraints which may be inelastic factor demands or factor supplies.

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[2]This study focuses on the decisions made by the male heads of the household. The term 'individual' or 'household' is used interchangeably.

2.1 Resource Allocation Model

The decision to participate jointly in the land and labor markets is modeled using the farm household production and consumption theory. The basic approach consists of identifying different feasible choices for an individual. Each solution from the model for a given choice is defined by a constrained demand system and a unique equilibrium value of the indirect utility function, which is then linked to the multinomial model of discrete choices. In the next section, I discuss the specification of the objective function under various resource constraints.

2.1.1 Specification of the objective function and constraints

Assume that the individual maximizes a continuous, twice differentiable and strictly concave utility function denoted by U. The arguments of the utility function are: amount of household time x_{lh}, an aggregate bundle of market goods x_m, Z_u consisting of factors affecting only the utility function, other exogenous characteristics Z_q such as stock of human capital, household size, etc. The factors in Z_q are also common to the farm production technology given by $F(x_{if}, x_j ; Z_q, Z_f)$ with the usual properties. The x_{if} $(i = 1, \ldots, k)$ is a vector of amount of own farm inputs that are also tradeable in the market; x_j $(j = k+1, \ldots, n)$ represents a vector of hired farm inputs, and Z_f refers to vector of farm fixed factors like equipment,

availability of irrigation, weather parameters, production credit, etc. This vector mostly contains the nontradeable factors of the household.

The individual is assumed to own a fixed amount of tradeable farm resources, denoted by vector $\bar{x}_i$ (i=1, ... k). These resources and hired farm resources are not perfect substitutes in production because own resources possess certain characteristics that are not available in the market inputs. For example, family labor and hired farm labor are unlikely to be perfect substitutes on the farm as family labor is less likely to shirk than hired labor.

It is also assumed that any unused tradeable input,, i.e., $x_{is} = (\bar{x}_i - x_{if})$ can be rented out at a competitively determined rental rate, r_i (i=1, ..., k). Further, the household is assumed to be a price taker both in the product and in the hired labor market. The price of the product is set to unity and p_m is the price of the market good. The price of the hired inputs used on the farm is denoted by vector r_j (j = k + 1, ..., n). These are the price constraints imposed on the individual.

The total income of the household consists of (1) farm profits which are returns to own inputs as well as to farm fixed factors, (2) earnings from the supply of the excess of the tradeable resources to the market such as labor and land, and (3) other non-farm, non-rental income accruing from past decisions such as interest on deposits or

other asset income, Y_v. Some could be from nonfarm subsidiary occupations which are not modeled here.

The objective of the household can be expressed mathematically as follows:

$$\text{Max } U = U(x_{1h}, x_m; Z_u, Z_q)$$

s.t.

$$\text{(i)} \quad p_m x_m \leqslant F(x_{if}, x_j; Z_f, Z_q) - \sum_{j=k+1}^{n} r_j x_j + r_1(\bar{x}_1 - x_{1h} - x_{1f}) + \sum_{i=2}^{k} r_i(\bar{x}_i - x_{if}) + Y_v$$

$$\text{(ii)} \quad \bar{x}_1 \geqslant x_{1h} + x_{1f}$$

$$\text{(iii)} \quad x_{1h} \geqslant 0$$

$$\text{(iv)} \quad \bar{x}_i \geqslant x_{if} \qquad (i = 2, \ldots, k)$$

$$\text{(v)} \quad x_{if} \geqslant 0 \qquad (i = 1, \ldots, k)$$

$$\text{(vi)} \quad x_j \geqslant 0 \qquad (j = k+1, \ldots, n)$$

The first constraint is the budget constraint. It states that the total expenditure on market goods does not exceed the total income from all sources.

Constraint number (ii) defines the range of the feasible combinations for the total amount of own time spent on the farm as well as in the household. This should not exceed the total amount of available time. Constraint number (iii) imposes a restriction on the maximum amount of time that can be spent in household activity which should not exceed the total amount available. The (iv) constraint sets an upper bound on the use of other farm resources that are tradeable in the market; i.e., for i=2, ..., k.

Constraint numbers (v) and (vi) are the non-negativity restrictions. They are the lower bounds on the decision vector. They may also be treated as upper bounds when desired; i.e., reflecting inability of the household to transact in the market. For example, suppose a household is observed not to lease in any land. This means that $x_j = 0$ where x_j refers to demand for hired land which could be either due to households' inability to transact land or as a result of inability to demand negative amount of land.

The model as defined above is similar to the standard version of the farm household production-consumption model. See, for example, Barnum and Squire (1979), and Sumner (1982). It is a static one period model and does not contain any explicit treatment of uncertainty. Further, there is no treatment of lifecycle issues such as accumulation of wealth, human capital though learning or experience as this is a model of short run behavior. I have also assumed that all home consumption is evaluated at market prices and have abstracted from the issue of marketable surplus.

Although resource allocation entails a number of decisions beyond the question of level of input and choice of which inputs, for example, timing of inputs are chosen as well. Joint treatment of all such decisions is very complex to model in this thesis. The objective of this research being specifically to study the joint decisions in the land and labor markets, I abstract from the study of other endogenous decisions and focus exclusively on these limited decisions. This a model of short-run behavior.

Hence, the range of subscripts for the own factors are: i=1, 2, representing own labor and own land, respectively, whereas the hired inputs are: hired land and hired labor. The two land market decisions are: (1) the decision to supply own land to the market, and (2) the decision to lease in land. The labor market decisions are: (1) the labor force participation decision of the household head, and (2) the decision to hire in labor on the farm.

Consider the maximization problem facing the individual. This is the classical nonlinear problem subject to inequality constraints. It can be converted to the classical nonlinear unconstrained optimization by introducing appropriate shadow prices or the Kuhn-Tucker multipliers related to the constraints.

With this modification, the unconstrained generalized Langrangean is:

$$\text{Max } V = U(x_{1h}, x_m; Z_u, Z_q) + \lambda_1 [F(x_{if}, x_j; Z_f, Z_q) - \sum_{j=3}^{4} x_j r_j + r_1(\bar{x}_1 - x_{1h} - x_{1f}) + (\bar{x}_2 - x_{2f}) r_2 + Y_v - p_m x_m] + \lambda_2(\bar{x}_1 - x_{1h} - x_{if}) + \lambda_3 x_{1h} + \sum_{i=1}^{2} \alpha_i x_{if} + \beta_2(\bar{x}_2 - x_{2f}) + \sum_{j=3}^{4} \rho_j x_j$$

where $(i = 1, 2)$, $(j = 3, 4)$, λ_1 to λ_3, α_1, α_2, β_2, ρ_3 and ρ_4 are the Kuhn-Tucker multipliers.

Under certain regularity conditions, namely concavity of the objective function and the convexity of the constraints, the Kuhn-Tucker theorem on concave programming guarantees the existence of these multipliers for any feasible solution and for a fixed exogenous vector called as the parameter vector, (Sydsaeter, 1981 and Walsh, 1975). Further, assuming the existence of the optimal solution vector, denoted by *, the decision vector satisfies the following first order conditions at the point of optimum:

Allocation of own labor:

$$U_1^* - \lambda_1^* r_1 - \lambda_2^* + \lambda_3^* = 0 \qquad (1.0)$$

$$\lambda_2^* \geq 0 \text{ and } x_{1h}^* + x_{1f}^* \leq \bar{x}_1 \qquad (1.1)$$

$$\lambda_3^* \geq 0 \text{ and } x_{1h} \geq 0 \qquad (1.2)$$

$$\lambda_1^* F_1^* - \lambda_1^* r_1 - \lambda_2^* + \alpha_1^* = 0 \qquad (2.0)$$

$$\alpha_1^* \geq 0 \text{ and } x_{1f}^* \geq 0 \qquad (2.1)$$

Allocation of own land:

$$\lambda_1^* F_2^* - \lambda_1^* r_2 + \alpha_2^* - \beta_2^* = 0 \qquad (3.0)$$

$$\alpha_2^* \geq 0 \text{ and } x_{2f}^* \geq 0 \qquad (3.1)$$

$$\beta_2^* \geq 0 \text{ and } x_{2f}^* \leq \bar{x}_2 \qquad (3.2)$$

Allocation of hired farm imputs:

$$\lambda_1^* F_j^* - \lambda_1^* r_j + \rho_j^* = 0 \qquad j = 3,4 \qquad (4.0)$$

$$\rho_j^* \geq 0 \text{ and } x_j^* \geq 0 \qquad j = 3,4 \qquad (4.1)$$

Market good:

$$U_m^* - \lambda_1^* p_m = 0 \qquad (5.0)$$

Budget constraint:

$$F(x_{if}^*, x_j^*; Z_f, Z_q) - \sum_{j=3}^{4} r_j x_j^* + r_1(\bar{x}_1 - x_{1f}^* - x_{1h}^*)$$

$$+ r_2(\bar{x}_2 - x_{2f}^*) + Y_v - p_m x_m^* = 0 \qquad (6.0)$$

where the subscripts on U and F refer to the appropriate first order partial derivatives.

The conditions (1.0), (2.0), (3.0) and (4.0) hold with equality. The complementary slack conditions are written with many inequalities. Condition (5.0) assumes interior solution for the market good while condition (6.0) is written with equality assuming that the budget constraint is always binding. Note that some of these constraints are mutually exclusive, namely those defining the lower bounds and the upper bounds. Also, the non-negativity conditions define the lower bounds on the decision vector.[3]

Consider these first order conditions. If an individual actively participates in all the markets, the first order conditions are (1) to (6) without the Kuhn-Tucker multipliers. These conditions define the usual interior solution. Also, it is not possible to undertake general comparative static results unless it is known which of the constraints are binding. In which case, the first order conditions may be specialized along with the appropriate shadow prices to study the influence of the exogenous vector on the decision variables.

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[3]To make it more explicit, recall that a constraint can be interpreted either as an upper bound or as a lower bound on the decision vector. In the former situation, the individual would like to hire in a factor but is unable to do so either due to institutional constraints or due to transaction costs. In the latter case, the individual would like to demand an input less than zero but is unable to do so at the corner. The interpretation of the constraints define the sign of the shadow prices and are important in testing for spillover effects from one market into another market, which are discussed more fully later.

The above first order conditions define an infinite number of possible optimal values for the objective function given the continuity of the decision vector. The optimal outcome for an individual is the one that yields the highest possible utility given the resource endowments, other characteristics and market factors. Since different individuals are likely to face different resource constraints, these optimal outcomes may be characterized into finite set of choices depending upon the binding or unbinding constraints for each of the decision variable using these first order conditions. The specialized marginal conditions for each decision variable can then be used to make some inferences on individual propensity to transact in the market, even though no general comparative static results are forthcoming from the model.

Associated with each complementary slack condition, there are three possible alternatives, namely: (1) if the shadow price is positive, the constraint holds with equality, (2) if the constraint is not binding, the value of the shadow price is zero, and (3) if the constraint is just binding at the optimum, the value of the shadow price is zero. Instead of characterizing all the possible choice situations, I focus on the marginal conditions for some potentially interesting choices below.

2.1.2 Identification of regimes

In the present study, there are four decision variables, namely: (1) allocation of own labor, (2) allocation of own land, (3) demand for hired land, and (4) demand for hired labor. Each decision variable can take a value of zero, some positive amount in a continuous range, or an upper bound defined by the constraint. If each of the possible segments for the decision variable is represented by a discrete value, then these discrete values can, in turn, be considered as identifying one choice dimension. Hence, in the present study, there are four choice dimensions. The set of all choices given by the combinations of these four choice dimensions forms the total number of mutually exclusive choices faced by an individual.

There are three potentially interesting choices that are worth investigating on the allocation of own labor, namely: (1) supply of labor to the market, (2) supply of labor on one's own farm, and (3) do both. The relevant first order conditions to characterize these choices are (1.0) to (2.1). This does not mean that the other conditions are not necessary. The optimal values actually observed depend on all the conditions. Assuming that the other conditions hold at interior points, manipulation of the above con- ditions yields the following criteria under which an individual will be observed as a participant or nonparticipant in these activities:

(i) one is a nonparticipant in labor supply activity and participant in farm activity if

$$\lambda_1^* r_1 < U_1^* = \lambda_1^* F_1^*,$$

(ii) one is a participant in labor supply activity and nonparticipant in farm activity if

$$\lambda_1^* r_1 = U_1^* > \lambda_1^* F_1^*,$$

(iii) one is a participant in both activities if

$$\lambda_1^* r_1 = U_1^* = \lambda_1^* F_1^*.$$

These conditions define the relationship between marginal utility from market time, marginal product of farm labor and marginal utility from household time. An individual is at an interior point with respect to farm and household activity if he participates in both these activities and also supplies some labor to the market, i.e., $\bar{x}_1 > x_{1f}^* + x_{1h}^*$. For this choice, the marginal utilities from all activities are equalized.

Similarly, it is possible to characterize the observed choices in the allocation of own farm land. Unlike the labor supply decision, these choices are feasible only for those owning land. In the allocation of own farm land, there are only three interesting choices, namely: (1) nonparticipant as a supplier of land, (2) participant and leasing out some land, and (3) participant and leasing out all land. The relevant first order conditions are (3.0) to (3.2). By definition, a household that does not farm is assumed to supply all land to the market.

For those who do not participate as a supplier of land, the market rental rate falls short of the marginal value product of own farm land. These households farm all their land and, hence, $F_2^* > r_2$. While for those that lease out all their land $F_2^* < r_2$ and for those that supply some land as well as farm, the rental rate is equal to the marginal product of own farm land.

The other decisions under investigation are the decision to lease in land and the decision to hire in labor from the market to the farm. There are only two feasible choices for each of these hired inputs, namely: (1) the individual chooses to participate in the market, or (2) he chooses not to. It follows from above that if the individual does not participate in the market then the value of the marginal product of the resource evaluated at the corner solution

is less than the rental rate; i.e., $F_j^* < r_j$ $(j = 3,4)$. If he participates then $F_j^* = r_j$. It is possible, however, that $F_j^* > r_j + t_j$ where t_j represents transaction costs or other costs of participation. These possibilities are not explored in this research.

Although in the discussion above I considered three alternative uses for own labor, I focus in the succeeding discussion on only the labor market participation decision facing the individual. Data limitations do not allow one to distinguish between time spent exclusively for household and for farm activities. This simplification also helps to place more emphasis on labor market behavior rather than on the farm activity.

Having defined the conditions under which an individual is likely to be observed as a participant or as a nonparticipant for each of the decision variables, the total number of choices generated for selected possible combinations can be schematically represented as in Table 1. The table shows that the behavior and response to variation in exogenous factors may vary depending upon the binding constraints. Also, characterizing the set of feasible choices for an individual, as in Table 1, shows its resemblance to a multidimensional contingency table used in analyzing discrete choice behavior as in urban travel behaviors. In agriculture, one of the earliest studies analyzing joint discrete decisions is that on

Table 1. Equilibrium conditions characterizing the participation decisions in the land and labor markets

regime	labor		land		labor		land	
	labor supply	hired labor	lease out	lease in	own[a]	hired	own[a]	hired
1	p	p	p	p	$\lambda_1^* r_1 = F_4^*$	$r_4 = F_4^*$	$r_2 > F_2^*$	$r_3 = F_3^*$
2	np	p	p	p	$\lambda_1^* r_1 < U_1^*$	"	"	"
3	p	np	p	p	$\lambda_1^* r_1 = U_1^*$	$r_4 > F_4^*$	"	"
4	np	np	p	p	$\lambda_1^* r_1 < U_1^*$	"	"	"
5	p	p	np	p	$\lambda_1^* r_1 = U_1^*$	$r_4 = F_4^*$	$r_2 < F_2^*$	"
6	np	p	np	p	$\lambda_1^* r_1 < U_1$	"	"	"
7	p	np	np	p	$\lambda_1^* r_1 = U_1^*$	$r_4 > F_4^*$	"	"
8	np	np	np	p	$\lambda_1 r_1 < U_1$	"	"	"
9	p	p	p	np	$\lambda_1^* r_1 = U_1^*$	$r_4 = F_4^*$	$r_2 > F_2^*$	$r_3 > F_3^*$
10	np	p	p	np	$\lambda_1^* r_1 < U_1^*$	"	"	"
11	p	np	p	np	$\lambda_1^* r_1 = U_1^*$	$r_4 > F_4^*$	"	"
12	np	np	p	np	$\lambda_1^* r_1 < U_1^*$	"	"	"
13	p	p	np	np	$\lambda_1^* r_1 = U_1^*$	$r_4 = F_4^*$	$r_2 < F_2^*$	"
14	np	p	np	np	$\lambda_1^* r_1 < U_1^*$	"	"	"
15	p	np	np	np	$\lambda_1^* r_1 = U_1^*$	$r_4 > F_4^*$	"	"
16	np	np	np	np	$\lambda_1^* r_1 < U_1^*$	"	"	"

p = participant; np = non participant

[a]These conditions relate to the decision to supply the own resource to the market only. The upper bound restrictions are not considered.

adoption of modern technology by Phillipino farmers undertaken by Nerlove and Press (1973).

To summarize, using the objective function, I have shown how some households may be observed leasing-in land while others may be leasing-out or some hiring-in labor or hiring-out labor and others doing neither. The observed sorting of individuals into different choices is based upon the first order conditions which hold with equality or with inequality for each of the decision variables.

The actual process of sorting of individuals may be viewed more clearly if one assumes that initially all markets are absent or closed. Individuals enter the market with some initial endowments. Call them abilities, stocks or fixed factors. These are exogeneously given. So, also, are the market parameters and other constraints which are beyond the control of individuals. Now simulate the opening of some of the markets, say, for land and labor. That is, individuals can supply, demand or do both.

Given the set of constraints which may constitute resource constraints, transaction or adjustment costs or even social constraints such as caste status, rational individuals will allocate resources so as to maximize their utility. This maximization will in turn depend on the substitution or complementarity of factors in production and consumption. Some individuals will express their notional demand for land if they possess more complementary factors of production that cannot be traded in the market. Others will lease

out land if they cannot hire in complementary factors. Similarly, individuals will express their notional demand and supply of labor in the labor market. It is unlikely that markets will close before complete adjustments are made because, until then, there is an incentive to enter into contracts. However, when complete adjustments are made, some individuals will be observed leasing in land, others leasing out land and so on. If there are no transaction or adjustment costs and all markets are present, all factors will receive their factor rewards equal to the rental rate determined by the market equilibrium.

If there are transaction or adjustment costs then at equilibrium, rental rates will exceed the marginal product and some individuals will not be observed hiring in that factor at all. It is also possible that some individuals may be rationed, i.e., may be unable to meet their notional demand or supply because there are quantity constraints in the land or labor market in the short run (Bardhan, 1979a). Under such restrictions, individuals may be observed making adjustments in other factor markets. Thus, there may be some "spillover" effects from one market to another.

Note that it is not necessary to observe the same pattern of behavior for the entire population as initial endowments across individuals differ inducing differences in marginal product or marginal utilities which are implicit functions of these exogeneous characteristics or constraints. Hence, the observed sorting of individuals will depend on the nature of the resource constraints

operating on the individual. The indirect utility function which is obtained by solving the first order conditions for each of the feasible choices and substituting these solutions back into the utility function will therefore contain prices, constraints and other exogeneous characteristics of the individual as its arguments. Hence, the probability that an individual will be observed under a particular regime will also be a function of the same arguments defining the indirect utility function.

As noted earlier, it is not possible to generate any general comparative static results across regimes. However, the model as formulated above provides some guidelines in specifying the determinants of these choices and conditions under which an individual may be observed jointly participating in these factor markets. Since the arguments of the indirect utility function vary from one choice to another, the impact of a change in an exogeneous variable on the participation decision will also vary depending upon the choice. The hypothesized determinants of these four decisions and the expected signs on these coefficients are discussed in detail in Chapter IV.

The next section generates some comparative static results for a specific regime. Some of the hypotheses generated in the next section, especially those dealing with "spillover" effects, are tested with respect to the participation decisions. The first impact of such constraints is more likely to be observed on discrete choices

rather than on the continuous choice. These results are used as a guideline in the discussion of the empirical model.

2.2 Comparative Statics Under Constraints

In this section, I present comparative static results for a specific regime and generate testable hypotheses whether tenancy is: (1) a response to nontradeability of owned farm resources such as farm equipment, managerial experience, or an 'imperfect' bullock market, (2) a response to 'supervision' constraint, (3) whether there are quantity constraints in the labor supply market, (4) whether any such constraints affect the land lease market, (5) whether lower caste members are unable to secure a lease due to social status, and (6) whether education has an impact on the decision to lease-in or lease-out land.

These hypotheses are generated using the ideas from the rationing model of Tobin-Houthaker (1951). In the context of consumption of a good, they show that, an individual faced with a constraint or a rationed good, will increase the consumption of unrationed good that is a substitute to the rationed good and decrease the consumption of complementary goods. Tobin-Houthaker derived the effect of a change in the constraint on the quantity of unconstrained good consumed. Since the focus in this research is on the discrete decisions rather than on the continuous variables, the comparative static results generated here are with respect to the

shadow prices of the constraint as changes in these shadow prices are directly related to crossing the threshold. The main conjecture is that if tenancy is an adjustment to these factors or constraints, then the decision to lease-in land will be positively (negatively) related to these factors depending on whether a change in these factors will decrease (increase) the shadow price of hired land. Similar comparative static results are also used to generate hypotheses to test for the presence of "spillover" effects.

2.2.1 The objective function

Consider a household that owns land, supplies some labor to the market, does not supply any land to the market nor leases in any land, but hires in labor on the farm. This household is in regime 13 in Table 1. The appropriate Langrangean for the household is:

$$
\begin{aligned}
V_{13} = {} & U(x_{1h}, x_m; Z_u, Z_q) + \lambda_1 [F(x_{if}, x_j; Z_f, Z_q) \\
& - \sum_{j=3}^{4} r_j x_j + r_1(\bar{x}_1 - x_{1f} - x_{1h}) \\
& + r_2(\bar{x}_2 - x_{2f}) + Y_v - p_m x_m] \\
& + \beta_2(\bar{x}_2 - x_{2f}) - \rho_3(\bar{x}_3 - x_3)
\end{aligned}
$$

The lower bound for x_3 in this Langrangean has been set to $\bar{x}_3$ which is almost equal to zero as is customary in the literature when it is desired to do comparative statics around zero. The first order conditions for the household are:

$$U_1^* - \lambda_1^* r_1 = 0 \qquad (1.0')$$

$$F_1^* - r_1 = 0 \qquad (2.0')$$

$$\lambda_1^* F_2^* - \lambda_1^* r_2 - \rho_2^* = 0 \qquad (3.0')$$

$$\lambda_1^* F_3^* - \lambda_1^* r_3 + \rho_3^* = 0 \qquad (4.0')$$

$$F_4^* - r_4 = 0 \qquad (4.0'')$$

$$U_m^* - \lambda_1^* p_m = 0 \qquad (5.0')$$

$$F(x_{if}^*, x_j^*; Z_q, Z_f) - \sum_{j=3}^{4} r_j x_j^* + r_1(\bar{x}_1 - x_{if}^* - x_{1h}^*) + r_2(\bar{x}_2 - x_{2f}^*) + Y_v - x_m^* p_m = 0 \qquad (6.0')$$

$$\bar{x}_2 - x_{2f}^* = 0 \qquad (7.0)$$

$$\bar{x}_3 - x_3^* = 0 \qquad (8.0)$$

Conditions (1.0'), (2.0'), (4.0") (5.0') and (6.0') are those related to interior solution with respect to allocation of own labor and consumption of market goods. Equations (3.0') and (4.0') contain the shadow prices of the constraints, while the constraints are expressed as two additional equations (7.0) and (8.0), respectively.

If the constraints are <u>just</u> binding, then the values of the shadow prices are zero, and one need not solve for these shadow prices endogenously. In fact, under such a situation, the marginal product of own farm land is equal to the supply rental rate; i.e., $F_2^* = r_2$. Also, $F_3^* = r_3$ and, hence, the conditions are "<u>as if</u>" interior solutions even though the optimal solution vector will contain the value of the constraints. If the constraints are binding and the values of the shadow prices are therefore not zero but positive, then the above first order conditions can be used to solve for a set of unconstrained demand system, the value of the constrained factors being equal to the value of the constraints and the value of the shadow prices as functions of all the exogeneous factors.

Alternatively, as is the general practice in the literature dealing with fixed factors, the constraints may be directly absorbed into the functions as exogeneous variables, i.e., into the vector Z. This is done when it is not desired to solve for the shadow prices. I do not do so because my emphasis here is to undertake comparative statics with respect to the shadow prices as they reflect households propensity to participate in the market.

Consider the first order conditions. The Jacobian of the endogeneous variables with respect to the parameters of the system, i.e., all exogenous constraints, is nonsingular by assumption and is equal to the determinant of the bordered Hessian. Hence, the first order conditions can be solved for the endogeneous variables. These are

the unconstrained and the constrained decision vector; the optimal value of the constrained variables being equal to the constraints.

The implicit function theorem guarantees the existence of a unique optimal solution for the unconstrained variables as well as for the shadow prices related to the constraints as functions of the constraints and the other exogeneous variables. These can be written as:

$$\underline{x}^* = x^*(\theta)$$

where:

$$\underline{x}^* = [x_{1h}^*, x_{1f}^*, x_m^*, x_{2f}^*, x_3^*, \lambda_1^*, \beta_2^*, \rho_3^*]' \qquad (i = 1,2)\ (j = 3,4)$$

$$\theta = [r_i, r_j, \bar{x}_3, \bar{x}_2, Z_f, Z_q, Z_u, Y_v, p_m]'$$

Substituting x_{1h}^* and x_m^* yields the indirect utility function $U_{13}^* = U_{13}^*(\theta)$. Further, if these solutions are substituted in the first order conditions, the first order conditions hold as identities at the point of equilibrium, and they can be differentiated to obtain all the comparative static results for maximizing systems (Silberberg, 1978). The approach used here is the traditional method of differentiating the first order conditions and using Cramer's rule to solve for the differentials.

Totally differentiating the first order conditions, the entire system can be written as:

$$[H]\ [dx^*_{1h},\ dx^*_m,\ d\lambda^*_1,\ dx^*_{if},\ dx^*_j,\ d\beta^*_2,\ d\rho^*_3]'$$

$$= \quad [A]\ [dr_i,\ dZ_q,\ dZ_f,\ dZ_u,\ dY_{vf},\ d\bar{x}_i,\ d\bar{x}_3,\ dp_m]'$$

where:

$$[H] = \begin{bmatrix} U_{11} & U_{12} & -r_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ U_{21} & U_{22} & -p_m & 0 & 0 & 0 & 0 & 0 & 0 \\ -r & p_m & 0 & 0 & F_2-r_2 & F_3-r_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & \lambda_1 F_{11} & \lambda_1 F_{12} & \lambda_1 F_{13} & \lambda_1 F_{14} & 0 & 0 \\ 0 & 0 & F_2-r_2 & \lambda_1 F_{21} & \lambda_1 F_{22} & \lambda_1 F_{23} & \lambda_1 F_{24} & -1 & 0 \\ 0 & 0 & F_3-r_3 & \lambda_1 F_{31} & \lambda_1 F_{32} & \lambda_1 F_{33} & \lambda_1 F_{34} & 0 & -1 \\ 0 & 0 & 0 & \lambda_1 F_{41} & \lambda_1 F_{42} & \lambda_1 F_{43} & \lambda_1 F_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \end{bmatrix}$$

and

$$[A] = \begin{bmatrix} \lambda_1 & 0 & 0 & 0 & -U_{1q} & 0 & -U_{1u} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -U_{2q} & 0 & -U_{2u} & 0 & 0 & 0 & 0 & \lambda_1 \\ -x_{1s} & -x_{2s} & x_3 & x_4 & -F_q & -F_f & 0 & -1 & -r_1 & -r_2 & 0 & x_m \\ \lambda_1 & 0 & 0 & 0 & -\lambda_1 F_{1q} & -\lambda_1 F_{1f} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \lambda_1 & 0 & 0 & -\lambda_1 F_{2q} & -\lambda_1 F_{2f} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \lambda_1 & 0 & -\lambda_1 F_{3q} & -\lambda_1 F_{3f} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \lambda_1 & -\lambda_1 F_{4q} & -\lambda_1 F_{4f} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \end{bmatrix}$$

The matrix [H] is similar to that obtained under interior solutions for the six decision variables, except now, it is bordered by two constraints relating to the shadow prices and $F_2^* - r_2$, $F_3^* - r_3$, which are not equal to zero.

The matrix [A] contains the coefficients with respect to the exogeneous vector. Note that I have assumed that the vectors Z_l, Z_q and Z_f to be exogeneous or fixed and binding. Hence, this matrix contains the partial derivatives of the production and utility function as well.

Let:

$$[V] = \begin{matrix} U_{11} & U_{12} & -r_1 \\ U_{21} & U_{22} & -p_m \\ -r_1 & -p_m & 0 \end{matrix}$$

and:

$$[Q^{14}] = \begin{matrix} \lambda_1 F_{11} & \lambda_1 F_{14} \\ \lambda_1 F_{41} & \lambda_1 F_{44} \end{matrix}$$

where superscripts (14) refer to the unconstrained decision variables namely x_{1f} and x_4. Also, let H, V and Q^{14} represent the determinants of these matrices with H_{ij}, V_{ij} and Q_{ij} representing cofactors of the (i,j) element in these matrices. The following properties of these matrices from Samuelson (1947) have been implicitly used in the following discussion:

(i) H is negative definite by assumption of maximization. This implies that the diagonal elements of H are negative, reflecting diminishing marginal utilities or diminishing marginal products.

(ii) $\text{sign}(H) = \text{sign}(V) * \text{sign}(Q) = (-1)^{2+1} * (-1)^{4+2} < 0$

(iii) $\text{sign}(H_{ii}/H) < 0$ $(i = 1,2,4,5,6)$, i.e., border preserving principal minors, hence all $H_{ii} > 0$.

(iv) $\text{sign}(H_{n+k,n+k}) = \text{sign}(H) < 0$ $(k = 1,2,3)$

The inverse of the Hessian [H] is presented below:

$$H^{-1} = \begin{matrix} U^{-1} & 0 & C' \\ 0 & F^{-1} & D' \\ C & D & E \end{matrix} \qquad U^{-1} = \frac{1}{V} \begin{matrix} V_{11} & V_{12} & V_{13} \\ V_{21} & V_{22} & V_{23} \\ V_{31} & V_{32} & V_{33} \end{matrix}$$

$$C = \frac{1}{\lambda_1 V} \begin{matrix} \beta_2 V_{31} & \beta_2 V_{32} & \beta_2 V_{33} \\ \rho_3 V_{31} & \rho_3 V_{32} & \rho_3 V_{33} \end{matrix} \qquad F^{-1} = \frac{1}{Q^{14}} \begin{matrix} F_{44} & 0 & 0 & -F_{41} \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ -F_{14} & 0 & 0 & F_{11} \end{matrix}$$

$$D = \frac{1}{Q^{14}} \begin{matrix} -Q_{21}^{124} & -Q_{14} & 0 & -Q_{24}^{124} \\ -Q_{31}^{134} & 0 & -Q_{14} & -Q_{34}^{134} \end{matrix}$$

$$E = \begin{matrix} -\frac{Q^{124}}{Q^{14}} + (F_2 - r_2)^2 \frac{V_{33}}{V} & -\frac{Q_{23}^{1234}}{Q^{14}} + (F_2 - r_2)(F_3 - r_3) \frac{V_{33}}{V} \\ -\frac{Q_{32}^{1234}}{Q^{14}} + (F_2 - r_2)(F_3 - r_3) \frac{V_{33}}{V} & -\frac{Q^{134}}{Q^{14}} + (F_3 - r_3)^2 \frac{V_{33}}{V} \end{matrix}$$

Note its similarity to the inverse obtained by dropping the two constrained factors or setting their values as equal to the constraints.

To determine the impact of exogeneous factors on individual propensity to transact in the land market, I undertake comparative statics on the shadow prices related to the binding constraints. This is discussed below.

2.2.2 Response to changes in market rental rates

Here I discuss the impact on individual propensity to supply own land to the market due to changes in the labor supply wage, wage rate paid to hire labor on the farm, land rent received and rent paid to lease in land. Similar comparative static results may be derived on individual propensity to lease in land.

Labor Supply Wage

The total opportunity cost of the constraint with respect to own farm land is equal to $\lambda_1^* r_2 + \beta_2^*$. At the optimum, λ_1^* and β_2^* are both functions of the exogeneous vector as well as the constraints. The impact of a change in the labor supply wage is given by partially differentiating this expression and substituting the solutions for $\partial\lambda^*_1/\partial r_1$ and $\partial\beta^*_2/\partial r_1$ into the above expressions. These solutions are obtained using the inverse of [H] and the matrix [A]. Let $\beta'_2 = \lambda^*_1 r_2 + \beta^*_2$. Then the partial derivative of β'_2 with respect to r, can be written as:

$$\partial\beta_2'/\partial r_1 = (\partial\lambda_1^*/\partial r_1)\, r_2 + \partial\beta_2^*/\partial r_1$$

Substituting the solutions for $\partial\lambda_1^*/\partial r_1$ and $\partial\beta^*_2/\partial r_1$ into the above equations and reorganizing yields:

$$\partial\beta'_2/\partial r_1 = F_2^* \left[x^*_{1s} (\partial\lambda_1^*/\partial Y_v) - \lambda_1^* (\partial x^*_{1h}/\partial Y_v)\right] - \lambda_1^* (Q_{21}^{124} / Q^{14})$$

The cofactor Q_{21}^{124} and the determinant Q^{14} are also evaluated at the point of optimum.

The sign of this partial derivative is ambiguous; i.e., a change in the wage rate may increase or decrease the opportunity cost of being in the regime. The total effect of a change in the wage rate comprises of three different effects; two from the consumption side of the model and one from the production. The consumption effects are valued at marginal product of own farm land evaluated at the constraint while the production effect is valued at marginal utility of income. Without further assumptions on these effects, it is not possible to unambiguously sign the total effect. Suppose I assume that $\partial\lambda^*_1/\partial Y_v < 0$ and $\partial x^*_{1h}/\partial Y_v > 0$; i.e., an exogeneous increase in income decreases the marginal utility of income and that household time is a normal good. Then the first term on the right hand side is negative. The second term or the production effect is actually a "spillover" effect due to the presence of the constraint. This term may be zero or non-zero depending on how cofactor of Q_{21}^{124}

is evaluated. Suppose the cofactor is evaluated without keeping the two constraints active. Then it reflects the substitution properties between own farm land and own labor in production. If these factors are production complements (q - complements) then $Q_{21}^{124} > 0$ and hence, $\partial \beta_2' / \partial r_1 < 0$. Under these assumptions, an increase in the labor supply wage reduces the propensity to farm and hence increases the propensity to supply land to the market.

Intuitively, this seems plausible. Because an increase in labor supply wage would also increase the opportunity cost of own labor supplied to the farm and hence increase the propensity to supply labor to the market. This will then increase the propensity to supply land to the market if own labor and own land are complements.

Land Supply Rental Rate

As in continuous demand models, an increase in own land rental rate decreases the opportunity cost of own farm land and hence unambiguously increases the propensity to supply land to the market. This can been seen from the following:

$$\partial \beta'_2 / \partial r_2 = (\partial \lambda^*_1 / \partial r_2)\ r_2 + \partial \beta^*_2 / \partial r_2$$

Substituting the solution for $(\partial \lambda_1^* / \partial r_2)$ and for $\partial \beta_2^* / \partial r_2$ yields:

$$\partial \beta'_2 / \partial r_2 = -1 < 0$$

Rental Rate on Hired Land

The rate of change in the opportunity cost of own farm land increases or decreases the propensity to lease out own farm land depending on the sign of $\partial\lambda^*_1/\partial Y_v$. To see this, one must partially differentiate β'_2 with respect to r_3 and use the solutions for $\partial\lambda^*_1/\partial r_3$ and $\partial\beta^*_2/\partial r_3$ to obtain

$$\partial\beta'_2/\partial r_3 = -x^*_3 (F^*_2 - r_2)(\partial\lambda^*_1/\partial Y_v)$$

If I assume that $\partial\lambda^*_1/\partial Y_v < 0$, then the term is positive, since $F^*_2 - r_2 > 0$. Thus, an increase in the rental rate on hired land is likely to increase the opportunity cost of own farm land and reduce the propensity to supply land to the market.

Hired Labor Wage

The impact of a change in the hired labor wage on households' propensity to farm depends whether hired labor and own farm land are complements or substitutes in production. In general, an increase in wages paid to hired labor reduces farm profits and may therefore reduce area under farming. The impact of a change in the wage rate paid to hired laborers on the opportunity cost of own land in farming is given by the following relation:

$$\partial\beta'_2/\partial r_4 = - x^*_4 F^*_2 \ (\partial\lambda^*_1/\partial Y_v) - (Q^{124}_{24}/ Q^{14}) \ \lambda^*_1$$

The first term is positive by assumption ($\partial\lambda^*_1/\partial Y_v < 0$). The second term reflects substitution or complementarity in farming between own land and hired labor. It is positive (negative) if these two factors are complements (substitutes). If the two factors are complements, the more likely case, then the sign of the partial derivative is ambiguous. If, however, the two factors are strong complements, then it is possible that the negative production effect may outweigh the positive consumption effect thus making $\partial\beta'_2/\partial r_4 < 0$. This is the implied assumption, hence an increase in the hired labor wage is expected to induce households to supply own land to the market.

2.2.3 Response to changes in individual attributes

In this section I use the comparative static results from the model to discuss the likely effect on the decision to lease out land due to a change in one of the components of Z_q and one from Z_f. Among the components of Z_q, I discuss the impact of a change in education while among the components of Z_f, I discuss the impact of farm experience.

Education

What would be the effect of education on the decision to supply land to the market? This, in general, is rather difficult to say. In this simple model, where education is hypothesized to affect both consumption and production, the overall effect of education would

depend on how it actually affects the arguments of these two processes. The role of education in utility or production is similar to that of technological change. It may enhance allocative efficiency (input mix) and input efficiency (productivity) (see Huffman, 1974). By specifying education as a fixed factor, I only consider the productivity effect of education as reflected in consumption and production. A change in education will affect the marginal utility of household time as well as market goods, while on the production side, it will affect the marginal productivity of all farm inputs. This can be seen by solving for the partial derivative of β_2' with respect to Z_q.

$$\partial\beta_2'/\partial Z_q = \frac{\partial\lambda_1^*}{\partial Z_q} r_2 + \partial\beta_2^*/\partial Z_q$$

Substituting the solutions for $\partial\lambda_1^*/\partial Z_q$ and $\partial\beta_2^*/\partial Z_q$ yields the following expression:

$$\partial\beta_2'/\partial Z_q = F_2^* [U_{1q}^* (\partial x_{1h}^*/\partial Y_v) + U_{2q}^* (\partial x_m^*/\partial Y_v) + F_q^* \partial\lambda_1^*/\partial Y_v]$$

$$+ \lambda_1^* [F_{1q}^* (Q_{21}^{124}/Q^{14}) + F_{2q}^* + F_{4q}^* (Q_{24}^{124}/Q^{14})]$$

Assume that $\partial x_{1h}^*/\partial Y_v$, $\partial x_m^*/\partial Y_v$ are positive, i.e., normal goods, and that U_{1q}^*, U_{2q}^* are positive; i.e., education enhances marginal utilities. Further, suppose that $Q_{21}^{124} > 0$, $Q_{24}^{124} > 0$ and also F_{1q}, F_{2q} and F_{4q} are all positive, i.e., education is a

complementary input in production. Assuming that all these positive terms outweigh the negative effect from $\partial\lambda^*_1/\partial Y_v$, the expression as a whole is expected to be positive. That is, an increase in education is expected to increase the opportunity cost of own farm land and hence reduce the propensity to supply land to the market.

Education may influence the decision to lease out land in much more complex ways than modeled here. For example, it may change the risk bearing ability of household heads or ability to process market information. It may also have differential impacts on the productivity of farm, market and household time. This may induce individuals to decrease the supply of own labor to the farm if education raises the productivity of market time in nonagricultural occupations more than in farming and hence increase the propensity to supply land to the market. This is a sectoral migration effect. Since it is difficult to sort out these different effects, I expect education to display a nonlinear impact on the decision to supply land, i.e., at a low level of schooling it is expected to have a positive impact due to complementarity, while at high level of schooling, individuals are expected to lease out land and hence display an inverse relation.

Farm Experience

Farm experience or managerial experience is assumed to affect only the farm production in the model. The nontradeability of farm

experience in Indian agriculture is hypothesized to be an important determinant of land lease decisions (see Bell, 1977; Bell and Zusman, 1976; and Bliss and Stern, 1982). For example, land owners who lack farming experience or inadequate farming skills are expected to lease out land to tenants that do possess such skills. This mode of adjustment to the absent market for managerial talent probably benefits both the landlord as well as the tenant. Tenants are able to obtain some rents to this fixed factor while landlords are able to obtain higher output or higher rents from the land if farm experience and own land are complements.

Like education, farm experience may have allocative and worker effects or even alter the risk-taking ability of the household head. For example, in the context of managerial talent, Rao (1971) empirically shows that the choice of the lease, uncertainty and entrepreneurial ability and the choice of the cropping pattern adopted on tenant farms are intricately related.

By specifying farm experience as a fixed factor of production, I only consider the worker or productivity effect of farm experience, although empirically it is difficult to sort these from the other effects. In the present model, the relation between the shadow price of own farm land and farm experience is given by the partial derivative of β_2' with respect to Z_f or

$$\partial\beta_2'/\partial Z_f = (\partial\lambda_1^*/\partial Z_f)\, r_2 + \partial\beta_2^*/\partial Z_f$$

Substituting for the solutions yields:

$$\partial\beta_2'/\partial Z_f = F_f^* F_2^* (\partial\lambda_1^*/\partial Y_v) + \lambda_1^* [F_{1f}^* (Q_{21}^{124}/ Q^{14}) + F_{2f}^* + F_{4f}^* (Q_{24}^{124}/ Q^{14})]$$

The sign of this partial derivative is also ambiguous as in the case of education. Since it is assumed to affect only the farm production, there is only one consumption side effect to deal with.

Again, with some assumptions that farm experience is a complementary factor of production with respect to all inputs, i.e., it augments productivity of inputs and that Q_{21}^{124} and Q_{24}^{124} are positive or production complements, it is expected that the second term will outweigh the negative effect from $\partial\lambda^*_1/\partial Y_v$ with the net effect being positive. An increase in farm experience is expected to induce the household to farm its own land and hence reduce the propensity to lease out land. Thus, in the absence of a market for this resource, land owners with low levels of this factor may prefer to lease out land to tenants who possess a greater amount of this complementary factor instead of self farming.

So far I have discussed the effects of changes in factor prices, one factor affecting only farming operations and one affecting both utility and farm production on the propensity to lease out own farm land. Next, I discuss the response to changes in quantity constraints. A more detailed discussion on the other determinants and their expected influence for the three other decisions is undertaken in Chapter IV.

2.2.4 Response to changes in quantity constraints

This section presents comparative static results dealing with the impact of a change in potential quantity constraints from the labor market on the propensity to lease out land. Drawing from the rationing literature, this section generates hypotheses to test whether tenancy is an adjustment to 'imperfections' in factor markets or to test for the presence of potential "spillover" effects from the labor market on the land market. The main conjecture is that if tenancy is an adjustment to potentially binding constraints in the land market, then the decision to lease out land will be positively (negatively) related to these constraints depending on whether a change in these constraints will decrease (increase) the shadow price of own farm land.

Three types of constraints are commonly discussed in the tenancy literature: (1) quantity constraints on labor supply, i.e., the inability of the individual to supply the desired amount of labor in the market or the high unemployment rates (Bardhan, 1979a); (2) quantity constraint in the hired labor market, i.e., the inability to hire in adequate amount of labor from the market to undertake self cultivation especially on large farms during the peak season(s), and (3) supervision constraint or prohibitive costs of supervising hired labor (see Rao, 1971; Sen, 1981; and Stiglitz, 1974). Although, in the long run, one would expect wage rates to rise and farmers to adjust their cropping patterns or resort to long term labor contracts; in the short run, the presence of such bottlenecks may force some adjustments through the land lease market.

The third constraint, i.e., the 'supervision constraint' is hypothesized as a motivation for sharecropping. The argument runs as follows: Large farmers who hire large amounts of labor face supervision problems with hired labor as hired labor is likely to shirk in the absence of supervision. Hence, "landlords may find it profitable to lease out, beyond a point, the land they own rather than cultivate the entire holding through hired labor" (Rao, 1971). This is referred to as "imperfection" in the hired labor market. (See Binswanger and Rosenweig, 1981.) It is rather difficult to justify why heterogeneity of labor is an imperfection. The presence of supervision costs implies that own farm labor and hired labor are not perfect substitutes on the farm or that family labor possess certain characteristics not possessed by hired labor. The sharing in farm profits by family labor may elicit more effort on the part of family members and may make them more reliable than hired labor. The supervision constraint implies that some households may face inelastic supply of family labor to one's farm and this may induce households to supply land to the market.

The theoretical model shows that the presence of such constraints will affect the land lease decisions in the form of spillover effects from one market to another. To test for the presence of constraints in the labor market or alternatively whether tenancy is a response to these constraints, I test for the presence of spillover effects from the labor market on the shadow prices relating to the propensity to lease out land.

Constraint on Labor Supply: A constraint on labor supply may be represented as a constraint on the demand for own labor, i.e., if an individual is unable to supply the desired amount of labor, this means adjustments will have to be made through the household and the farm. Assume that all adjustments are made through the farm in the case of males. This constraint is similar to that imposed on x_3. Hence the impact on individual propensity to lease out land from such a constraint may be obtained by differentiating β_2' with respect to $\bar{x}_3$ or

$$\partial\beta_2'/\partial\bar{x}_3 = (\partial\lambda_1^*/\partial\bar{x}_3)\, r_2 + \partial\beta_2^*/\partial\bar{x}_3$$

Substituting for the optimal solutions yields:

$$\partial\beta_2'/\partial\bar{x}_3 = F_2^*(F_3^* - r_3)\,(\partial\lambda_1^*/\partial Y_v)\, r_2 - (Q_{32}^{1234}/Q^{14})$$

The expression is negative if I assume that the marginal utility of income decreases with income and that own labor and own land are production complements. Thus the presence of a constraint is expected to reduce the opportunity cost of own farm land and hence increase the propensity to supply land to the market. This may be justified intuitively as follows: suppose own land and own labor are production complements, then the presence of a constraint on the labor supply leads to increased supply of labor to the farm thus increasing the demand for own farm land and hence decreasing the propensity to supply land to the market.

Constraint on Hired Labor: Using similar comparative static results as above, it can be shown that the presence of this constraint will lead to increased propensity to supply land to the market.

The results, with respect to the decision to lease in land, are similar. A more detailed discussion is presented in the empirical model.

The next chapter focuses on the econometric aspects of this research. The model estimated is the multinomial logit model. Since there are several references that provide a good discussion on the model and its weaknesses, only a brief discussion and salient features of the model are presented in the next chapter.

CHAPTER III

ECONOMETRIC ISSUES

In this chapter, I discuss the econometric aspects of the study. This is presented under three headings: (1) choice of the econometric model, (2) the likelihood function, and (3) goodness of fit and statistical inference.

3.1 Choice of the Econometric Model

The four decisions under investigation; namely to hire-out labor, to hire-in labor on the farm, to lease-out land and to lease-in land are determined simultaneously. Hence, in statistical estimation, it is necessary to treat these endogeneously. It may be necessary to clarify the use of the concept of endogeneity used in this study. Endogeneity, as used in the econometric literature, generally refers to structural endogeneity such as in simultaneous equations that are structurally related to each other; whereas as used in the discrete choice literature, it refers to probabilistic association among different dimensions of a multidimensional contingency table. The simultaneous nature of choices as in a multidimensional contingency table is also referred to as 'joint dependence' of endogeneous variables to distinguish it from structural

simultaneity. See, for example, Maddalla (1983), Fienberg (1977) and Nerlove and Press (1973) for some discussion on these issues.

Accordingly, there are two distinct approaches to analyzing discrete choices. One is where each index reflecting individual propensity to transact in the market structurally affects the other index. This is the traditional simultaneous equations method. The other is to treat these decisions as jointly dependent, as in the context of a contingency table. The main difference between the two approaches lies in the specification of the error structure of the econometric model.

Ideally, it would be preferable to use a structurally simultaneous equation model wherein one could measure the relative magnitude of the impact of one decision on another. In multinomial models, it is not possible to determine this impact as they are less general than the structurally simultaneous equations. Besides, assessing the effect of exogeneous variables on these simultaneous decisions however, the former models provide a test for structural simultaneity of these decisions. The difference between the two approaches with respect to the nature of simultaneity is like the difference between the correlation coefficient and the regression coefficient. The correlation coefficient provides a measure of association between variables while the regression coefficient provides a measure of magnitude of the impact of one variable on another.

The structurally simultaneous equations method was not used in this study due to software and data limitations, namely the presence of sampling zeros and relatively few number of observations in some cells. In the presence of sampling zeros, the likelihood function becomes unbounded while few observations per cell generally result in estimates sensitive to the empirical specification.

3.2 The Multinomial Model

In the chapter on theoretical model, I demonstrated that each choice faced by the household head corresponds to a specific set of first order conditions and hence can be represented by an indirect utility function or a maximand function which embodies the simultaneous nature of these four decisions. Further, this indirect function is a function of the respective constraints, household, individual and market characteristics. Each choice may be viewed as a cell in a multidimensional contingency table defined by the joint nature of these four decisions. Hence, an appropriate econometric method to study these decisions is that developed by McFadden (1974) or DaGanzo (1979) or Goodman (1972), and later modified by Nerlove and Press (1973).

These models are called multinomial models of discrete choice as they view each choice (cell) faced by an individual as an alternative from a fixed set of choices and assume a multinomial sampling scheme.

The process can best be described using two joint decisions. Consider, for example, the decision to supply labor and land. These are indexed by the continuous variables x_{1s} and x_{2s}, respectively. Defining $x_{is} = 0$ $(i = 1, 2)$ if the individual does not supply the factor to the market and $x_{is} = 1$ $(i = 1, 2)$ if he supplies to the market, these two decisions can be viewed as generating four possible discrete choices as shown below.

x_{1s} \ x_{2s}	0	1
0	(0,0)	(0,1)
1	(1,0)	(1,1)

If each of these choices are indexed by an underlying latent variable or the maximand function reflecting individual propensity to be in the regime, then the objective of the individual may be defined as selecting the choice that corresponds to maximum of these maximand functions. In doing so, the individual implicitly chooses a set of joint decisions represented by the two dimensions of the contingency table.

In simplest form, this index may be defined as an additive function of determinants affecting the two decisions and an error component. This can be written as:

$$I_{ij} = V_{ij} + e_{ij}$$

where I_{ij} = underlying index for the (i,j) cell.

V_{ij} = deterministic component of the index.

e_{ij} = stochastic component of the index for the cell.

Different assumptions on the stochastic component or on the deterministic component generate different econometric models of multinomial choice. For example, the assumption of normality of e_{ij} yields the multinomial probit model (see Daganzo, 1979). If e_{ij} is assumed to be distributed as independent Gumbel variates, this yields the multinomial Logit model of McFadden (1974) and Nerlove and Press (1973).

The choice of the multinomial model in this study; i.e., probit or logit was based on the computational tractability. The likelihood function for the probit is computationally cumbersome for a set of 16 choices studied here. Hence, it was decided to use the multinomial logit model.

Although both the Nerlove and Press and the McFadden model are multinomial logit in nature, the difference between the two lies in the specification of the deterministic component of the index V_{ij}.

In the present study, I will use the Nerlove and Press method of specifying the deterministic component of the index because it contains fewer parameters to be estimated and the 'unsaturated' nature of the model does not lead to unboundedness of the likelihood function when some of the cells are empty.

In the next section I summarize briefly the derivation of the likelihood function used in this research. This is undertaken so as to reveal the similarities between the McFadden parameterization and that of Nerlove and Press.

3.2.1 The likelihood function

The transition from a set of discrete choices to the specification of probabilities of the likelihood function for the multinomial logit model following McFadden is discussed below. For ease of exposition, the entire discussion is conducted with respect to two decisions. Rewrite the latent index representing individual propensity to choose the r^{th} choice ($r = 1,2,3,4$) as follows:

$$I_r = V_r + e_r$$

where I_r = underlying latent index for the r^{th} choice

V_r = deterministic component of the index

e_r = stochastic component of the index

Assuming that the stochastic component "e_r" is independent, identically distributed Gumbel variate with parameters n = 0 and w = 1 with the cumulative distribution

$$F(\varepsilon) = e^{-e^{-w(\varepsilon-n)}}$$

the probability that an individual chooses the r^{th} choice following McFadden (1974) is given by

$$P(r) = P(V_r + e_r > V_s + e_s) \quad \forall \; s \neq r, \quad s = 1,\ldots,4$$

$$= P[(V_r + e_r > \text{Max}(V_s + e_s)]$$

$$= \frac{e^{V_r}}{\sum_{s=1}^{4} e^{V_s}}$$

or equivalently

$$P(i,j) = \frac{e^{V_{ij}}}{\sum_{m=0}^{1} \sum_{n=0}^{1} e^{V_{mn}}} \qquad (9.0)$$

Hence, given a sample of N individuals, the likelihood function can be written as:

$$L = \prod_{t=1}^{N} \prod_{i=0}^{1} \prod_{j=0}^{1} P(i,j)^{d_{ij}} \qquad (10.0)$$

$d_{ij} = 1$ if the individual is in the (i,j) cell

$= 0$ otherwise

and $\sum_{i} \sum_{j} d_{ij} = 1$

In order to make the model useful for analyzing the choices, it is necessary to write the deterministic component of the index as a function of determinants of these choices. Nerlove and Press (1973), following Goodman (1972), adopted a specific parameterization of the deterministic component which is discussed below.

Consider the deterministic component V_{ij}. Goodman (1972) decomposed V_{ij} into effects such as arising from decision to supply labor and from decisions to supply land as well as an additional term reflecting the probabilistic association between these two decisions. This can be written as:

$$I_{ij} = \alpha_1(i) + \alpha_2(j) + \gamma_{12}(i,,j)$$

where $\alpha_1(i)$ = a component due to the decision to supply labor

$\alpha_2(j)$ = a component from the decision to supply land

and $\gamma_{12}(i,j)$ = a term reflecting the joint nature of these two decisions

Nerlove and Press (1973) modified the main effect components of V_{ij} as functions of explanatory variables affecting these joint decisions. Thus, setting

$$\alpha_1(i) = X_{1i}\beta_{1i} \text{ and } \alpha_2(j) = X_{2j}\beta_{2j}$$

where X_{1i}, X_{2j} are vectors of determinants affecting the labor supply and land supply, respectively, and β_{1i} and β_{2j} are vectors of parameters to be estimated. Using this paramaterization, the probability that an individual would participate jointly in the $(i,j)^{th}$ regime is given by:

$$P(i,j) = \frac{e^{X_{1i}\beta_{1i} + X_{2j}\beta_{2j} + \gamma_{12}(i,j)}}{\sum_s \sum_t e^{X_{1s}\beta_{1s} + X_{2t}\beta_{2t} + \gamma_{12}(s,t)}}$$

This is the Nerlove and Press model for two decisions without imposing any restrictions on the parameters. Further, if $\gamma_{12}(i,j)$ is also made a function of explanatory variables, one obtains the

McFadden model. These parameters would capture effects that vary jointly with the decisions. Thus, the interaction term in the Nerlove and Press model reflects aggregate effects from unmeasured characteristics of these decisions that vary jointly across the cells and are suppressed as a constant parameter. In the present analysis, γ_{12} is assumed to be a constant rather than a function of the exogeneous variables as it enables to test for simultaneity of these decisions.

Alternatively, one can start with the expression for the index of individual propensity to be in the $(i,j)^{th}$ cell as:

$$I_{ij} = X_{1i}\beta_{1i} + X_{2j}\beta_{2j} + \gamma_{12}(i,j) + e_{ij}$$

and with the assumptions on the error component derive the multinomial logit model.

The model as specified in (9.0) suffers from an identification problem, namely if the numerator and denominator are multiplied by a constant, the probabililties are unaffected. This is because the sum of probabilities of all regimes is one by definition. To overcome this problem, either one can set $\beta_1 = 0$ or the sum of all parameters to zero. The latter constraint is generally imposed on the model for uniqueness of parameters. Nerlove and Press also impose additional restrictions on parameters. Note that it is not possible to impose these restrictions if the choice dimensions are polytomous in nature. In the present study, each choice dimension is

dichotomous, and it is desirable to impose such restrictions on theoretical grounds. For example, the effect of an exogeneous variable on individual propensity to participate in the market is likely to be equal and opposite to that on nonparticipation. Under these assumptions these restrictions are as follows:

$$X_{10} = X_{11} = X_1;\ X_{20} = X_{21} = X_2$$

$$\beta_{10} = -\beta_{11} = -\beta_1;\ \beta_{20} = -\beta_{21} = -\beta_2$$

$$\gamma_{12}(i,0) = -\gamma_{12}(i,1);\ \gamma_{12}(0,j) = -\gamma_{12}(1,j)$$

Since $\gamma_{12}(i,j)$ measures the association between the two decisions they are symmetric; i.e., $\gamma_{12}(i,0) = \gamma_{12}(0,j)$ and $\gamma_{12}(i,1) = \gamma_{12}(1,j)$. Further, setting $\gamma_{12}(1,1) = \gamma_{12}$ yields one measure of association for the interaction terms, i.e.,

$$\gamma_{12}(1,0) = \gamma_{12}(0,1) = -\gamma_{12}$$

$$\gamma_{12}(0,0) = -\gamma_{12}(0,1) = \gamma_{12}$$

Using all the restrictions, the probability of being in the (i,j) regime can now be written as

$$P(0,0) = (e^{-X_1\beta_1 - X_2\beta_2 + \gamma_{12}})/D$$
$$P(1,0) = (e^{X_1\beta_1 - X_2\beta_2 - \gamma_{12}})/D$$
$$P(0,1) = (e^{-X_1\beta_1 + X_2\beta_2 - \gamma_{12}})/D$$
$$P(1,1) = (e^{X_1\beta_1 + X_2\beta_2 + \gamma_{12}})/D$$

where $D : P(0,0) + P(1,0) + (0,1) + P(1,1) = 1$

These restrictions implicitly embody the restriction for identification of parameters. Substituting these probabilities into (10.0) yields the sample likelihood function for the two joint decisions. If the available set of choices differ as in the case of landless and landed individuals, then the parameters corresponding to that decision, as well as some of the interaction terms, can be set to zero. The likelihood function will now be a product of two separate sets of probabilities defined for each class.

In the present study, there are four joint decisions under investigation. Each individual is assumed to face 16 different feasible alternatives defined by four jointly dependent variables; hence, there will be four main effects which are functions of explanatory variables affecting these decisions and six bivariate associations.

Restricting to landowners only, the specific likelihood function for the entire sample is:

$$L = \prod_{t=1}^{N} \prod_{i} \prod_{j} \prod_{k} \prod_{l} P(i,j,k,l)^{d_{ijkl}}$$

d_{ijkl} = 1 if the individual is in (i,j,k,l) regime

= 0 otherwise

and $\sum_{i} \sum_{j} \sum_{k} \sum_{l} d_{ijkl} = 1$

The corresponding probabilities for the 16 regimes are as follows:

$$P_{ijkl} = D_{16}^{-1} \left[\sum_{q}^{4} d_q X_q \beta_q + \sum_{s<t} \sum d_s d_t \gamma_{st} \right]$$

where: $d_q = 1$ if $u = 1$
$= -1$ if $u = 0$ $\quad \forall \; u = i, j, k, l$

and $D_{16} : \sum_i \sum_j \sum_k \sum_l P_{ijkl} = 1$

The maximization of this likelihood was done using the Davidson-Fletcher-Powell (DFP) algorithm in Goldfeld-Quandt Optimization package (GQOPT). The package requires user supplied subroutine for the likelihood function and the first partial derivatives with respect to parameters.

The likelihood function for the multinomial logit is globally concave; i.e., the Hessian is negative semi-definite. Hence, a solution to the first order conditions provides a unique estimate of the parameters. Further, these estimates are under relatively general consistent conditions, asymptotically efficient and asymptotically normal (McFadden, 1974). The estimated asymptotic variance-covariance matrix of the estimates is given by negative of the inverse of the Hessian of the likelihood function evaluated at the point of optimum (Theil, 1971).

3.3 Goodness of Fit and Statistical Inference

There are a number of criteria that are used to evaluate the goodness of fit for different specifications for a given likelihood function. These are extensively discussed by Amemiya (1981). Each has its own advantages and disadvantages. In this study I report three different measures for each specification.

(1) log of the likelihood function at the point of optimum

(2) McFadden's $\rho^2 = 1 - L(\hat{\beta})/L(0)$.

where $L(\hat{\beta})$ = log of the likelihood function at optimum

and $L(0)$ = log of the likelihood when all parameters are zero.

(3) percent of correct predictions: an observation was defined as correctly predicted in the observed regime if the predicted probability was greater than one-half

The hypotheses testing was done using the asymptotic t-values in the case of a simple hypothesis and the likelihood ratio test for compound hypotheses. The likelihood ratio statistic is obtained by maximizing the likelihood function with and without the restrictions and "-2 times the difference is distributed asymptotically as Chi-square with as many degrees of freedom as coefficients set to zero" (Nerlove and Press, 1973, p. 45).

The next chapter deals with the description of the data, the definition of variables and the empirical model. The latter enumerates the determinates of the four main effects and discusses the expected responses on individual propensity to transact in the factor market due to a change in these determinants.

CHAPTER IV

EMPIRICAL MODEL

This chapter deals with the empirical aspects of the research. Here I discuss the data, the definition of variables and the specification of the empirical model including a detailed discussion on the hypothesized determinants of the decisions as well as expected signs and the assumptions implied therein.

4.1. Description of the Sample

This research was done using the ICRISAT longitudinal survey of 240 households spread over six villages in the Semi-Arid Tropical region of South India. The data collection has been underway since May , 1975. However, only two years of data corresponding to 1975-1976 and 1976-1977 were available for this study.

The selection of the original sample had been done as follows. Three districts in two states representing broad agroclimatic characteristics of the semi-arid region (soil, rainfall and cropping patterns) were selected first. The choice of these districts was based upon two criteria: (1) they had to be close to ICRISAT headquarters in Hyderabad to enable close monitoring of the project, and (2) they had to have either an agricultural university, agricultural research stations or some ongoing agricultural research development programs.

From these three districts, five talukas (counties) were selected representing modal value of the characteristics of all the talukas in the region so as to represent the whole tract of the region. Within these talukas, one or two villages were selected with a total of six villages in each talukas. Each village was stratified into two types of households based upon operational holding: (a) cultivating households operating (not owning) more than 0.2 acres of land and (b) labor households whose major source of income is from supply of labor but operated less than .2 acres of land. The cultivator group was further stratified into three sizes, namely small farmers, medium farmers and large farmers.

Ten households were randomly selected from the labor households and 30 from the cultivator group. Next, 10 households were selected randomly from each strata of the cultivator group. For additional details, see Binswanger and Jodha (1977).

Table 2 presents the total number of households in different categories and the sampling fractions in the villages. The two most dominant classes in these villages are cultivators and laborers. The latter constitutes around 25 percent in Dokur to 39 percent in Kindheda, while the former constitutes 72 percent in Dokur to 58 percent in Kindheda. This categorization of the household reflects the status of main occupation. But, individuals in the household may have more than one occupation besides being a laborer or a cultivator.

Table 2. Total number of households in various categories in the six selected villages

Village:	Aurepalle	Dokur	Shirapur	Kalman	Kanzara	Kinkheda
Number of Households:						
Laborers	146 (30.7)[a]	76 (24.3)	97 (32.7)	156 (36.9)	54 (32.0)	55 (38.5)
Cultivators	322 (67.7)	226 (72.2)	183 (61.6)	211 (49.9)	109 (64.5)	85 (58.0)
Others[b]	8 (1.7)	11 (3.5)	17 (5.7)	56 (13.2)	6 (3.6)	5 (3.5)
Total	476 (100.0)	313 (100.0)	297 (100.0)	423 (100.0)	169 (100.0)	143 (100.0)
Sampling Fractions (%):						
Laborers	6.85	13.16	10.31	6.41	18.52	18.18
Cultivators	9.32	13.27	16.39	14.22	27.52	36.14
Others[b]	0	0	0	0	0	0
Total	8.40	12.78	13.47	9.46	23.67	27.97

[a]Figures in parentheses are the percentage of households in each category.

[b]Includes artisans, shopkeepers, traders, etc.

Source: Binswanger and Jodha (1977).

For each household the following schedules were available on tape:

1. VLS-C Household member characteristics
2. VLS-D Plot and crop rotation
3. VLS-E Animal inventory
4. LVS-F Farm implement inventory
5. VLS-H Cultivation
6. VLS-K Labor, draft animal and machinery utilization
7. VLS-L Household transactions.

The recording of data was done as follows. Schedules C and D were recorded regularly for changes in the household composition, other characteristics of the household members and characteristics of plot cultivation, respectively. Schedules E and F were taken on July 1, once a year. Schedules H, K and L were recorded at intervals of two or four weeks. A more detailed description on the schedules is presented in the next section.

4.1.1 Definitions of variables by schedules

This section describes the procedure adopted in defining the explanatory and the dependent variables used in the study. The attributes for each individual in the household were defined for each agricultural year, and those relating to the land plots were aggregated at the household level.

VLS-C: Household member schedule

This schedule records socio-economic characteristics of the household and the changes that occurred during the agricultural year. It contains age, sex, marital status, etc. Before constructing any variables from this schedule, it was adjusted to retain every member of the household only once during the agricultural year. If there was a change of status for the member, say the member left the household died or re-entered during the agricultural year, the member was retained for that year if the change in status occurred during the first agricultural season. For example, if a member died or left the household after the 300th day, he or she was retained for the current agricultural year, but deleted for the next year. If a member re-entered the house after the rabi (spring) season, he was not included for the current agricultural year.

Generally, members entered the household beginning of khariff (fall) season and left after this season. These were retained as an observation in the year under consideration. This pattern reflects seasonal migration of members in search of work outside the village during the post-khariff or slack season.

After these translations and deletions, the following variables were defined for each agricultural year.

AGE: age of the member in completed years.

AGESQ: square of age.

The following dummies define the educational status of a member. The status code refers to years of schooling completed.

DILLIT = 1 if status code = 0

0 otherwise

DPRIM = 1 if status code is 1 to 4

0 otherwise

DJHIGH = 1 if status code is 5 to 9

0 otherwise

DSHIGH = 1 if status code is greater than 9

0 otherwise

A set of job experience indicators were defined based upon the individual's main and sub occupation. An individual's main or sub occupation had been recorded by noting which of the occupations he would retain if he had the desired choice in succession.

DFEXP = 1 if main or sub occupation is farming

0 otherwise

DPSEXP = 1 if main or sub occupation is attached laborer or shepherd

0 otherwise

DLEXP = 1 if main or sub occupation is laborer

0 otherwise

DSCEXP = 1 if have professional job such as teaching

0 otherwise

DTEXP = 1 if main or sub occupation is trading, shop-keeping, moneylending

0 otherwise

DCTEXP = 1 if main or sub occupation is rural crafts or traditional caste occupations

0 otherwise

Note that these dummies were defined independently and are not mutually exclusive. For example, an individual may hold farming as a main occupation and trading as a sub occupation. Hence, both DFEXP = 1 and DTEXP = 1.

The following dummies indicate the caste status of an individual. These were defined separately for each village as per the classification used by Ryan (1981). The four dummies represent successively lower caste status in the hierarchy.

DCASTE1 = 1 if individual belongs to the highest caste group, mostly priests, cultivators, weavers, blacksmiths or poets

DCASTE2 = 1 if individual belongs to the second highest caste group, mostly traders, agricultural laborers, dancers, etc.

DCASTE3 = 1 if individual belongs to third highest caste group, mostly butchers, goldsmiths, carpenters, shepherds, etc.

DCASTE4 = 1 if individual belongs to the lowest caste group, mostly schedule castes.

The potential number of farm workers and labor suppliers in the household were measured as the total number of able-bodied males and females in the household during the agricultural year. Members residing outside the village or farm servants were not included. These variables are:

FABMH = potential number of male farm workers, excluding the male head of household

FABMH1 = FABMH + 1, i.e., including the male head

FABMS = potential number of male suppliers of labor, excluding the male head of household

FABMS1 = FABMS + 1, i.e., including the male head

FABFH = potential number of female farm workers

FABFS = potential number of female suppliers of labor.

VLS-D: Plot and crop rotation schedule

This schedule contained general characteristics of the plot. A plot had been defined as a contiguous parcel of land not separated by physical characteristics such as road, irrigation, etc. It also contained information on type of crops grown, ownership status, area owned by the household, etc.

The operational status of the plot was used to compute the total area owned, the total area leased in and the total area leased out.

Before constructing any variables from this schedule, the following adjustments were undertaken on the data from the tape. These were done so as to retain one status for the plot for each agricultural year.

If a plot had a change in operational status (sold or bought), it was treated as being retained during the year if the change occurred during the crop year. Like VLS-C, each plot, subplot or sub-subplot was retained only once during the agricultural year. If a plot was leased out in the second season and taken back in the third season, it was treated as self-operated for the entire year. Alternatively, if a plot was leased in the first season or second or third season and returned during the same year, it was treated as leased in for the entire year. This seems reasonable since very few farms undertake double cropping in these villages.

If a plot was leased in during the second or third season but no crops were grown except in the next year, this lease in decision was allocated to the next year. Similarly, leased out decisions in the third season were allocated to the next agricultural year. Finally, all leased out plots or leased in plots that continued under the same status for that household were treated as separate decisions under the same status for the next agricultural year. Most of the lease decisions were for one or more agricultural year, and there were very few seasonal decisions in the data.

Next, the plot or sub-plot or sub-sub-plot characteristics were aggregated for each household and for each agricultural year using the proportion of area of the plot as appropriate weights. The following is a list of variables constructed from this schedule.

AREA01 = total area owned, i.e., sum of area owned and operated, leased out, added by purchase or by gift, taken back from leaseholder net of that subtracted by family division or by sale

AREAD1 = total area leased in

DAREAD1= 1 if AREAD1 > 0

AREAS1 = total area leased out

DAREAS1= 1 if AREAS1 > 0

In computing these totals (i) area taken back from tenants or given back by tenants was not treated as a separate decision and (ii) continuous lease was treated as a new lease. These decisions probably reflect changing resource position or recontracting in the market and may ought to be treated as separate decisions. But, when this was done, the new totals did not differ much from those defined above. Hence, the simplest of the totals were retained.

The following variables were also defined for the household:

WDISTO1 = weighted average distance from owned area to the house.

$$\frac{\sum_{\text{plots}} \text{Cultivable area of the owned plots} * \text{distance to each plot}}{\sum_{\text{plots}} \text{cultivable area for the owned plots}}$$

IRIG01 = total irrigable area owned by the household

AVAL01 = average value of owned land per acre in Rs 100.

VLSK: Time allocation schedule

This schedule contains information on (i) total number of days participated in the daily labor market during the interview period for each member of the household, and (ii) total hours allocated to various activities on the day prior to the interview date along with the off-farm wages received on that day (Rupees/day). In the present analysis, only the latter information was used to define the labor market participation decision and to compute the off-farm wages.

The labor market participation dummy (DLS) was defined as follows: First, using the time allocation data on day prior to the interview, the total number of hours spent in hired activities were computed. This was then weighted by proportion of days in the interview period to the total number of days in the agricultural year

which was obtained by summing the total number of days over all available interview periods. This is average hours per day per year spent in one's activities off farm. The household head was defined as a participant; i.e., DLS = 1 if the average hours per day per year hired out was greater than 0.1. This assumes constant allocation time for the activities during the interview period.

The same procedure as above was adopted to compute weighted average off-farm wages received by household members. These wages were then averaged for the entire village by sex and by agricultural year. The male and female wages were next deflated by PFOOD, an index of foodgrain prices. (See the section on VLSL for its definition.)

The variables defined using this schedule are:

DLS = 1 if average hours hired out per day in the daily labor market during the agricultural year were greater than 0.1

VMACPP = deflated male off-farm wage by village by year in Rupees/day

FEMCPP = deflated average of male and female off-farm wage by village by year in Rupees/day.

VWBOTHP= deflated average of male and female wage by village and year in Rupees/day.

VLSE: Inventory of farm animals

This schedule contains an inventory of animals maintained by the household. Animals on the farm are maintained as a source of farm

power or as part of subsidiary occupations such as dairy. To distinguish between these two objectives, the following variables were defined:

NOX = total number of oxen on the farm

NDAIRY = total dairy animals; i.e., cows and she-buffaloes

NDAIRYOX= NOX + NDAIRY

VLSF: Inventory of farm equipment

This schedule contains value, type and number of farm equipment owned by the household. The market value of different types of equipment was aggregated into mutually exclusive categories; each category representing a certain operational use on the farm. These categories are as follows:

TNIREQ = value of traditional non-irrigation equipment such as country plows, country seed drill, etc. in Rupees

MNIREQ = value of modern non-irrigation equipment such as tractor and tractor operated implements in Rupees

IREQ = value of irrigation equipment including value of pipes, etc.

NFDCEQ = value of non-food crop equipment such as sugarcane crushers, oil extractors and the like in Rupees

NONFEQ = value of non-farm equipment such as that used in handicraft or used in other subsidiary occupations in Rupees

EQUIP = TNIREQ + MNIREQ + NFDCEQ.

VLSH: Cultivation Schedule

This schedule contains data on inputs used on the plots and subplots as well as the type of crops grown. Unfortunately, the amount of family and hired labor used on the farm was recorded together and only for three aggregate categories: male, female and child labor. The amount of hired labor also included exchange labor and that of farm servants.

This schedule was used to determine the household's participation as a demander in the hired labor market. The following variables were computed:

THIRE = total male and female labor hired on the farm

DFHI = 1 if THIRE > 100 hours.

A cut off point of 100 hours was used to account for the use of exchange labor from purely hired wage labor market.

VLS-L: Household Transaction Schedule

This schedule records all types of transactions undertaken by the household during the interview period. The unit of observation is the household. It records resources entering and leaving the household account. These transactions were divided into various activity classes like production, consumption, durables, etc. It also records rent received from leasing out land or payments on rented land in Rupees per acre.

Schedule VLS-L was used to construct (1) average price of foodgrains: i.e., cereals and pulses in the villages and (2) average village land rents.

PFOOD: average price of foodgrains. This was computed as follows. First, the entire cereal group was divided into coarse and fine cereals. The coarse cereals are pearl millet, sorghum, maize and finger millet, while fine cereals are wheat and rice. Since the hybrids generally have different prices than the local varieties, these cereal groups were further divided into local and hybrids. For each group, the total value of the quantity sold during the agricultural year in the village for the sample households was divided by total quantity for the group to arrive at an average price per kilogram for that group. The local and hybrid prices were then averaged (simple) to obtain average prices for cereals. This, and the price of pulses, was then averaged (simple) to obtain the price of foodgrains. A better method of computing an index is to apply appropriate weights using household consumption data across seasons and even income levels, as was done by Ryan (1981). But this was not done in this study.

Average village level land rent (LRENT) was also constructed from this schedule. There were several problems in constructing this variable from the data. Due to the method of recording transactions in VLS-L, it was rather difficult to identify rent received with the year of the lease for the household. Some households indicated

leasing out land but did not report any rent on the leased out plot. Sometimes rents are paid after the agricultural year or before the agricultural year and such recordings as and when the transaction was actually made in VLS-L did not tally with VLS-D where transactions of plot transfers were recorded.

Similar problems, plus some others, effectively prevented computation of a meaningful measure for the rent payments on leased-in land. Also, the payments of land rent as well as taxes and other government charges on cultivated land were recorded under the same code in VLS-L. For the years under study, 1975-76 and 1976-77, it was not possible to distinguish the nature of these payments for these transactions.

Accordingly, it was decided to obtain a simple average for the entire village using three years of available data from 1975-76 to 1977-78. First, an average of payments received in the village was computed by dividing the total payments by total land leased out in the village. Next, an average of payments made on hired land was obtained by dividing total payments made in the village by total leased-in area. From these two measures an aggregate measure of land rent (LRENT) was defined as simple average of the two. This measure of land rent is less than satisfactory, but is best given the data limitations.

Besides depending on land characteristics such as soil quality, irrigability, etc., land rental rates are also determined at the individual level by other interlinked transactions as well as by

DVILA = 1 if the village was Aurepalle

DVILB = 1 if the village was Dokur

DVILC = 1 if the village was Khinkheda

DVILD = 1 if the village was Kanzara

DVILE = 1 if the village was Shirapur

DVILF = 1 if the village was Kalman

DYEAR5 = 1 if the agricultural year was 1975-1976

DYEAR6 = 1 if the agricultural year was 1976-1977

In the empirical model either the village dummies or the factor rental rates were used, but not both.

4.2 Empirical Model

This section presents the specification of the determinants of the main effects for the four decisions under investigation. Here I discuss the expected effect of the explanatory variables on the marginal propensity to participate in the factor markets. The discussion in the theoretical model suggests that each of these decisions are functions of individual, household and market constraints. Since the mamximization principle does not provide unambigucus predictions, these expected signs embody certain assumptions about the nature of substitution and complementarity between the factors.

4.2.1 The decision to hire-out labor:

The hypothesized determinants of the labor market participation for the household head as well as the expected signs are presented in Table 3.

Characteristics of the household head:

AGE: Age is hypothesized to have a quadratic effect on the labor market participation decision. This variable may reflect a host of characteristics of the individual that are correlated with it and vary over the lifecycle. First of all, it may reflect health status of the individual; i.e., younger individuals are more likely to supply labor to the market than older workers. Second, aging leads to specilization or accumulation of specific human capital which may lead to lower participation in the daily labor market. In the case of small farmers, those formerly participating in the labor market may now choose to devote more time to managerial aspects of the farm. The presence of such lifecycle effects is expected to result in a positive coefficient on AGE and a negative on AGESQ.

EXPERIENCE: The next six variables are specified as proxy for different types of experience. Although a continuous measure of experience is certainly preferrable to discrete ones, the available data on hand did not permit a continuous measure. Hence, the dummies should therefore be interpreted cautiously. The dummies are expected to capture experience effects as they reflect preference of one occupation over another. If the preferred occupation is the actual occupation, then they may be a potential source of simultaneity bias.

The farm experience variable (DFEXP), the permanent servant dummy (DPSEXP), and the domestic servant dummy (DDEXP) are all hypothesized to negatively influence the probability of supplying labor to the daily market. The inverse relation between farm experience and labor supply is expected assuming complementarity of the two inputs in farm production.

Experience as a permanent or domestic servant, on the other hand, may reflect direct and indirect effects also influencing inversely the propensity to supply labor. The direct effect is due to participation in alternate activities; i.e., individuals possessing skills as domestic or farm servants are more likely to supply labor under contractual arrangements rather than in the daily labor market. Indirectly, being a permanent or domestic servant leads to accumulation of farm experience and by increasing the propensity to farm will reduce the probability of participation in the daily labor market.

Similar effects are also hypothesized with respect to the other experience dummies DTEXP and DCTEXP. Although these experience dummies are hypothesized to reduce the propensity to supply labor, it is possible that the coefficients may be positive. The expected impact depends whether these trade or caste related occupations are specialized skills or are a means of risk diversification associated with the daily labor market. In the former case, the coefficients may be negative, while in the latter they may be positive. Daily labor market experience (DLEXP) however is expected to have a positive influence on the participation decision.

EDUCATION: The educational status of the individual is represented by a set of four dummies. The interpretation of these dummies depends on the excluded dummy. In the present study, DSHIGH is the excluded dummy. The effects are expected to be positive and increasing in magnitude, since individuals with lower educational level are more likely to participate in the daily labor market than those with higher educational level. This is expected for two reasons. First, education as a complementary factor of farm production may raise marginal product of farm time more than in the daily labor market, thus reducing the propensity to supply labor to this activity. Second, education may raise the productivity of market time in the non-daily labor market more than in any other activity. For example, higher educated individuals are generally observed in government jobs as teachers, clerks, peons, etc. While the former induces farming, the latter effect leads to migration out of farming. In either situation, education is expected to reduce the propensity to supply labor to the daily market.

CASTE: The caste status of the individual is introduced to determine if there is any social stigma attached by higher caste members to participation in the daily market. Each successive dummy from DCASTE1 to DCASTE2 reflects lower level of caste status. If there is any consistent pattern reflecting dislikes of higher caste members to participation in the daily labor market, one should observe an inverse relation between caste status and the decision to supply

labor. In other words, using DCASTE1 as the excluded dummy, the coefficients on the other dummies should be positive and increasing in magnitude from higher caste status to lower caste status.

Note, however, that even though the higher caste members may have an aversion to working in the daily labor market, it may be difficult to sort this effect from a purely wealth effect. For example, higher caste households are relatively better endowed than lower caste households. Given this difficult situation these coefficients may have to be interpreted cautiously.

Potential farm workers

The next two variables represent potential own farm workers. The negative signs are postulated assuming farm time of the male head of the household and that of other members in the house (male or female) are complementary in farm production. The signs on the coefficients of these variables also provide an indirect test whether family labor and hired labor are substitutes or complements on the farm; i.e., a test of the 'supervision constraint.' For example, if hiring-in labor involves supervision costs and farmers face supervision constraints; i.e., not enough family members to supervise hired labor, then an increase in the number of able-bodied members in the household will lead to relaxation of this constraint and, assuming complementarity between family and hired labor, will increase the propensity to farm or decrease the propensity to supply

labor to the market by the household head. A positive relation would indicate that family labor and hired labor are production substitutes.

Farm Characteristics:

FARM ANIMALS: The number of dairy and oxen owned (NDAIRYOX) is assumed to have a negative effect on the decision to supply labor. Maintenance of farm animals either for milk or for draught purposes increases demand for farm time and hence reduces that available for labor supply. It is further expected that an increase in the total number of animals on the farm will decrease the propensity to supply labor at an increasing rate. Hence, both a linear and a quadratic term are introduced in the model.

FARM EQUIPMENT: Non-farm equipment (NONFEQ) is assumed to have an ambiguous effect on the propensity to supply labor in the daily labor market. Households may own nonfarm equipment for two reasons. In the case of those practicing craft and other subsidiary occupations such as goldsmiths, weaving, blacksmiths, etc., it may reflect specialization. Alternatively, it may be an optimal adjustment to agricultural seasonality in these villages.

If ownership of nonfarm equipment reflects specialization into a particular form of trade, then it is most likely that this coefficient will be negative. On the other hand, if it is an adjustment to seasonality so as to raise the marginal productivity of nonfarm time

in slack periods or as a means of achieving alternate sources of income, then it may be positively related to the decision to supply labor. In this case, it may mostly reflect the poverty status of the household.

The next two variables, IREQ and EQUIP, are values of irrigation and non-irrigation equipment owned, respectively. Both are expected to decrease the propensity to supply labor to the labor market assuming the negative income effect reinforces the complementarity of farm time with farm equipment.

These two variables are specified separately, even though both are expected to influence the marginal product of farm time in the same direction because subsidies on investments in irrigation equipment is a common form of intervention in Indian agriculture. This is undertaken generally through reduced interest rates on loans or payments on part of the cost of equipment especially for small farmers. One of the main arguments is that irrigation equipment leads to higher cropping intensities and thereby increases the demand for labor on the farm. For small farmers, this means fuller utilization of family resources such as family labor or animal power. On large farms such subsidies are expected to lead to increased demand for hired labor. Hence, the two types of farm equipment are introduced separately to discriminate the differential nature of these impacts.

LAND ENDOWMENTS: The total amount of area and irrigable area owned by the household are specified as separate determinants of the decision to supply labor to the market. The amount of irrigable area owned by the household (IRIG01) is introduced in the model even though the value of irrigation equipment owned may be correlated with it. The reported measure of irrigable area is likely to reflect farmers' expectations on the availability of water supply year round and hence reflect different types of investments such as in medium or large irrigation projects. The assumed availability of water supply is likely to be an important determinant of labor and land intensive technology and influence the demand for farm time. It is hypothesized that this coefficient is negative assuming the negative income effect reinforces the complementarity effect of irrigation with farm time.

Area owned (AREA01) is used to capture purely a wealth effect on the participation decision. It is expected that large landowners are less likely to supply labor to the daily labor market than small owners of land.

This variable may also measure farm fixity effect as a result of high adjustments costs in the land lease market. For example, large owners of land may choose to farm because of high transaction costs in the land lease market. But it is more likely that the fixity effect will be captured by EQUIP and IRIG01 rather than by AREA01 because the market for farm equipment is virtually absent and farm

time is likely to be highly complementary with irrigable area than AREA01. Hence, AREA01 is expected to reflect purely a wealth effect.

VALUE OF LAND: Average value of land owned per acre (AVAL01) is hypothesized to be inversely related to the decision to supply labor. Even though this variable may show some correlation between irrigable area owned by the household, it is expected to measure the variable demand for own farm time across farms due to such factors as soil types, slope and other physiographic characteristics of the land. Farmers with higher value of land and with higher croppping intensity are more likely to farm than are others. Hence, this effect is expected to be negative.

RENTAL RATES: The market rental rates introduced in the model are average land rent (LRENT) per acre and off-farm male (VMWALLP) and off-farm female (VFWALLP) wages.

The sign on the coefficients of LRENT is difficult to predict. Since these are cross effects, the maximization principle does not provide any prediction on its sign. Also, given an owner of land has an option to be either a supplier or a demander of land, the response to a change in the rental rate for land on the decision to supply labor will therefore depend on the substitution between own farm land and hired land, and the complementarity between own labor and land as well. Assuming that the decision to lease in land and to supply land are separate decisions, an increase in LRENT is likely to induce

individuals to lease-out land and hence increase the propensity to supply labor assuming own labor and own land are production complements. Similarly, assuming that own labor and hired land are also substitutes, an increase in LRENT is also likely to increase the propensity to supply labor to the daily labor market. Hence, I expect a positive sign for this variable.

The male and female off-farm wage rates reflect own and cross effects on the participation decision of the household head. An increase in VMWALLP raises the opportunity cost of own farm labor and hence is expected to increase the propensity to supply labor to the market.

The impact of a change in the female wage rate (VFWALLP) is likely to be ambiguous and depends whether male labor of the head is complementary or substitute to female labor on the farm. It is quite likely that an increase in female wage rate will induce participation of the females, leaving fewer members to work on the farm which may then induce households to lease out land and increase the probability of supplying labor by the household head. Assuming explicitly that the farm time of the household head and family female labor are production complements in farm production, VFWALLP is expected to influence positively the labor force participation decision.

Note that these wages as off-farm wages may also capture an indirect effect on the labor market participation of the household head through the demand for hired labor. In this case, the coefficients on VMWALLP and VFWALLP will be exactly opposite to those

postulated above. For example, an increase in VMACPP will reduce the use of hired labor on the farm and hence increase the supply of own labor to the farm, thus decreasing the propensity to supply labor to the market. Similarly, an increase in VFWALLP will reduce the demand for hired female labor on the farm and is likely to increase the supply of family female labor to the farm. If family female labor and time of the head is complementary on the farm, this will decrease the propensity to supply labor to the market. The signs on the coefficient may therefore differ from those in the table.

4.2.2 The decision to hire-in labor

The empirical determinants affecting the propensity to hire labor on the farm are specified in Table 5. These factors are mostly the same as those specified for the decision to supply labor.

Characteristics of the household heads

AGE: The age variable is expected to have a U-shaped effect on the propensity to hire-in labor. This is assuming that younger male heads are less likely to hire in labor as compared to older workers. Younger heads of households are more likely to work longer hours on the farm than older heads of households, either due to better health status or due to a tendency towards specialization in farming. Over the lifecycle, the accumulation of assets is correlated with age and if these assets are complementary with hired labor, then this

Table 4. Empirical determinants and hypothesized impact on decision to hire labor on the farm (DFHI)

Explanatory variables:			
Characteristics of the household head:			Expected sign
AGE	:	in years	-
AGESQ	:	square of age	+
DFEXP	:	farm experience	+
DLEXP	:	daily labor market	+
DILLIT	:	illiterates	-
DPRIM	:	primary	-
PJHIGH	:	junior high	
DSHIGH	:	senior high	excluded
DCASTE1	:	highest caste	excluded
DCASTE2	:	second highest caste	-
DCASTE3	:	third highest caste	-
DCASTE4	:	lowest caste	-
Potential farm workers in the household:			
FABFH	:	females	+
FABMH	:	males	+
Farm characteristics:			
IREQ	:	value of irrigation equipment in Rupees	
EQUIP	:	value of non-irrigation equipment in Rupees	+
AREA01	:	area owned in acres	+
IRIG01	:	irrigable area owned in acres	+
AVAL01	:	average value of land per acre in 100's of Rupees	+
Rental rates:			
LRENT	:	average land rent per acre by village, in Rupees	-
VWBOTHP	:	average off-farm wage in Rupees per day by year by village	-
Year effect:			
DYEAR6	:	1 if agricultural year was 1976/77	+/-

complementary effect is more likely to outweigh the negative effect due to deterioration of health, thus increasing the propensity to hire in the labor on the farm.

EXPERIENCE: DFEXP is expected to increase the propensity to hire in labor assuming farming experience is complementary with hired labor. The coefficient on DLEXP is also expected to be positive; i.e., labor market experience induces participation in the labor supply market and hence increases the propensity to hire in labor on the farm.

EDUCATION: The education dummies are hypothesized to increase the propensity to hire in labor. The increased propensity to hire in labor at higher educational levels is expected to be due to complementarity of education with other inputs or due to substitution between own labor and hired labor in different tasks. Since the excluded dummy is DSHIGH, all the other coeffients are expected to be negative and increasing in magnitude. Thus,. illiterates are expected least likely to hire in labor on the farm.

CASTE: The caste status of the household is also hypothesized to influence the decision to hire in labor on the farm. It is expected that lower caste members are least likely to hire in labor. In other words, higher caste members may have an aversion to working on the farm and are more likely to hire in labor than lower caste members. They may also hesitate to be hired by one of a lower caste.

As discussed earlier, these dummies may reflect many other characteristics of the household. If caste status and ownership of farm assets or wealth status are correlated, then those effects may be difficult to sort out. Hence, the 'aversion' to working on the farm by females of the higher caste households, mentioned in the literature, may just reflect higher caste households' preference to raise higher quality children rather than an aversion to working on the farm. This topic is worth pursuing in future research.

Potential Own Farm Workers

Potential male and female own farm workers are specified in the model to test the presence of supervision constraints in the hired labor market. The expected impact of these variables on the propensity to hire in labor may be ambiguous depending upon the relative importance of the different effects. If own labor and hired labor are substitutes on the farm, then one can expect a negative impact. However, as discussed under the determinants of the decision to supply labor, if hiring in labor involves supervision, and farmers do face such constraints; i.e., not enough family members to supervise hired labor, then family labor and hired labor would be complementary inputs on the farm and hence an increase in the number of potential farm workers in the household will lead to a relaxation of this constraint and increase the propensity to hire in labor. The expected positive signs assume the latter.

Farm Characteristics

FARM EQUIPMENT: IREQ and EQUIP are hypothesized to influence positively this decision to hire in labor on the farm. Farm equipment may influence this in two ways. Farm equipment such as IREQ is likely to be complementary with hired labor and hence increase its marginal product thereby leading to increased propensity to hire in labor.

EQUIP, on the other hand, may be a substitute for hired labor. For example, a farmer may substitute hand weeding through interculturing or harvesting equipment may be used to substitute for hired labor and hence decrease this propensity. However, most of the EQUIP owned by the sample households is traditional land preparation equipment which is less likely to be used as a substitute for hired labor. Hence, this coefficient is also expected to be positive.

LAND ENDOWMENTS: Controlling for quality of land or irrigation potential of the farm, large landowners are observed to hire in more labor on the farm than small landowners. Own land and hired labor therefore are likely to be complements in farm production. Hence, an increase in area owned is expected to increase the propensity to hire-in labor.

Irrigable area is specified to identify the farm intensity effect on the propensity to hire in labor. Owners of large irrigation tracts are more likely to farm intensively during the same season or have a higher cropping intensity as compared to farmers with less irrigable area. Also, the nature of crops grown on

irrigable area are also likely to be more labor intensive such as paddy and sugar- cane. Assuming that irrigation and hired labor are complements, the coefficient on IRIG01 is expected to be positive.

VALUE OF LAND: Although the value of land owned also depends on the amount of irrigable area owned by the households, it is introduced in the model to discriminate differential impacts that may arise purely from quantity of irrigable area owned from those that may be due to soil quality, seasonal availability of water and other intrinsic properties of the owned land. The variation in land improvement factors may be as a result of past investments on the plots such as preventive measures to restrict soil erosion, wells or watersheds, etc. These land improvement factors are assumed to be complementary with hired labor and hence increase the propensity to hire in labor on the farm.

Rental Rates

Since the decision to hire-in labor on the farm refers to either male or female labor there are only two relevant rental rates, namely LRENT and VWBOTHP. The first relates to the land market while the next one is the average off-farm wage rate for males and females.

The sign on LRENT may be positive or negative, depending on the substitution of complementarity of hired labor with land. If the farm is labor intensive, then hired labor and land may be substitutes and this sign may be positive, holding output constant. If output is

allowed to vary, then hired labor and land are likely to be complements and this sign may be negative. In this study, the sign is hypothesized to be negative.[4]

A change in VWBOTHP may have two similar effects on the propensity to hire in labor, both acting in the same direction: (1) VWBOTHP measures village level off-farm wages and as an own effect on hired labor it ought to be negative; (2) as an off-farm wage for family labor, the sign may be negative if family labor and hired labor are production complements.

4.2.3 The decision to supply land

The empirical specification for the decision to supply land is undertaken to test the following: (1) whether prior farming experience or either as a permanent farm servant or as a domestic servant reduces the probability of leasing out land, (2) whether education and own land are complementary in farm production, (3) whether there exists any spillover effects from the labor market on the decision to supply land, and (4) whether ownership of

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[4]A word of caution is in order here. This sign may turn out to be positive if, for example, family labor and hired labor are substitutes or if family female and hired females are substitutes and females constitute a large fraction of the total labor utilization on the farm.

nontradeables such as oxen and farm equipment reduces the probability of leasing out land. The variables hypothesized as influencing the propensity to supply land are presented in Table 4.

Characteristics of the Household Head:

AGE: AGE and AGESQ are hypothesized to have a U-shaped effect on the probability of leasing out land. Aging, as discussed before, may reflect two different lifecycle effects which move in opposite directions. These are due to the accumulation of farm experience and due to the health status. In general, it is difficult to predict the sign for the coefficients. The hypothesized U-shaped effect is based on the assumption that the positive impact on the marginal productivity of own farm land due to the accumulation of farm experience is likely to be outweighed by the negative impact arising from deterioration in health. This may occur until around the age of 55 to 60 when the health factor is most likely to outweigh the experience effect.

EXPERIENCE: Among the experience indicators, I investigate the effect of farm experience (DFEXP) as a permanent servant (DPSEXP) and as a domestic servant (DDEXP) on the decision to lease out land. It is expected that all these experience effects reduce the propensity to lease out land.

Table 5. Empirical determinants and hypothesized impact on decision to lease out land (DAREAS1)

Explanatory variables:			
Characteristics of the household head:			Expected sign
AGE	:	in years	-
AGESQ	:	square of age	+
DFEXP	:	farm experience	-
DPSEXP	:	permanent servant experience	-
DDEXP	:	domestic servant experience	-
DILLIT	:	illiterates	+
DPRIM	:	primary education	+
DJHIGH	:	junior high	+
DSHIGH	:	senior high	excluded
Potential suppliers of labor in the household:			
FABFS	:	females	+
FABMS1	:	males	+
Potential farm workers in the household:			
FABFM	:	females	-
FABMH1	:	males	-
Farm characteristics:			
NDAIRY	:	dairy animals	-
NDAIRYSQ	:	square of dairy animals	+
NOX	:	oxen	-
IREQ	:	value of irrigation equipment in Rupees	-
EQUIP	:	value of non-irrigation equipment in Rupees	-
AREA01	:	area owned in acres	+
IRIG01	:	irrigable area owned in acres	+
WDIST01	:	average distance to own plots in miles	+
AVAL01	:	average value of land per acre in 100's of Rupees	+
Rental rates:			
LRENT	:	average land rent per acre by village, in Rupees	+
VMWALLP	:	average off-farm male wage in Rupees per day by year by village	+
VFWALLP	:	average off-farm female wage in Rupees per day by year by village	+
Year effect:			
DYEAR6	:	1 if agricultural year was 1976/77	+/-

Farm experience is hypothesized to be a complementary input with own farm land. Owners who have such experience are more likely to farm or less likely to supply land to the market. The inverse relation hypothesized between land supply decision and the other two dummies is based on the observation that most male farm or domestic servants are generally involved in simple farm management tasks such as recruiting farm labor or other simple supervisory roles on the farm. In this form it is an investment in accumulation of farm experience through on-the-job training. Assuming complementarity, this is expected to increase the shadow price of own farm land, leading to a lower propensity to supply land to the market.

EDUCATION: Education is hypothesized to lower the propensity to supply land to the market. In other words, it is expected that less educated individuals are more likely to supply land to the market than more educated individuals. This implicitly assumes that education as a complementary input in farm production raises the marginal productivity of own land for educated households than for less educated households, inducing the latter to farm rather than lease it out.

Education may also influence the farm production through other processes. For example, more educated individuals may be able to organize and manage the farm more efficiently than others. They may have better access to or knowledge of modern techniques or be in a better position to process farm information as well as undertake

marketing of the produce more efficiently than less educated individuals. Empirically, it is however difficult to sort out all these effects.

The actual impact of education, in general, is difficult to predict because it is quite possible that there may be sectoral migration effects which makes more educated individuals to supply labor to non-farm or other high skill jobs and, hence, supply land to the market. As discussed before, this will occur if education raises the marginal product of market time in non-farm activities more than in farming. In this case, the sectoral migration effect may distort the underlying complementarity impact of education on the decision to supply land. Hence, it is quite likely that the coefficients on the dummies may not show a consistent pattern as hypothesized in the table. For example, excluding DSHIGH, the coefficients on DJHIGH, DPRIM and DILLIT ought to consistently increase the magnitude and be positive if less educated individuals are more likely to lease out land. If there are sectoral migration effects, a different pattern of relative magnitudes of coefficients may emerge.

Quantity constraints in the labor market

Potential suppliers of labor are specified in the model to test for the presence of quantity constraints in the labor supply market

while potential own farm workers are used to test whether own labor and family labor are substitutes or complements in farm production. The arguments related to these hypotheses have been discussed in the chapter dealing with the comparative static results.[5]

FABFS and FABMS1 are the total number of potential female and male suppliers of labor including the head in the household, respectively. These are introduced to test for the presence of any "spillover" effects from the labor supply market on the decision to supply land. The signs on these coefficients are expected to be positive, i.e., an increase in the potential suppliers of labor is expected to induce the household to lease out land. Although this runs contrary to intuition, the argument for hypothesizing the expected positive effect is the following: Suppose own labor and own land are complementary inputs in production. A relaxation of the constraint on labor supply in the market can be assumed to be the same as a decrease in the amount of labor supplied to the farm and, hence, a decrease in the demand for own farm land assuming own land and own labor are production complements, or an increase in the propensity to supply land to the market. Thus, the presence of any quantity constraints on labor supply is expected to reflect as

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[5]The actual amount of own or hired labor cannot be used here as it is endogeneous. Instead, potential suppliers of labor or own farm workers are likely to be good proxies for the amount of labor supplied to the market or used on the farm respectively. This is exploited here to postulate the signs.

spillover effects on land supply decisions. This assumes that the adjustments are mostly made through the land market. The statistical significance of these coefficients therefore forms an indirect test of the presence of 'imperfections' or quantity constraints on male or female labor supply in the market.

FABFH and FABMH1 are used to test a different sort of hypothesis which was also mentioned earlier. This is generally referred to in the tenancy literature as the 'supervision constraint.' As discussed in the comparative static results, the existence of the so-called supervisory constraint is more likely to reflect the fact that own labor and hired labor are not perfect substitutes on the farm rather than to reflect some 'imperfection' of the market. Alternatively, the decision to supply land by households with fewer potential farm workers may be an adjustment to an inelastic own labor supply to the farm. This suggests that, in the presence of the 'supervision constraint' or an inelastic own labor supply to the farm, own labor and hired labor are likely to be production complements rather than substitutes. With this assumption and assuming that own labor and own land are also production complements, an increase in the number of potential farm workers or a relaxation of the constraint is hypothesized to increase the demand for own farm land and decrease the propensity to supply land to the market. The expected signs are therefore negative.

Farm Characteristics:

DAIRY: The total number of dairy animals, NDAIRY, and its square NDAIRYSQ are used to measure the impact of the absent fodder market on the decision to lease out land. It is expected that the presence of dairy animals on the farm raises the shadow price of own farm land and reduces the propensity to supply land to the market. Being a highly time intensive operation, dairy farming may also have an indirect effect on this decision arising from the demand for farm time, i.e., specialization in dairy is likely to substitute own time away from crop production activities. Thus, farmers who rear milk cattle and also own large amounts of land are more likely to lease out land. This positive impact due to specialization beyond a certain acreage may outweigh the negative impact due to the absent fodder market. Hence,both a linear and a quadratic term ar included. An increase in the total number of dairy animals is hypothesized to have a U-shaped impact on the propensity to lease out land.

DRAUGHT ANIMALS: The total number of oxen, NOX, is specified to identify the presence of potential constraints in the bullock rental market. It is frequently cited in the tenancy literature that the bullock rental market is 'imperfect' or absent. (See, for example, Bliss and Stern, 1982; Bell, 1977; Bardhan, 1980; and Jodha, 1979). Hence, individuals owning bullocks are expected to lease-in land more than others. Although, as cited in the literature, this is in reference to the decision to lease in land. It is also tested with respect to the decision to supply land.

Assuming that own land and bullock power are complementary inputs in farm production, the sign of this coefficient is expected to be negative; i.e., an increase in number of bullocks owned is expected to increase the shadow price of own farm land and hence, reduce the propensity to supply land to the market. It is possible that the suppliers of land are adjusting to a different set of constraints than the demanders of land. For example, if most suppliers of land have adequate amount of farm power, then this may not be a potentially binding constraint and, therefore, will not affect the propensity to supply land. Further, the 'imperfection' of the hired bullock market is more likely to be on the supply side of the market rather than on the demand side. Bell (1977) observes that in Bihar, "the total supply of bullock team-days hired out is very small." This nature of the market will imply that ownership of oxen may be an important determinant of the decision to lease in land but not to supply land.

FARM EQUIPMENT: IREQ and EQUIP are hypothesized to be inversely related to the decision to supply land. It is expected that an increase in irrigation or non-irrigation equipment owned by the household will raise the shadow price of farming and hence reduce the propensity to supply land to the market. As in the discusison on the decision to supply labor, the coefficients on IREQ and EQUIP are hypothesized to be different because the amount of irrigation equipment owned is likely to lead to intensive nature of farming,

thereby increasing the demand for own farm land while nonirrigation equipment results in extensive nature of farming, i.e., enables cultivation of a larger tract of land. Given the increased concern by policy makers on the likely impacts of subsidies on farm equipment and its influence on operational size of the holdings, it is empirically important to sort these differential impacts.

LAND ENDOWMENT: The coefficients on amount of area owned and the amount of irrigable area owned are hypothesized to be positive; i.e., an increase in AREA01 or in IRIG01 is expected to increase the propensity to supply land to the market. Generally, the amount of area owned will have only an income effect on the decision to lease out land. This income effect would decrease the propensity to supply land to the market. If, however, there are other binding constraints such as the availability of farm power or hired labor, etc., which are complementary to own land, then it is possible that large owners of land may lease out land as an adjustment to these constraints.

Similarly, irrigation as a complementary input with own farm land will raise the shadow price of own land and thereby decrease the propensity to supply land to the market. But, households with large tracts of area under irrigation may find it difficult to farm land intensively -- especially if they do not possess adequate amounts of other complementary nontradeable resources. It is expected that the latter effect dominates the former; hence, increasing the propensity to lease out land.

VALUE OF LAND: AVAL01 is included in the specification to measure those effects on the land supply decision arising from intrinsic properties of the land such as soil type, topography of the plot or other physiographic characteristics of the plot. It is expected that households owning higher quality of land are more likely to lease out land.

DISTANCE TO THE FARM: The variable WDIST01 or weighted average distance from one's house to the land owned is included in the specification to test whether a household has preference to lease out plots away from home and retain the nearby plots for self cultivation. There may be a number of reasons for such a behavior. First of all, plots away from home involve greater commuting distance to perform daily agricultural operations. Although this may not seem to be a constraint where transportation is well developed, it is likely to be an important factor in these villages where household members either walk to their fields or use bullock carts. Hence, high commuting costs due to distance is likely to increase the propensity to supply land. Second, besides the commuting costs of the members, the household generally have to bear the cummuting cost incurred on hired laborers or recruiting costs especially if the plots are outside the villages. Finally, another reason why households may prefer to lease out distant plots is the cost involved in protecting the growing crop or final output from birds, animals or from theft.

Providing security means either a hired laborer or a household member will have to be constantly on guard day and night in the field.

In the long run, households may choose the optimal distance from the plots to their home by selling plots outside the village or buying plots within the village. If such an adjustment has been undertaken or the opportunity cost of commuting time is low, it is likely that this coefficient may not be as expected.

Rental Rates

The next three variables are the market rental rates. All three signs are expected to be positive assuming complementarity between own farm land and other inputs.

An increase in land rent (LRENT) is expected to unambiguously increase the propensity to supply own land as it raises the opportunity cost of own farm land. Similarly, male and female labor, family or hired labor is assumed to be complementary with own farm land, hence an increase in off-farm wages is also expected to affect this decision positively.

4.2.4 The decision to lease in land

The determinants of the decision to lease-in land or, alternatively to be a tenant, are hypothesized to be the same as those influencing the decision to lease-out land, excepting that here the caste dummies are also specified as determinants of this decision while WDIST01 is excluded. Although the hypotheses under

investigation are the same as those discussed with reference to decision to lease out land, it is quite possible, as noted earlier, that the demanders of land may be adjusting to a different set of constraints than the suppliers of land. Hence, the set of estimates and their relative importance with respect to the two decisions would be different.

Note that I did not include the caste status of the household as a determinant of the land supply decision, but it is included in the land lease decision. This is because I feel that individuals' preference to supply land is less likely to be affected by the caste status. Instead, the caste status may determine an individual's ability to lease in land.

All the hypothesized signs with respect to this decision, are assumed to be opposite to those in Table 4. Hence, only a brief discussion is provided on these determinants.

AGE is hypothesized to display a U-shaped impact on the decision to lease in land. It is expected that the experience effect dominates the health effect at an early age and the latter dominating the former at an older age. DFEXP, DPSEXP and DDEXP are all expected to be complementary with hired land and hence, increase the propensity to lease in land.

Education is also hypothesized to be complementary with hired land, hence, more educated individuals are more likely to lease in land; i.e., illiterates are least likely to lease in land.

The caste dummies are included in the empirical model to determine the presence of caste discrimination in the land lease market. The caste status may also reflect some attributes of the household such as reliability, honesty, or even wealth or occupational status, hence suppliers of land may use the caste status of the tenant as a cheap screening device. For example, higher caste status households own greater amounts of complementary farm factors than lower caste households. But, in these closely knit villages where such information is almost perfect, the caste status is more likely to reflect an element of social discrimination in the tenancy market rather than screening effects. Empirically, it may be difficult to sort out screening effects from discrimination effects. As is customary in the literature, the significance of coefficients on the dummies may have to be interpreted cautiously. Statistical significance, however, would suggest the need for additional research in this area.

The discussion on the other hypothesis related to the decision to lease in land is similar to that presented under the land supply section. Besides these determinants, I also introduce village and year specific dummies in the model. These are specified to control for any village or year specific effects in the sample.

Village and year dummies

Village dummies, DVILA to DVILF, are expected to measure any village specific effects. Since the market rental rates are also

village specific, these two sets of variables form mutually exclusive sets. Hence, both sets of variables cannot be introduced together in the model. The appropriateness of these two sets is to be determined based upon the predictive ability of the model.

Although it is possible to hypothesize the impact of changes in the rental rates on these decisions, it is relatively difficult to do so in the case of these dummies. The village dummies may measure a host of village specific effects such as agroclimatological differences, seasonal variation across villages, cropping patterns, specific socio-economic characteristics, price variations and general infrastructural levels of development. These variables were specified to detect any potentially systematic village level biases on the coefficients rather than to explain any specific effects. Similarly, DYEAR6 is introduced in the model to remove any yearly systematic biases on the coefficients of the other key determinants. This dummy may measure annual variation in the data due to weather, prices or even differential resource levels across years.

The next chapter presents a discussion on the estimated set of results and tests of hypothesis. It also contains predicted participation rates due to changes in selected explanatory variables.

CHAPTER V

RESULTS

This chapter discusses the results. In the first section I provide a brief discussion on the observed participation decisions of landowners relating to the different choices. Here I also present sample means, Chi-square tests and correlations between the dummy dependent variables and the set of explanatory variables. This discussion is only suggestive. This is then followed by the section on the estimation. Here I discuss five aspects of the research: (1) choice of the econometric model, (2) relative importance of the determinants of the four decisions, (3) likelihood ratio tests for selected hypotheses, (4) estimated responses by land holding class, and (5) selected results on predicted participation rates due to changes in explanatory variables. The chapter is concluded with a brief summary of results.

5.1 Sample Characteristics and Tests of Association

Table 6 presents the observed sorting of the sample observations in the sixteen land and labor market choices. The total sample consisted of 351 observations. Out of these, 110 observations participated jointly in the labor market but not in the land market

Table 6. Observed joint participation in the land and labor markets for the sample households

Choice (cell)	Labor Market		Land Market		Frequency
	Hire out labor	Hire in labor	Hire out land	Hire in land	
1	p	p	p	p	2
2	np	p	p	p	0
3	p	np	p	p	0
4	np	np	p	p	0
5	p	p	np	p	30
6	np	p	np	p	27
7	p	np	np	p	4
8	np	np	np	p	1
9	p	p	p	np	10
10	np	p	p	np	6
11	p	np	p	np	20
12	np	np	p	np	3
13	p	p	np	np	110
14	np	p	np	np	111
15	p	np	np	np	19
16	np	np	np	np	8

Note: p = participant; np = non participant.

(choice 16). Nearly one-third hired in labor but did not supply any labor nor participated in the land market (choice 14). The observed sample participation rates, i.e., marginal proportions, were as follows: 56 percent supplied labor, 84 percent hired in labor, only 12 percent leased out land and 18 percent leased in land. Note that the data for the households for the two years has been pooled together to compute these proportions. Almost 50 percent of the observations belonged to 1975 and the other to 1976. Thus there are about two observations per household, one for each year.

In this research, each observation is treated as an independent random drawing since adequate treatment of serial correlation in the context of multinomial logit does not exist in the literature. As in linear models, it is possible that the estimated standard errors are biased downwards and hence the actual significance levels may be biased upwards. However, a year dummy was specified in the model to isolate year specific effects.

The discussion of sample means for the participants and non-participants, chi-square tests and correlations is presented next separately for each of the participation choices. The chi-square tests were undertaken between the dependent variable and the discrete independent variables only. Tests that were statistically not significant (below 20 percent) are reported as 'n.s.'

5.1.1 Labor market participation decisions

This section contains a discussion on the labor market participation decisions. This is presented under two subheadings: (1) the decision to hire out labor and (2) the decision to hire in labor.

Decision to Hire Out Labor:

This discusses the means and measures of association with respect to the decision to hire out labor by the male head of the household and its hypothesized determinants. These are presented in Table 7. Observe that out of a total of 351 observations, nearly 40 percent are nonparticipants.

The average age for the nonparticipants was 48, while it was 41 for the participants. Excepting the other occupational experience indicator, all the other experience effects were as hypothesized. For example, farm experience was negatively related to the decision to hire out labor with a correlation of 0.09 which was also significant at 10 percent level (column 4). Experience as a permanent farm servant or as a domestic servant also reduced the propensity to supply labor as evident from the negative correlations. The Chi-square tests associated with these indicators and the decision to hire out labor were also significant around 5 percent.

Daily labor market experience significantly increased the propensity to supply labor. The Chi-square tests and the correlation coefficient were highly significant at less than 1 percent level.

Table 7. Means and Measures of Association: Decision to Supply Labor

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Characteristics of the household head				
Age	48.62 (12.59)	41.16 (10.49)		-0.31 (0.00)
Farm experience	98.08 (13.78)	94.36 (23.13)	2.57 (0.11)	-0.09 (0.08)
Permanent servant experience	9.62 (29.58)	5.13 (22.11)	3.51 (0.06)	-0.09 (0.11)
Labor market experience	10.26 (30.44)	60.00 (49.12)	87.90 (0.00)	0.51 (0.00)
Domestic servant experience	12.18 (32.81)	5.13 (22.11)	5.14 (0.02)	-0.12 (0.02)
Trading experience	6.14 (24.57)	0.00 (0.00)	11.06 (0.00)	-0.17 (0.00)
Other occupational experience	5.77 (23.39)	13.33 (34.08)	5.94 (0.01)	0.13 (0.02)
Illiterates	41.03 (49.35)	54.87 (49.89)	6.85 (0.01)	0.14 (0.00)
Primary education	19.87 (40.03)	18.46 (38.90)	n.s.	n.s.
Junior high	30.13 (46.03)	23.08 (42.24)	2.33 (0.13)	-0.08 (0.14)
Senior and above	8.69 (26.73)	0.00	n.s.	-0.09 (0.09)
Highest caste	56.41 (49.75)	30.26 (46.06)	19.23 (0.00)	-0.26 (0.00)
Second highest caste	17.31 (37.95)	26.67 (44.34)	2.67 (0.10)	0.11 (0.04)
Third highest caste	19.23 (39.54)	24.10 (42.88)	n.s.	n.s.
Lowest caste	7.05 (25.68)	18.97 (39.31)	10.38 (0.00)	0.17 (0.00)
Potential own farm workers				
Females	1.56 (1.13)	1.53 (0.83)	31.24 (0.00)	-0.19 (0.03)
Males	1.31 (1.13)	0.87 (1.01)	19.96 (0.00)	-0.21 (0.08)

Table 7. (Continued)

Explanatory variables	Means (Standard Deviation)		χ tests (p-values)	Simple correlations (p-values)
	Non participants	Participants		
Farm characteristics				
Farm animals	7.09 (7.62)	2.22 (3.94)		-0.08 (0.00)
Nonfarm equipment	72.68 (414.33)	27.57 (219.27)		-0.07 (0.19)
Value of irrigation equipment	1221.83 (1767.05)	207.44 (728.73)		-0.36 (0.00)
Value of non irrigation equipment	275.54 (299.66)	116.05 (128.74)		-0.35 (0.00)
Area owned	18.00 (17.15)	6.96 (5.81)		-0.41 (0.00)
Irrigable area	2.38 (3.64)	0.68 (1.24)		-0.31 (0.00)
Average value of own land	20.52 (10.79)	16.77 (10.80)		-0.19 (0.00)
Rental rates				
Own land	101.05 (83.40)	126.55 (89.84)		0.14 (0.01)
Hired land	260.27 (279.49)	192.70 (221.57)		-0.07 (0.20)
Off-farm male wage	1.92 (0.74)	2.11 (0.78)		0.13 (0.01)
Off-farm female wage	1.11 (0.45)	1.21 (0.49)		0.04 (0.00)
Village and year indicators				
Aurepalle	21.80 (41.42)	10.26 (30.42)		
Dokur	17.95 (38.50)	21.03 (40.85)		
Kinkheda	19.23 (39.54)	13.33 (34.08)		
Kanzara	13.46 (34.24)	19.49 (39.71)		
Shirapur	9.62 (29.58)	20.51 (40.48)		
Kalman	17.95 (38.50)	15.39 (36.17)		

Table 7. (Continued)

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Agricultural year 1975	42.95 (49.66)	54.87 (49.89)		
Agricultural year 1976	57.05 (49.66)	45.13 (49.89)		
Other dependent variables				
Hire in land	17.95 (38.50)	18.46 (38.90)	n.s.	n.s.
Hire out land	5.77 (23.39)	16.41 (37.13)	7.78 (0.01)	0.16 (0.00)
Hire in labor	92.31 (26.73)	77.95 (41.57)	13.52 (0.00)	-0.20 (0.00)
Total observations	156	195	351	351

Consider the educational dummies. The observed means indicate that the illiterates are more likely to participate in the labor market than those with some education. For example, 55 percent of the participants were illiterates while only 41 percent of the non-participants were illiterates. The Chi-square test between DLS and for DILLIT indicated a statistically significant association betwen illiteracy and labor supply of the household head.

The caste indicators suggest that the highest caste members are least likely to be participants as compared to all the other castes. For example, the proportion of household heads belonging to DCASTE1 in the nonparticipants is nearly twice that in the participants. The association between DCASTE1 and DLS or DCASTE4 and DLS was also highly significant at less than one percent level (column 3). The former was negative and the latter positive.

Comparing the relative asset position among the two categories, the nonparticipants had more irrigation as well as nonirrigation farm equipment as compared to the participants. The average value of irrigation equipment owned by nonparticipants was six times more than that owned by the participants. These correlation coefficients were negative and statistically significant at less than one percent level. These results suggest that farm equipment is likely to be complementary with farm time and, in absence of explicit rental markets, raises the shadow price of own labor, thereby reducing the propensity to supply labor.

AREA01 was also negatively related to the labor force supply decision. The nonparticipants owned three times as much area as participants, i.e., 18 acres and 7 acres, respectively. The differences in means across the two categories indicate that large owners of land are more likely to devote time to farming and, hence, are less likely to participate in the labor market.

Irrigation, as a complementary input, was hypothesized to reduce the propensity to supply labor. The amount of irrigable area owned IRIG01 was expected to capture cropping pattern characteristics, farming intensity, as well as croping intensity. Consistent with expectation, there was considerable difference in the amount of irrigable area owned by the two categories. The participants, for example, owned less irrigable area than the nonparticipants indicating an overall tendency to reduce the propensity to supply labor with an increase in irrigable area.

The next four variables are average village rental rates.[6] Excepting LRENTD, all are positively related to this decision. The nonparticipants in the sample faced lower land supply rental rates than the participants by Rs. 22.

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[6]Although a single measure of land rent was defined in the empirical model, preliminary analysis displayed a negative relation between the decision to lease out land and LRENT. It was subsequently decided to split LRENT as two different measures, namely LRENTS and LRENTD. The former as a relevant rental rate for the allocation of own farm land, the latter for hired land. This may seem odd in the context of market equilibrium where only one rental rate is expected to prevail as all land is traded in the same market. Since

The average male and female village wage off one's own farm were marginally higher for the participants than the nonparticipants. However, comparing the male and female wages, females on the average received lower wages than the males by nearly 40 percent. A trend that seems to be fairly universal.

The simple correlation between the male wage and labor force participation decision was positive and statistically significiant at one percent level indicating higher male wages induced participation in the market.

Decision to Hire in Labor

This section provides a brief discussion on the means and measures of association between the decision to hire in labor on the farm and its determinants. These are presented in Table 8.

The average age of the participants as well as nonparticipants was around 45 years. The correlation between age and decision to

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these rental rates are computed from individual observations, it is possible that these two measures are not equal for several reasons: (1) The suppliers of land are different than demanders of land in the sample; (2) There are differences in land quality across the two groups; (3) The presence of transaction costs also leads to divergence between the demand and supply price; (4) This is also partly due to reporting, i.e., due to the fact that the land lease decisions and payments were not matching and also due to the inclusion of taxes, levies in these payments instead of reporting them separately; and (5) This may even be due to interlinked transactions in these villages. It is possible that credit payments may also be reported as part of rent payments for confidential reasons. A detailed investigation on determinants of land rent using a hedonic approach is left for future research. These coefficients on land rental rates are therefore to be interpreted cautiously.

Table 8. Means and measures of association: Decision to hire-in labor

Explanatory variables	Means (Standard Deviation)		χ tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Characteristics of the household head				
Age	44.96 (12.24)	44.39 (12.02)		
Farm experience	87.27 (33.64)	97.64 (0.15)	20.03 (0.00)	0.19 (0.00)
Labor market experience	41.82 (49.78)	37.16 (48.41)	n.s.	-0.04 (0.00)
Illiterates	69.09 (46.64)	44.93 (49.83)	2.68 (0.10)	-0.18 (0.00)
Primary education	12.73 (33.64)	20.27 (40.27)	n.s.	0.07 (0.19)
Junior high	18.18 (38.93)	27.70 (44.83)	n.s.	0.08 (0.14)
Senior and above	0.00 (0.00)	6.42 (24.55)	2.02 (0.16)	0.10 (0.05)
Highest caste	29.09 (45.84)	44.26 (49.75)	n.s.	0.11 (0.04)
Second highest caste	18.18 (38.93)	23.31 (42.35)	n.s.	0.04 (0.00)
Third highest caste	18.18 (38.93)	22.64 (41.92)	1.83 (0.18)	n.s.
Lowest caste	34.55 (47.99)	9.80 (29.78)	9.21 (0.00)	-0.26 (0.00)
Potential own farm workers				
Females	1.51 (0.88)	1.55 (0.99)	n.s.	n.s.
Males	2.02 (1.01)	2.08 (1.10)	n.s.	n.s.
Farm characteristics				
Value of irrigation equipment	178.18 (686.29)	747.49 (1467.97)		0.15 (0.01)
Value of non irrigation equipment	49.37 (48.91)	208.18 (243.05)		0.25 (0.00)
Area owned	5.05 (4.62)	13.14 (14.08)		0.22 (0.00)
Irrigable area	0.47 (1.04)	1.62 (2.90)		0.15 (0.00)

Table 8. (Continued)

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Farm characteristics				
Average value of own land	15.29 (12.05)	18.92 (10.64)		0.12 (0.02)
Rental rates				
Own land	101.45 (79.73)	118.14 (89.13)		0.13 (0.01)
Hired land	348.72 (309.95)	199.49 (231.19)		-0.08 (0.18)
Off-farm wage	1.36 (0.49)	1.78 (0.65)		
Village and year indicators				
Aurepalle	34.55 (47.99)	11.82 (32.34)		
Dokur	18.18 (38.93)	19.93 (40.02)		
Kinkheda	14.55 (35.58)	16.22 (36.92)		
Kanzara	18.18 (38.93)	16.55 (37.23)		
Shirapur	7.27 (26.21)	17.23 (37.83)		
Kalman	7.27 (26.21)	18.24 (38.69)		
Agricultural year 1975	36.36 (48.55)	52.03 (50.04)		
Agricultural year 1976	63.64 (48.55)	47.97 (50.04)		
Other dependent variables				
Hire in land	9.09 (29.01)	19.93 (40.02)	3.39 (0.07)	0.10 (0.06)
Hire out land	41.82 (49.78)	6.08 (23.94)	123.66 (0.00)	-0.40 (0.00)
Supply labor	78.18 (41.68)	51.35 (50.01)	13.52 (0.00)	-0.20 (0.00)
Total observations	55	296	351	351

hire in labor on the farm was not statistically significant even at 20 percent level.

The proportion of participants having farm experience was more than among the nonparticipants, providing an indication that farm experience and hired labor may be complements. This association was also significant at less than one percent level (see the Chi-square value). Labor market experience and the decision to hire in labor, on the other hand, were negatively related but were not statistically significant.

Education was hypothesized to be complementary with hired labor. In other words, more educated individuals were expected to hire in labor on the farm than less educated individuals. This tendency was weakly revealed by the relative proportion of observations in the two categories across the four educational dummies. There were relatively more illiterates and fewer educated household heads among the nonparticipants than the participants. Compare columns 1 and 3.

The next four variables are the caste dummies. Comparing the relative proportions, caste status and the decision to hire in labor seem to be inversely related. For example, the Chi-square tests for the highest caste status and the lowest caste status were statistically significant at less than 5 percent level.[7]

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[7]Note that the caste status is an ordered categorical variable and hence separate Chi-square tests for DCASTE2 and DCASTE3 are not meaningful.

The Chi-square test between the decision to hire in labor and caste status as an ordered categorical variable was statistically significant at 5 percent level (not reported here). The simple correlation coefficient was also positive indicating that higher caste members were more likely to hire in labor on the farm. Since these results are only suggestive, a likelihood ratio test on the importance of the caste status, controlling for the asset levels, is undertaken later.

The value of irrigation or nonirrigation equipment owned by the participants was nearly four times that of the nonparticipants. Simple correlations between the decision to hire in labor and value of irrigation equipment, as well as with value of non irrigation farm equipment, were positive indicating that these fixed factors are complementary with hired labor. The correlations were also statistically significant at one percent level.

The average land holding size owned by participants was 13 acres. It was 5 acres for the nonparticipants. The former also owned relatively more irrigable area and had relatively higher valued land than the latter. These positive correlations and statistically significant at less than one percent level suggest that land, irrigation and other soil productivity factors augment the marginal product of hired labor and thereby increase the propensity to hire in labor on the farm.

The mean land rent faced by the participants was Rs. 118 which was about 15 percent more than that faced by the nonparticipants.

5.1.2 Land market participation decisions

This section deals with the land lease decisions of the household. First, I discuss the means and measures of association for the decision to hire out land followed by the decision to hire in land.

Decision to Hire Out Land

Table 9 presents the mean, standard deviations and measures of association between the explanatory variables and decision to hire out land. Note that, out of a total of 351 observations, nearly 88 percent do not lease out any land and only 12 percent lease out some or all of their land.

The average age of the male head of household was around 44 years, both for the participants as well as for the nonparticipants.

Farm experience was hypothesized to be complementary with own farm land. The Chi-square test between farm experience and the decision to supply land was statistically significant at 4 percent level. Further, the correlation coefficient between individuals' propensity to supply land and farm experience was negative and also statistically significant.

The nonparticipants had more dairy animals than the participants. The mean number of dairy animals for the former was three times the latter. Also, the nonparticipants had nearly twice the number of oxen than the participants.

Table 9. Means and measures of association: Decision to hire out land

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Characteristics of household head				
Age	44.59 (12.28)	43.63 (10.16)		n.s.
Age^2	3128.23 (1154.48)	2004.66 (928.50)		n.s.
Farm experience	96.77 (17.70)	90.24 (30.04)	4.03 (0.04)	-0.11 (0.04)
Permanent servant experience	7.42 (26.25)	4.88 (21.81)	n.s.	n.s.
Domestic servant experience	8.39 (27.76)	7.32 (26.37)	n.s.	
Illiterates	47.42 (50.01)	58.54 (49.88)	1.79 (0.18)	0.07 (0.18)
Primary education	20.00 (40.07)	12.20 (33.13)	n.s.	n.s.
Junior high	25.81 (43.83)	29.27 (46.07)	n.s.	n.s.
Senior and above	6.13 (24.03)	0.00 (0.00)	2.66 (0.10)	-0.09 (0.10)
Potential labor suppliers				
Females	2.37 (1.28)	2.66 (1.37)	n.s.	0.07 (0.18)
Males	2.56 (1.28)	2.29 (1.12)	n.s.	n.s.
Potential own farm workers				
Females	1.55 (0.97)	1.51 (1.03)	n.s.	-0.01 (0.01)
Males	2.10 (1.09)	1.83 (1.02)	n.s.	-0.08 (0.13)
Farm characteristics				
Dairy animals	3.24 (5.83)	1.02 (2.10)		-0.13 (0.02)
Number of oxen	1.50 (1.72)	0.71 (1.82)	28.54 (0.00)	-0.15 (0.00)

Table 9. (Continued)

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Farm characteristics				
Value of non irrigation equipment	195.83 (238.52)	88.55 (135.02)		n.s.
Value of irrigation equipment	661.55 (1409.48)	633.54 (1247.91)		n.s.
Area owned	11.73 (11.79)	12.91 (22.19)		n.s.
Irrigable area owned	1.39 (2.78)	1.79 (2.26)		
Average value of own land	17.96 (10.54)	21.33 (13.37)		0.10 (0.06)
Distance to own plots	0.88 (0.52)	0.78 (0.49)		-0.07 (0.00)
Rental rates				
Own land	112.87 (87.04)	135.65 (92.24)		n.s.
Hired land	218.45 (253.12)	256.34 (231.30)		n.s.
Off-farm male wage	2.07 (0.77)	1.68 (0.68)		-0.12 (0.03)
Off-farm female wage	1.18 (0.48)	1.04 (0.41)		0.08 (0.14)
Village and year indicators				
Aurepalle	15.81 (36.54)	12.20 (33.13)		
Dokur	17.10 (37.71)	39.02 (49.39)		
Kinkheda	15.48 (36.23)	19.51 (40.12)		
Kanzara	16.13 (36.84)	21.95 (41.91)		
Shirapur	17.10 (37.71)	4.88 (21.81)		
Kalman	18.39 (38.80)	2.44 (15.62)		

Table 9. (Continued)

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Village and year indicators				
Agricultural year 1975	52.26 (50.03)	29.27 (46.37)		
Agricultural year 1976	47.74 (50.03)	70.73 (46.37)		
Other dependent variables				
Hire-in land	20.00 (40.07)	4.88 (21.81)	5.55 (0.02)	-0.13 (0.02)
Supply labor	52.58 (50.01)	78.05 (41.91)	7.78 (0.01)	0.17 (0.00)
Hire in labor	**89.70 (30.48)**	**43.90 (50.24)**	**123.66 (0.00)**	**-0.41 (0.00)**
Total observations	310	41	351	351

The correlation coefficients between the decision to supply land and number of dairy animals as well as with the number of oxen were negative and statistically significant indicating that the presence of animals on the farm tends to increase the shadow price of own farm land and thereby reduces the propensity to supply land to the market.

The mean value of EQUIP owned by the nonparticipants and participants was Rs. 196 and Rs. 89, respectively. There was, however, very little difference in the value of irrigation equipment owned by the two categories. See columns 1 and 2.

The mean amount of area owned was 12 acres for the nonparticipants and 13 acres for the participants while the amount of irrigable area owned was only one acre in the former and two acres in the latter. None of the correlations were significant.

The average off-farm male wage (wage on hired out activity which may be farm or non-farm) faced by the participants and nonparticipants was Rs. 2.68 and Rs. 2.07 per day, respectively. The correlation coefficient between the decision to supply land and the average wage was negative and statistically significant at less that 5 percent level.

Unlike the male off-farm wages, the female off-farm wage was positively correlated with this decision which indicates that an increase in the female wage increases the propensity to supply land.

Across the villages, most of the nonparticipant observations were spread fairly uniformly across the six villages. The highest proportion of participants was in Dokur, while the lowest proportion

was in Kalman. This relative variation in proportions across villages reflects variation in resource endowments and adjustments across these villages. For example, Dokur is relatively between irrigated and is mostly cotton growing, i.e., labor intensive than the other villages. For more on this, see Ryan and Ghodake (1979).

Decision to Hire in Land

The means and simple measures of association between the decision to hire in land its determinants are presented in Table 10. First of all, observe that only 18 percent of the sample leased in any land.

The average age for the two categories was also around 44 years. Moreover, most participants as well as nonparticipants have had some prior farm experience. Among the other characteristics of the household head, only experience as a domestic servant displayed a statistically significant association. See column 3. The estimated Chi-square value was 8.2 and was statistically significant at less than one percent.

Nearly 50 percent of the sample were illiterates. The educational dummies displayed mixed results. For example, among the participants there were relatively more illiterates and more with primary education This trend reversed for the other two categories. Both the Chi-square tests were statistically significant at 20 percent level. These trends may indicate some underlying sectoral effects across the educational classes.

Table 10. Means and measures of association: Decision to hire-in land

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Characteristics of the household head				
Age	44.43 (12.20)	44.67 (11.40)		
Farm experience	95.47 (20.83)	98.44 (12.50)	n.s.	n.s.
Permanent servant experience	7.32 (26.09)	6.25 (24.40)	n.s.	n.s.
Domestic servant experience	6.27 (24.29)	17.19 (38.03)	8.23 (0.00)	n.s.
Illiterates	47.74 (50.04)	53.13 (50.30)	n.s.	n.s.
Primary education	17.77 (38.29)	25.00 (43.64)	1.77 (0.18)	0.07 (0.18)
Junior high	27.53 (44.74)	20.31 (40.56)	n.s.	n.s.
Senior and above	6.27 (24.29)	1.56 (12.50)	2.27 (0.13)	-0.08 (0.13)
Highest caste	40.42 (49.16)	48.44 (50.37)	n.s.	n.s.
Second highest caste	22.65 (41.93)	21.88 (41.67)	n.s.	n.s.
Third highest caste	20.91 (40.74)	26.56 (44.52)	n.s.	n.s.
Lowest caste	16.03 (36.75)	3.13 (17.54)	7.38 (0.01)	-0.15 (0.00)
Potential own farm workers				
Females	1.54 (0.97)	1.56 (1.01)	n.s.	n.s.
Males	2.04 (1.06)	2.20 (1.21)	n.s.	n.s.
Potential labor suppliers				
Females	2.45 (1.25)	2.23 (1.46)	16.80 (0.02)	n.s.
Males	2.49 (1.23)	2.69 (1.37)		n.s.

Table 10. (Continued)

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Farm characteristics				
Number of oxen	1.24 (1.79)	2.16 (1.32)	62.88 (0.00)	0.20 (0.00)
Dairy animals	2.89 (5.73)	3.38 (4.83)		
Value of non irrigation equipment	172.99 (237.58)	229.53 (195.80)		0.10 (0.08)
Value of irrigation equipment	678.63 (1432.66)	567.00 (1185.31)		n.s.
Area owned	12.03 (14.08)	11.18 (9.72)		n.s.
Irrigable area owned	1.46 (2.86)	1.32 (2.02)		n.s.
Average value of own land	18.47 (11.16)	17.84 (9.97)		n.s.
Rental rates				
Own land	116.99 (89.04)	108.96 (82.53)	n.s.	n.s.
Hired land	231.65 (255.08)	183.52 (227.45)		-0.08 (0.16)
Off-farm male wage	2.05 (0.78)	1.94 (0.70)		n.s.
Off-farm female wage	1.18 (0.48)	1.10 (0.44)		-0.08 (0.14)
Village and year indicators				
Aurepalle	16.38 (37.07)	10.94 (31.46)		
Dokur	20.21 (40.23)	17.19 (38.03)		
Kinkheda	16.03 (36.75)	15.63 (36.60)		
Kanzara	13.24 (33.95)	32.81 (47.32)		

Table 10. (Continued)

Explanatory variables	Means (Standard Deviation)		χ^2 tests	Simple correlations
	Non participants	Participants	(p-values)	(p-values)
Village and year indicators				
Shirapur	16.38 (37.07)	12.50 (33.33)		
Kalman	17.77 (38.29)	10.94 (31.46)		
Agricultural year 1975	50.87 (50.08)	43.75 (50.00)		
Agricultural year 1976	49.13 (50.08)	56.25 (50.00)		
Other dependent variables				
Hire-out land	13.59 (34.33)	3.13 (17.53)	5.55 (0.02)	-0.13 (0.02)
Supply labor	55.40 (49.79)	56.25 (50.00)	n.s.	n.s.
Hire-in labor	82.58 (38.00)	92.19 (27.05)	3.39 (0.07)	0.10 (0.06)
Total observations	287	64	351	351

The caste status of an individual was hypothesized to be positively related with this decision.[8] The relative proportions of the first three caste categories among the participants was fairly equal to that among the non- participants. But only three percent of the participants belonged to the lowest caste compared with 16 percent among the nonparticipants. The Chi-square and the correlation coefficient were negative and significant at one percent.

Consider the relative asset position of the two categories. The participants on an average had more dairy animals, more oxen and more farm equipment than the nonparticipants. (Compare columns 1 and 2.) For example, the mean number of oxen owned by the former was Rs. 230 while it was Rs. 173 for the latter. These differences in relative asset position between the two groups indicate that tenancy maybe a response to fuller utilization of farm fixed factors as suggested by Jodha (1979).

The next section discusses the estimation results and the estimated responses on the marginal propensity to transact in the market due to changes in the determinants of these decisions.

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[8]First of all, ownership of complementary farm assets and caste status are likely to be highly correlated and, secondly, the possibility of caste discrimination in the land lease market, i.e., lower caste members may be unable to secure a lease from those leasing out.

5.2 Estimation

This section presents a discussion on the maximum likelihood estimates obtained under three different assumptions about the econometric models, namely: (1) that each of the participation decisions are independent. These sets of estimates are presented under MODEL I, (2) that the land market decisions are independent of the labor market decisions. These are presented under MODEL II, and (3) that all the four participation decisions are simultaneous. These are presented under MODEL III.

Although a number of other specifications were tested for each of the models, only two sets of estimates for each model are presented here. The first set under each model corresponds to the most general specification as discussed above in the chapter on empirical models. The next set was obtained by deleting those variables that were statistically not significant even at 20 percent.[9]

The discussion below is presented under the following headings: (1) Choice of the econometric model, (2) Relative importance of the determinants of decisions; (3) Likelihood ratio tests for selected hypotheses; and (4) Responses by land holding classes.

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[9]The statistically nonsignificant variables were deleted to check on the stability of estimated coefficients within the model. Some other specifications were also tried to determine the presence of multicollinearity in the data. In most of the specifications within the model, there was very little change in statistical significance due to inclusion or deletion of variables from the model.

5.2.1 Choice of the econometric model:

This section discusses two aspects of the research: (1) Tests on the simultaneity of the decisions, and (2) Selected summary measures for the estimated models. The estimated parameters and responses for these models are presented in the next section.

As discussed in the chapter on the econometric model, a single equation model or any other model is a mis-specified model if the true model is, in fact, a four decision joint model. Further, if a binary model is estimated for each of the cells separately, then as Amemiya (1981) notes, ". . . (1) the sum of the [sixteen] estimated probabilities could exceed unity. (2) A correlation among the [four] dependent variables [would be] ignored." The discussion on the choice of the model here relates to the appropriateness of the assumptions of the econometric model and not to the choice of the specification within the model.

Tests on the simultaneity of the decisions: This test was performed using the likelihood ratio tests. The results are presented in Table 11. The restricted log of likelihood is the sum of the estimated log of likelihoods under the assumption of independence. The unrestricted value is that estimated under the assumption of joint dependence.

Observe that the likelihood ratio test rejects the hypothesis of independence of the four decisions. The value of the chi-square is 36.0 and statistically significant at less than one percent. A similar test was undertaken to test whether the land market decisions

Table 11. Likelihood Ratio Tests for Simultaneity of Decisions

Hypothesis	Negative of the log of likelihood		Degrees of Freedom	Chi-square
	Restricted	Unrestricted		
1. All decisions are independent	387.9	369.9	6	36.0**
2. Land market decisions are independent of the labor market decisions	385.7	369.9	4	31.6**
3. Land market decisions are independent	182.2	181.96	1	0.5
4. Labor market decisions are independent	205.7	203.51	1	4.4*

*: Significant at 5 percent.

**: Significant at 1 percent.

are independent of the labor market decisions. This was also rejected at one percent level (see the second row). The third and fourth hypotheses relates to the independence of each of the decisions in the land market and labor market, respectively. These results indicate that the decision to lease in land is independent of the decision to lease out land. This is not usual given the fact that only two households simultaneously lease in and lease out land while 70 percent of the observations are non participants in the land market. The decision to hire out labor and the decision to hire in labor however are jointly determined.

The likelihood ratio test, with respect to the land market, therefore provides evidence that the demanders of land are adjusting to different sort of constraints than the suppliers of land and, hence, the need to obtain a separate set of estimates with respect to the two decisions.

The test on the independence of the decision to supply labor and the decision to hire in labor was statistically rejected at less than five percent level. This result is consistent with the observation that most household heads simultaneously supply labor to the market as well as hire in labor on the farm.

In conclusion, the test on the simultaneity of the four decisions confirms the expectation that the appropriate econometric model is MODEL III. In the next section, I present selected summary measures for the different estimated models. There I investigate the appropriateness of the different models as well as the specification within each model.

Selected Summary Measures: Table 12 contains selected summary measures for the three models under the different assumptions of independence of decisions. The first two rows in the table report the values of the log of likelihood function when all the parameters are set to zero; i.e., L(0) and the value of the log of likelihood at the maximum; i.e., $L(\hat{\beta})$, respectively. The values reported under MODEL I and II are the sums of the likelihood estimated separately for each of the decision and separately for each of the market, respectively. The next row contains the values of McFadden's ρ^2 which is similar to R^2 in ordinary regression analysis. Since, under the presence of simultaneity of these decisions, MODEL I, II and III are nonnested, I also report the Akaike Information Criteria computed as $-L(\hat{\beta}) + K$, where K is the number of estimated parameters (Amemiya, 1981). The next two rows present the total of wrong predictions over all the sixteen cells (D) and the total of percent wrong marginal predictions for the four decisions, respectively.

Columns 1 and 2 report these measures for MODEL I under the assumption that all the four decisions are independent. Columns 3 and 4 report these measures for MODEL II under the assumption that the land market decisions are independent of the labor market decisions. The last two columns report the results for two different specifications for MODEL III. Specification 'a' for each model is the same as the fully specified empirical model as discussed in the chapter on Empiries, while some of the statistically non-significant parameters set to zero yields specification 'b'. Note that MODEL

I(a) is nested in MODEL III(a) if all the decisions are independent. Since the likelihood ratio test on independence was rejected at one percent level, these models are nonnested. In other words, the likelihood function for MODEL III(a) under the dependence of the four decisions cannot be obtained from the four separate likelihood functions of each of the decisions. Thus, the choice between MODEL I, II and III cannot be made using the value of the log of the likelihood function at the maximum nor using McFadden's ρ^2. These measures are, however, useful to choose between specifications within a model.

In the present study, the choice of the model was based upon the lowest value of D. D was defined as the sum of absolute deviations between the actual and predicted cell frequencies for the 16 cells. In Table 12, the first column reports the value of D for MODEL I. Column 3 reports the value of D for MODEL II and column 5 for MODEL III.

A look at the table indicates that the four decision joint model yields the lowest value of D of 70 in relation to the other models. Using this criterion, MODEL I is not a good predictor of the joint participation choices. The same holds true for MODEL II. Note, however, that empirically, MODEL III is more than twice efficient predictor than to MODEL I (see the corresponding values of D).

In the next row, I present a different measure of relative efficiency for the same set of models. Here, I report the total percentage of wrong predictions from each of the participation

Table 12. Summary measures for the three models

Criteria	MODEL (specification) I(a)	I(b)	II(a)	II(b)	III(a)	III(b)
$-L(0)$	973.2	973.2	973.2	973.2	973.2	973.2
$-L(\hat{\beta})$	387.9 (104)	411.7 (66)	385.7 (106)	409.11 (68)	369.9 (110)	393.0 (72)
McFadden's $\rho^2 = 1 - \frac{L(\hat{\beta})}{L(0)}$	0.61	0.58	0.60	0.58	0.62	0.60
Akaike Information Criteria $-L(\hat{\beta})$ + number of estimated parameters	491.9	477.7	491.7	477.1	479.9	465.0
$D = \sum_{i=1}^{16} \lvert n_i - N_i \rvert$	162		100		70	82
Total of percent wrong marginal predictions	53.9		48.4		48.1	51.8

The number in parentheses are the total number of estimated parameters.

$L(0)$: value of the likelihood when all parameters are zero.

$L(\hat{\beta})$: value of the likelilhood evaluated at the maximum.

n_i: actual cell frequency.

N_i: estimated cell frequency.

decisions to discriminate between the models. As is evident from the table, the performance of this measure is not as good as that of D. For example, the total percent of wrong predictions is very close to each other around 50 percent across the three models. In fact, there is no difference in predictive ability between MODEL II and MODEL III using this measure.

5.3 Relative Importance of the Determinants of Decisions

One of the objectives of statistical models is to enable efficient discrimination of the factors influencing the dependent variable. This aspect of the research is dealt with in this section. Specifically, I discuss two aspects of the estimates: the direction of the signs of the estimates and their statistical significance.

5.3.1 Labor market estimates

The estimates for the labor market decisions are discussed here. These are discussed separately for the decision to hire out labor and for the decision to hire in labor.

Decision to Hire Out Labor

The estimates for the decision to supply labor, male or female, are presented in Table 13. Columns (1) to (3) contain estimates for the most general specification as discussed in the empirical model. Column 1 contains estimates for MODEL I(a), Column 2 contains estimates for MODEL II(a), while the third column contains estimates for MODEL III(a).

Table 13. Maximum likelihood estimates and marginal responses: Decision to supply labor

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Intercept	6.0066 (0.02)	3.0077 (0.00)	3.2525 (0.00)	4.0220 (0.00)	2.0567 (0.00)	2.1770 (0.00)
Characteristics of the household head						
Age	-0.0104 (0.91) [-0.003]	-0.0075 (0.85) [-0.004]	-0.0097 (0.85) [-0.039]			
Age^2	-0.0007 (0.46) [-0.018][a]	-0.0003 (0.42) [-0.017][a]	-0.0003 (0.60) [-0.017]			
Farm experience	0.4297 (0.68) [0.107]	0.3301 (0.49) [0.145]	0.2350 (0.77) [0.118]			
Permanent farm servant experience	-1.2698 (0.16) [-0.301]	-0.6846 (0.11) [-0.315]	-0.6148 (0.41) [-0.262]	-1.3357 (0.03) [-0.313]	-0.7131 (0.02) [-0.324]	-0.6294 (0.04) [-0.270]
Labor market experience	2.0647 (0.00) [0.453]	1.0753 (0.00) [0.474]	1.0744 (0.01) [0.481]	1.7211 (0.00) [0.391]	0.8840 (0.00) [0.403]	0.8875 (0.00) [0.411]
Domestic servant experience	0.2765 (0.76) [0.067]	0.1428 (0.73) [0.070]	0.0816 (0.91) [0.166]			
Trading experience	-1.7800 (0.15) [-0.389]	-0.8972 (0.13) [-0.380]	-0.8710 (0.20) [-0.361]	-2.0624 (0.08) [-0.425]	-1.0615 (0.06) [-0.422]	-1.0788 (0.06) [-0.407]
Other occupational experience	0.8280 (0.27) [0.189]	0.3967 (0.26) [0.187]	0.3972 (0.48) [0.190]			
Illiterates	0.0651 (0.90) [0.016]	0.0240 (0.92) [0.014]	-0.0207 (0.97) [0.001]			
Primary education	0.5455 (0.31) [0.130]	0.2854 (0.29) [0.138]	0.2455 (0.72) [0.126]			
Second highest caste	0.4013 (0.43) [0.097]	0.2030 (0.41) [0.097]	0.2229 (0.78) [0.100]			
Third highest caste	0.2241 (0.68) [0.055]	0.1498 (0.57) [0.068]	0.1698 (0.79) [0.078]			

Table 13. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Characteristics of the household head						
Lowest caste status	0.3421 (0.63) [0.083]	0.0747 (0.84) [0.035]	0.1497 (0.86) [0.058]			
Potential farm workers						
Females	-0.0887 (0.69) [-0.022]	-0.0423 (0.64) [-0.021]	-0.0409 (0.70) [-0.019]			
Males	0.0582 (0.77) [0.014]	0.0234 (0.79) [0.012]	0.0227 (0.82) [0.011]			
Farm characteristics						
Farm animals	-0.2843 (0.00) [-0.095]	-0.1890 (0.00) [-0.094]	-0.1861 (0.00) [-0.093]	-0.3243 (0.00) [-0.080]	-0.1560 (0.00) [-0.078	-0.1536 (0.00) [-0.077]
Farm animals^2	0.0077 (0.00) [0.189]^a	0.0038 (0.00) [0.188]^a	0.0038 (0.00) [0.188]^a	0.0066 (0.00) [0.163]^a	0.0032 (0.00) [0.158]^a	0.0031 (0.00) [0.157]^a
Nonfarm equipment	0.0001 (0.86) [0.002]^a	0.0001 (0.77) [0.003]^a	0.0001 (0.86) [0.002]^a			
Irrigation equipment	3.9×10^{-7} (1.00) [0.000]^a	3.9×10^{-7} (0.99) [0.000]^a	-4.9×10^{-6} (0.96) [0.000]^a			
Non irrigation equipment	0.0000 (0.98) [0.001]^a	0.0001 (0.83) [-0.002]^a	0.0001 (0.86) [0.004]^a			
Area owned	-0.0724 (0.02) [-0.018]	-0.0346 (0.00) [-0.018]	-0.0351 (0.01) [-0.019[	-0.0829 (0.00) [-0.021]	-0.0380 (0.00) [-0.020]	-0.0385 (0.00) [-0.021]
Irrigable area owned	-0.2998 (0.04) [-0.074]	-0.1413 (0.02) [-0.072]	-0.1362 (0.04) [-0.072]	-0.2687 (0.02) [-0.067]	-0.1260 (0.01) [-0.063]	-0.1237 (0.01) [-0.066]
Average value of own land	-0.0511 (0.02) [-0.013]	-0.0262 (0.01) [-0.013]	-0.0254 (0.03) [-0.014]	-0.0557 (0.02) [-0.014]	-0.0274 (0.00) [-0.014]	-0.0272 (0.00) [-0.015]

Table 13. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Rental rates						
Own land	0.0053 (0.09) [0.131][a]	0.0028 (0.06) [0.135][a]	0.0025 (0.15) [0.126][a]	0.0076 (0.01) [0.187][a]	0.0039 (0.00) [0.190][a]	0.0034 (0.00) [0.169][a]
Hired land	-0.0022 (0.04) [-0.055][a]	-0.0012 (0.01) [-0.060][a]	-0.0011 (0.08) [-0.056][a]	-0.0021 (0.01) [-0.051][a]	-0.0012 (0.00) [-0.058][a]	-0.0010 (0.03) [-0.051][a]
Off-farm male wage	-1.0119 (0.33) [-0.249]	-0.4968 (0.31) [-0.247]	-0.4167 (0.43) [-0.199]	-0.3923 (0.64) [-0.097]	-0.1865 (0.66) [-0.093]	-0.0595 (0.90) [-0.023]
Off-farm female wage	0.7619 (0.066)	0.4350 (0.059)	0.3521 (0.68)	-0.0114 (0.99)	0.0482 (0.95)	-0.0836 (0.92)
Year = 1976	-1.2139 (0.00)	-0.6354 (0.00)	-0.6505 (0.08)	-0.9685 (0.00)	-0.5169 (0.00)	-0.5356 (0.00)
Bivariate associations						
Hire in labor		-0.2560 (0.01)	-0.1625 (0.18)		-0.2341 (0.02)	-0.1392 (0.19)
Hire out land			0.2003 (0.13)			0.2453 (0.04)
Hire in land			0.1749 (0.28)			0.1562 (0.07)

NOTE: Figures in parentheses are p-values.
The estimated responses are in square brackets.

[a]These responses are to be multiplied by 10 to obtain estimated responses in percentage points. All others are to be multiplied by 100.

The remaining three columns report estimates for the three models after deleting selected statistically nonsignificant variables, i.e., for specification 'b.'

There are a number of interesting facts to be noted from this table. First of all, note that the signs of the coefficients are unchanged across the three models. Second, the magnitude of the coefficients decreases as one moves from MODEL I to MODEL III. The coefficients of MODEL II are nearly one-half of those in MODEL I. Third, observe that the estimates are not very sensitive to the exclusion of the statistically non-significant variables in relation to the general specification within the model. Finally, note that the significance level of the coefficients across three models reduces, i.e., some of the coefficients that were statistically significant in MODEL I are less significant in MODEL III.

With these remarks, I now proceed to discuss the estimated direction of the impact on the decision to h ire out labor. This discussion, unless otherwise stated, pertains to the estimates from MODEL IIIa and MODEL IIIb.

Characteristics of the Household Head:

Age and its square did not display the expected -shaped pattern or any statistically significant effect on the decision to supply labor by the household head.

Among the experience dummies, labor market experience was statistically significant at one percent level. It increased the probability of participation by nearly 41 to 48 percent, but as a

domestic servant, decreased it 16 percent. Being a trader, however, decreased the probability of participation by as much as 40 percent. Such varied impacts on the probability of participation with respect to these indicators reflect contractual and time intensive nature of these activities. For example, most domestic servants generally work part-time while permanent servants work on a full-time basis. Hence, the probability of withdrawal from the daily labor market is much higher for the latter than the former. Similarly, trading is mostly a full-time household activity and, hence, strongly reduces the propensity to supply labor to the market.

As noted before, these estimates with respect to the experience indicators may have to be interpreted cautiously since they mostly reflect occupational preference and may be a potential source of endogeneity.

The next two coefficients pertain to the education dummies.[10] Note that none of the dummies are statistically significant, nor do they have the expected sign.

Also, none of the coefficients for the caste status are statistically significant. Compare this result with the measures of association discussed in the previous section. Thus, controlling for

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[10]Although the discussion under the empirical model corresponded to four dummies, due to sampling zeros for DSHIGH in some cells, it was decided to redefine only three dummies; namely, DILLIT, DPRIM, as before, and DJHIGH consisting of all observations with above primary education.

the other endowments of the household, it does not seem that the heads of higher caste households have an aversion to working off one's farm.

Potential Farm Workers: An increase in potential female farm workers in the household increased the propensity to supply labor by the household head while an increse in the number of male workers decreased the propensity to supply labor. However, none of these effects were statistically significant.

Farm Characteristics: Total number of farm animals and its square were statistically significant at less than one percent level and had the expected signs. The presence of farm animals thus decreases and then increases the probability of supplying labor to the market. The minimum occurring at 25 animals on the farm. The estimated partial derivative indicated that every additional animal on the farm reduced the probability of participation by nearly 8 percent.

The signs, with respect to the other resource endowments such as area owned, irrigable area owned and land characteristics, were also consistent with expectation and the coefficients were statistically significant at less than 5 percent.

The estimated response due to a unit change in area owned on probability of participation was around 1 to 2 percent only, while a unit change of irrigable area owned changed the same by 7 percent.

A thousand rupees increase in land values on the other hand decreased the probability of participation by less than 2 percent. These results are consistent with those reported by Bardhan (1979b) for Bihar, and by Rosenweig (1980) at the district level for India.

The next four variables are village level rental rates. The coefficients on LRENTS and LRENTD were positive and negative, respectively. That on LRENTS was not statistically significant in column 3 but became significant in column 6. LRENTD, on the other hand, had a statistically significant coefficient at less than 5 percent level in both the specifications. A 100 rupees increase in rental payments received on own land increased the probability of participation of the male head by 13 percent while an identical increase in LRENTD decreased the same by 5 percent. It is interesting to note that in spite of the data limitations, the signs on these coefficients reflect tendencies that were predicted in the theoretical model. These results support the hypothesis that own land and family labor are complements on the farm. In other words, an increase in the rental rate on own land decreases the opportunity cost of farming one's land thereby increasing the propensity to supply land to the market and increasing the propensity to supply own labor to the market. The negative sign on LRENTD indicates that heads of households treat hired land and own labor as substitutes. Thus, an increase in rental payments on hired land induces the household to apply more effort on the farm and decrease the propensity to supply labor to the market.

The coefficient on the average male wage off one's own farm was expected to be positive, but irrespective of the model specificaiton, the sign was negative and also statistically significant. Similar results are reported by Bardhan (1979b) and Rosenweig (1980). Rosenweig therefore concludes in favor of a backward bending labor supply curve. Why an increase in wage would decrease the propensity to supply labor is not clear. Neither Bardhan nor Rosenweig attempt to justify this inverse relationship. Although such a relationship may be justified in the context of a continuous measure of labor supply, the same arguments cannot be invoked in the case of labor market participation. The conclusion arrived by Rosenweig is therefore unfounded because the dependent variable used by Rosenweig is the proportion working as hired agricultural laborers.

A wage increase, in the absence of any substitution effects, ought to unambiguously increase the proportion working as hired laborers. This sign probably reflects an indirect effect through the reduced demand for hired male labor on the farm, which may induce the male head to increase the supply of own labor to the farm and hence decrease the propensity to supply to the market. Thus, it is possible that wage and participation decision is inversely related if a change in wage through its effect on the demand for hired labor raises the threshold point. A detailed investigation is left for future research.

An increase in the average female wage increased the propensity to supply labor to the market as expected and the coefficient was statistically significant at less than 5 percent level. This result supports the hypothesis that labor of the household head and female labor are complementary inputs on the farm. The complemenarity arising from the fact that most of the male and female farm tasks are segmented in these villages.

The estimated partial derivatives indicate that an increase in the female wage by one ruppee reduced the probability of participation by the household head by 14 percent while the same increase in male wage decreased it by nearly 20 percent.

Decision to hire in labor:

This section discusses the estimation results on households propensity to hire in male and female labor on the farm from the daily labor market. The estimates for the two different specifications for the three models are presented in Table 14. The order of presentation is the same as that discussed in the previous section.

Characteristics of the household head: Most of the characteristics of the household head had no statistically significant influence on this decision. The coefficients on farm and labor market experience displayed some instability with respect to their standard errors across models as well as across the specifications. For example,

Table 14. Maximum likelihood estimates and marginal responses: Decision to hire in labor

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Intercept	-6.6170 (0.01)	-2.9991 (0.01)	-3.4653 (0.00)	-4.3907 (0.00)	-1.9822 (0.00)	-2.3866 (0.00)
Characteristics of the household head						
Age	0.0732 (0.42) [0.002]	0.0369 (0.35) [0.002]	0.0421 (0.45) [0.001]			
Age^2	-0.0005 (0.55) [-0.001]^a	-0.0003 (0.41) [-0.001]^a	-0.0004 (0.52) [-0.001]^a			
Farm experience	1.5207 (0.04) [0.070]	0.7720 (0.02) [0.064]	0.8398 (0.30) [0.058]	1.1717 (0.10) [0.047]	0.5951 (0.08) [0.051]	0.6976 (0.07) [0.050]
Labor market experience	0.4522 (0.30) [0.010]	0.3704 (0.06) [0.007]	0.4585 (0.48) [0.009]	0.3963 (0.33) [0.009]	0.3352 (0.08) [0.008]	0.3970 (0.06) [0.010]
Illiterates	-0.4355 (0.42) [-0.986]^a	-0.2021 (0.43) [-1.016]^a	-0.2484 (0.61) [-0.939]^a			
Primary education	0.0260 (0.97) [0.058]^a	0.0275 (0.93) [-0.168]^a	-0.1935 (0.78) [-0.830]^a			
Second highest caste	0.5604 (0.38) [0.011]	0.2936 (0.33) [0.011]	0.3338 (0.53) [0.008]			
Third highest caste	1.7443 (0.01) [0.027]	0.8226 (0.01) [0.027]	0.7258 (0.22) [0.016]	1.2357 (0.01) [0.022]	0.5743 (0.00) [0.022]	0.4533 (0.04) [0.017]
Lowest caste	0.4787 (0.49) [0.009]	0.1874 (0.58) [0.007]	0.2232 (0.70) [0.005]			
Potential farm workers						
Females	0.0158 (0.95) [0.035]^a	-0.0030 (0.98) [0.033]^a	-0.0093 (0.95) [0.054]^a			

Table 14. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Males	-0.0237 (0.92) [-0.053]^a	-0.0072 (0.94) [-0.035]^a	-0.0463 (0.76) [-0.090]^a			
Farm characteristics						
Irrigation equipment	-0.0001 (0.99) [-0.000]^a	-0.0001 (0.81) [-0.000]^a	-0.0001 (0.73) [-0.000]^a			
Non irrigation equipment	0.0134 (0.00) [0.030]^a	0.0066 (0.00) [0.032]^a	0.0044 (0.00) [0.016]^a	0.0131 (0.00) [0.031]^a	0.0066 (0.00) [0.175]^a	0.0040 (0.00) [0.018]^a
Area owned	0.0810 (0.13) [0.181]^a	0.0331 (0.20) [0.199]^a	0.0576 (0.01) [0.168]^a	0.0831 (0.10) [0.195]^a	0.0354 (0.12) [0.486]^a	0.0586 (0.00) [0.201]^a
Irrigable area owned	0.2198 (0.30) [0.492]^a	0.1017 (0.23) [0.649]^a	0.2071 (0.03) [0.701]^a	0.2049 (0.30) [0.479]^a	0.0901 (0.17) [0.182]^a	0.1511 (0.05) [0.606]^a
Average value of own land	0.0249 (0.30) [0.056]^a	0.0092 (0.35) [0.073]^a	0.0195 (0.11) [0.065]^a	0.0264 (0.21) [0.062]^a	0.0098 (0.25) [0.029]^a	0.0197 (0.05) [0.087]^a
Rental rates						
Own land	0.0029 (0.33) [0.007]^a	0.0018 (0.16) [0.006]^a	0.0028 (0.21) [0.007]^a	0.0024 (0.38) [0.006]^a	0.0017 (0.16) [0.004]^a	0.0029 (0.03) [0.008]^a
Hired land	-0.0009 (0.37) [-0.002]^a	-0.0005 (0.26) [-0.001]^a	-0.0008 (0.29) [-0.002]^a	-0.0005 (0.59) [-0.001]^a	-0.0004 (0.34) [-0.001]^a	-0.0007 (0.11) [-0.002]^a
Off-farm wage	1.2911 (0.01) [0.029]	0.6252 (0.00) [0.030]	0.4276 (0.32) [0.014]	1.4273 (0.00) [0.033]	0.6821 (0.00) [0.034]	0.4455 (0.04) [0.017]
Year = 1976	-0.4385 (0.11) [-0.012]	-0.3055 (0.10) [-0.008]	-0.1655 (0.79) [-0.003]	-0.4708 (0.23) [-0.011]	-0.2928 (0.09) [-0.009]	-0.1477 (0.45) [-0.004]
Bivariate associations						
Supply labor		-0.2360 (0.01)	-0.1625 (0.18)		-0.2341 (0.02)	-0.1392 (0.19)

Table 14. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Hire out land			-0.6822 (0.00)			-0.6694 (0.00)
Hire in land			0.0892 (0.66)			0.0471 (0.69)

NOTE: Figures in parentheses are p-values.
The estimated responses are in square brackets.

[a]These responses are to be multiplied by 10 to obtain estimated responses in percentage points. All others are to be multiplied by 100.

farm experience was not significant in MODEL III but was significant at less than 10 percent when some of the variables were deleted. (Compare columns 3 and 6.)

There was no evidence that higher caste members have a higher propensity to hire in labor on the farm or that higher caste members have an aversion to working on the farm. Among the caste dummies, only the coefficient on the third highest caste was statistically significant at less than 5 percent level. This probably reflects the fact that those under this caste group are mostly traders who generally have a greater demand for hired labor on the farm than by those belonging to the other caste groups.

Potential own farm workers: Consider the coefficients on these two variables. These were specified to test for the presence of the 'supervision constraint.' None of these coefficients had the expected sign. Further, the standard errors were also very large. These results therefore do not support the hypothesis that households face supervision constraints in these villages as hypothesized in the tenancy literature. The negative coefficients however suggest that own labor and hired labor are not complements but substitutes on the farm. The degree of substitutability - given our results - must be left for future research.

Farm characteristics: Among the farm assets, the coefficients on irrigation equipment was negative with very high standard errors while that on non-irrigation equipment was positive and also statistically significant at less than 1 percent level. The positive coefficient on the latter supports the hypothesis that land preparation and other non-irrigation equipment is complementary with hired labor and hence increases the demand for hired labor on the farm. The estimated response to changes in the value of farm equipment on the marginal propensity to hire in labor on the farm was, however, very small.

Changes in area owned, irrigable area owned and in average value of land had statistically significant impact on the probability of hiring in labor on the farm. The estimated increase in probability of hiring in labor due to a unit increase in irrigated area was nearly three and one half times more than a unit change in area owned by the household.

Rental Rates: The next three variables are the rental rates. Neither of the land rental rates were statistically significant in column 3, while these increased in significance in column 6. However, there was very little change in the magnitude of the coefficients across the two specifications. The sign on LRENTD and LRENTS was negative and positive, respectively. The negative sign indicates that hired land and hired labor are complements while the

positive sign indicates that own land and hired labor are substitutes. This is consistent with the observed behavior in these villages where small farmers who farm land more intensively per acre and those that lease in land are most likely to hire in labor on the farm.

The coefficient on average village wage which is average off-farm wage received by male and female labor, though statistically significant, was not as hypothesized. The positive sign therefore implies that an increase in off-farm wages received by family labor increases the propensity to hire in labor on the farm and that family labor and hired labor are substitutes on the farm and not complements as hypothesized.

5.3.2 Land market estimates:

This section discusses estimates for the land market decisions. This is presented under two headings: (1) the decision to hire out land, and (2) the decision to hire in land. Broadly speaking, the determinants of these choices also throw some light on individuals preference to be a landlord or a tenant given the ownership of land in these villages.

Decision to Hire Out Land:

The estimated parameters for the decision to lease out land are presented in Table 15. The estimates for the specifications of MODEL III are in column 3 and column 6.

Table 15. Maximum likelihood estimates and marginal responses: Decision to hire-out land

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Intercept	0.4212 (0.90)	0.0150 (0.99)	-1.5281 (0.15)	-0.6044 (0.67)	-0.4951 (0.48)	-1.6542 (0.04)
Characteristics of the household head						
Age	-0.0199 (0.90) [-0.009]a	-0.0073 (0.91) [-0.009]a	0.0119 (0.86) [0.001]a			
Age^2	-0.0002 (0.92) [-0.000]a	-0.0001 (0.87) [-0.000]a	-0.0002 (0.77) [-0.000]a			
Farm experience	-1.3040 (0.17) [-0.012]	-0.6170 (0.16) [-0.012]	-0.0990 (0.91) [-0.006]	-0.7297 (0.41) [-0.006]	-0.3365 (0.43) [-0.005]	0.1543 (0.75) [-0.001]
Permanent farm servant experience	-1.6005 (0.18) [-0.004]	-0.7860 (0.15) [-0.004]	-0.7831 (0.37) [-0.006]	-1.0718 (0.31) [-0.004]	-0.5261 (0.28) [-0.004]	-0.4691 (0.39) [-0.006]
Domestic servant experience	-1.7243 (0.09) [-0.004]	-0.7456 (0.12) [-0.005]	-0.6984 (0.30) [-0.006]	-1.9214 (0.05) [0.005]	-0.7861 (0.10) [0.006]	-0.6053 (0.29) [0.002]
Illiterates	1.4293 (0.03) [0.720]a	0.7291 (0.01) [0.768]a	0.6006 (0.06) [0.874]a	0.9481 (0.06) [0.497]a	0.4952 (0.03) [0.547]a	0.4586 (0.06) [0.640]a
Primary education	-0.0997 (0.91) [0.044]a	-0.0352 (0.93) [-0.039]a	-0.0213 (0.98) [0.085]a			
Potential suppliers of labor						
Females	0.6112 (0.06) [0.279]a	0.2978 (0.03) [0.295]a	0.2896 (0.16) [0.373]a	0.2344 (0.24) [0.117]a	0.1174 (0.15) [0.135]a	0.1331 (0.09) [0.194]a
Males	0.0588 (0.89) [0.027]a	0.0282 (0.89) [0.032]a	0.0076 (0.99) [0.024]a			

Table 15. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Potential farm workers						
Females	-0.3976 (0.32) [-0.181]^{a}	-0.1897 (0.28) [-0.186]^{a}	-0.1652 (0.59) [-0.220]^{a}			
Males	-0.2878 (0.54) [-0.131]^{a}	-0.1381 (0.52) [-0.141]^{a}	-0.1798 (0.73) [-0.224]^{a}			
Farm characteristics						
Dairy animals	-0.4055 (0.15) [-0.185]^{a}	-0.2045 (0.12) [-0.200]^{a}	-0.2577 (0.00) [-0.329]^{a}	-0.4692 (0.00) [-0.234]^{a}	-0.2337 (0.00) [-0.254]^{a}	-0.3022 (0.00) [-0.421]^{a}
Dairy animals^{2}	-0.0045 (0.87) [-0.002]^{a}	-0.0021 (0.87) [0.002]^{a}	0.0045 (0.00) [0.006]^{a}	-0.0075 (0.75) [-0.004]^{a}	-0.0037 (0.75) [-0.004]^{a}	0.0052 (0.00) [0.007]^{a}
Oxen	-0.4177 (0.24) [-0.190]^{a}	-0.1954 (0.25) [-0.204]^{a}	-0.1448 (0.40) [-0.199]^{a}			
Irrigation equipment	0.0001 (0.87) [0.000]^{a}	0.3×10^{-4} (0.84) [0.000]^{a}	0.0001 (0.88) [0.000]^{a}			
Non irrigation equipment	-0.0246 (0.00) [-0.011]^{a}	-0.0122 (0.00) [-0.012]^{a}	-0.0091 (0.00) [-0.013]^{a}	-0.0264 (0.00) [-0.013]^{a}	-0.0129 (0.00) [-0.014]^{a}	-0.0099 (0.00) [-0.015]^{a}
Area owned	0.2421 (0.00) [0.110]^{a}	0.1201 (0.00) [0.118]^{a}	0.1209 (0.00) [0.132]^{a}	0.2303 (0.00) [0.115]^{a}	0.1140 (0.00) [0.126]^{a}	0.1210 (0.00) [0.141]^{a}
Irrigable area owned	0.2597 (0.19) [0.118]^{a}	0.1218 (0.20) [0.121]^{a}	0.0837 (0.24) [0.023]^{a}	0.2428 (0.14) [0.121]^{a}	0.1132 (0.14) [0.128]^{a}	0.0616 (0.17) [0.008]^{a}
Distance to own plots	-0.7386 (-.15) [-0.337]^{a}	-0.3674 (0.11) [-0.356]^{a}	-0.3188 (0.29) [-0.403]^{a}	-0.3829 (0.07) [-0.441]^{a}	-0.4310 (0.04) [-0.464]^{a}	-0.3863 (0.08) [-0.534]^{a}
Average value of own land	0.0551 (0.03) [0.025]	0.0269 (0.01) [0.027]	0.0330 (0.00) [0.032]	0.0444 (0.04) [0.022]	0.0215 (0.03) [0.025]	0.0320 (0.00) [0.031]

Table 15. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Rental						
Own land	0.0010 (0.81) [0.001][a]	0.0005 (0.77) [0.001][a]	0.0020 (0.45) [0.003][a]	0.0029 (0.44) [0.002][a]	0.0015 (0.33) [0.002][a]	0.0022 (0.15) [0.003][a]
Hired land	-0.0022 (0.13) [-0.001][a]	-0.0011 (0.07) [-0.001][a]	-0.0014 (0.04) [-0.002][a]	-0.0024 (0.06) [-0.001][a]	-0.0013 (0.03) [-0.001][a]	-0.0015 (0.00) [-0.002][a]
Off-farm male wage	-3.7343 (0.01) [-0.017]	-1.8638 (0.00) [-0.018]	-1.6214 (0.00) [-0.022]	-0.1792 (0.01) [-0.016]	-1.5920 (0.00) [-0.017]	-1.4601 (0.00) [-0.021]
Off-farm female wage	5.1738 (0.03) [0.024]	2.5666 (0.02) [0.025]	2.4071 (0.01) [0.032]	4.0557 (0.06) [0.020]	2.0103 (0.03) [0.022]	2.0439 (0.02) [0.029]
Year specific effect						
Year = 1975	1.1848 (0.05) [0.569]	0.5960 (0.02) [0.599]	0.5351 (0.45) [0.537]	1.0885 (0.05) [0.567]	0.5510 (0.02) [0.581]	0.5433 (0.04) [0.598]
Bivariate associations						
Supply labor			0.2003 (0.13)			0.2453 (0.04)
Hire in labor			-0.6822 (0.00)			-0.6694 (0.00)
Hire in land		-0.1400 (0.51)	-0.1212 (0.62)		-0.1989 (0.34)	-0.1996 (0.20)

NOTE: Figures in parentheses are p-values.
The estimated responses are in square brackets.

[a]These responses are to be multiplied by 10 to obtain estimated responses in percentage points. All others are to be multiplied by 100.

Characteristics of the household head: Age of the household head did not have any statistically significant effect on the propensity to lease out land. Neither did it have the expected sign. Among the other characteristics of the household head the educational dummy for the illiterates was significant at less than 10 percent. This sign was consistently positive confirming the expectation that illiterates are more likely to supply land to the market than the educated farmers. Thus, comparing education versus no education, one finds that education is complementary with own farm land and hence decreases the propensity to supply land to the market. The variability in the data was not sufficient to detect the influence of other educational dummies on the propensity to lease out land.

Potential suppliers of labor: Total number of potential female and male suppliers of labor were specified to test for the presence of potential spillover effects from the female and male labor supply constraints on the land lease decisions, respectively. Potential male suppliers of labor had no statistically significant impact on the decision to lease out land while the significance of potential female suppliers of labor varied from less than 20 percent level in column 3 to 10 in column 6. This indicates the presence of potential spillover effects or binding constraints with respect to the female labor supply but not with respect to the male labor supply. These results are consistent with some of the observed facts in these villages.

Ryan and Ghodake (1979) find that female unemployment rates are much higher than male unemployment rates. The possibility of such binding constraints has been hypothesized in the literature by Bardhan (1979a) as suggested by the following quote: ". . . we may also note that the wage rate even though it is sensitive to demand pressures does not adjust sufficiently to fully clear the labor market . . ." Given that most unemployment is involuntary, these results suggest that the females are more likely to face constraints on their labor supply than the males. The overall response due to changes in potential labor supply entrants on the probability of leasing out land was, however, very small. A unit increase in one potential female supplier of labor supply market increased the probability of leasing out land by only 0.03 percent. This was 10 times higher than that with respect to a unit increase in one potential male supplier of labor.

Potential own farm workers: The signs on these coefficients were negative as hypothesized. Both these coefficients, however, had very high standard errors and consequently had low statistical significance. These results, therefore, do not provide any evidence on the hypothesis that households face 'supervision constraint' or an inelastic labor supply to the farm in these villages .

Farm Characteristics: Total number of dairy animals and its square were as hypothesized and both the coefficients were statistically significant at less than 1 percent level (column 3). An increase in dairy animals decreased and then increased the propensity to lease out land. The minimum occurred at 28 animals on the farm. The statistically significant U-effect supports the hypothesis that the absence of the fodder market in these villages increases the marginal value of farm land, while risks associated with specialization tends to decrease it.

Number of oxen on the other hand, was not an important determiminant of the decision to lease out land. Thus, the result indicates that the decision to lease out land is not an adjustment to inelastic supply of farm power or 'imperfect' bullock market in these villages. To determine whether total dairy animals and the number of oxen were collinear, each was introduced separately but this did not change the results.

An increase in the value of irrigation equipment increased the probability of leasing out land, while an increase in the value of non-irrigation equipment decreased the probability of leasing out land. However, only the latter effect was significant at less than 1 percent. These results did not change when each of these variables were introduced separately.

The statistically significant negative impact with respect to the non-irrigation farm equipment reflects the absence of adequate rental market for farm equipment in these villages and that the decision to lease out land is a response to more efficient utilization of farm equipment. An increase of 1000 rupees worth of farm equipment decreased the probability of leasing out land by 10 percent.

Other farm assets, namely increase in area owned as well as increase in irrigable area owned increased the probability of leasing out land. Similar results are also reported by Bardhan (1979b) using district level data for India.

A unit increase in area owned by the household increased the probability of leasing out land by nearly four times than a unit increase in irrigable area. The positive impact of a change in land ownership on households propensity to supply land indicates that land reforms such as ceiling on acres owned would tend to decrease the extent of land under tenancy and hence lead to possible misallocation of resources under the existing market structure at least in the short run.

In the long run, households would adjust to this constraint by selling assets that are complementary with own farm land such as farm equipment as well as specializing in other time intensive operations

such as dairy farming to substitute time away from farming, i.e., to increase the marginal value of time spent in farming. Thus, in the long run, such adjustments would tend to eliminate these inefficiencies. However, the long run effect of such ceilings may result in more equal distribution of income which may be one reason why land ceilings have been and are quite popular with underdeveloped nations.

An increase in distance from own plots to one's residence decreased the probability of leasing out land. The sign was also consistently negative irrespective of the specification. Thus, it seems that households are more reluctant to lease out distant plots than plots closer to home. This result may be due to the fear of losing land to the tenant under the current tenancy laws or to avoid possible misuse of the land by the tenant. In other words, the cost of supervising tenants seems to override the cost of commuting.

An increase in average value of land increased the probability of supplying land to the market. The positive sign is consistent with Cheung's hypothesis (Cheung, 1969) that higher valued land is more likely to be leased out than lower valued land (see Bell, 1977), and is quite contrary to the notion in the literature that households would prefer to self farm more productive land and lease out less productive land. The estimated response was, however, quite small. A thousand ruppees increase in the value of land increased the probability of leasing out land by two and one half percent.

Rental Rates: Changes in rental rate on own farm land did not have a statistically significant impact on the probability of leasing out land. Changes in rental rate on hired land, on the other hand, was negative and statistically significant at less than 5 percent supporting the hypothesis that own land and hired land are substitutes in production.

Thus, an increase in hired rental rate increases the opportunity cost of own farm land and hence decreases the propensity to supply own land to the market. The impact on the probability of participation was however, very small. At the mean level, an increase of 100 rupees in the rental rate on hired land decreased the probability of supplying land by only 0.1 percent. To determine whether these rental rates were correlated with land values, separate estimations were done excluding land values. There was no change in the results.

The decision to lease out land was highly responsive to changes in male and female wage rates and the coefficients were also statistically significant at less than 5 percent level. Further, the estimated response on the probability of leasing out land was different with respect to changes in female wages than to changes in male wages. A one ruppee increase in male wage rate decreased the probability of supplying land by nearly 2 percent while an identical increase in female wage rate increased it by 3 percent. The differential nature of the results are consistent with the observations made by Ryan and Ghodake (1979). These authors document that of the

total labor hired on the farm or of the total labor utilized more than 50 percent consists of female labor. Hence, increase in female wage rates are more likely to have positive influence on the decision to supply land than changes in the male wage rates.

Decision to Hire in Land

The estimated parameters with respect to this decision are presented in Table 16. This discussion unless otherwise mentioned also corresponds to column 3; i.e., the four decision simultaneous model.

Characteristics of the household head: The coefficients on age and its square were as hypothesized. Younger male heads of household were more likely to lease in land while older male heads of household were less likely to lease in land. This tendency decreased beyond 49 years. However, both the coefficients had high standard errors with low level of statistical significance.

The coefficient on farm experience, that on permanent servant and on domestic servant were all positive. Though the level of significance with respect to these coefficients was much higher in column 6 than in column 3 there was very little difference in the estimated coefficients across the two specifications. Among the three indicator variables, domestic servants had a higher probability of leasing in land followed by permanent servants. The probability of

Table 16. Maximum likelihood estimates and marginal responses: Decision to hire-in land

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Intercept	-2.7738 (0.31)	-1.4425 (0.19)	-1.7101 (0.10)	-0.8748 (0.56)	-0.5784 (0.44)	-0.8098 (0.32)
Characteristics of the household head						
Age	0.0853 (0.42) [0.650][a]	0.0420 (0.37) [0.665][a]	0.0390 (0.45) [0.623][a]			
Age^2	-0.0010 (0.38) [-0.008][a]	-0.0005 (0.33) [-0.008][a]	-0.0004 (0.44) [-0.008][a]			
Farm experience	1.7544 (0.20) [0.072]	0.8599 (0.17) [0.075]	0.8571 (0.29) [0.080]	1.7423 (0.19) [0.0074]	0.8595 (0.18) [0.0077]	0.8912 (0.19) [0.080]
Permanent servant experience	1.0730 (0.15) [0.120]	0.5254 (0.14) [0.121]	0.6235 (0.30) [0.124]	0.9677 (0.19) [0.106]	0.4722 (0.18) [0.108]	0.5793 (0.14) [0.114]
Domestic servant experience	4.2897 (0.00) [0.763]	2.2347 (0.00) [0.762]	2.1344 (0.00) [0.772]	4.3525 (0.00) [0.774]	2.1471 (0.00) [0.772]	2.2031 (0.00) [0.787]
Illiterates	0.6080 (0.23) [0.047]	0.3047 (0.22) [0.049]	0.2918 (0.57) [0.048]	0.4355 (0.27) [0.034]	0.2175 (0.24) [0.036]	0.2019 (0.32) [0.034]
Primary education	0.3508 (0.48) [0.029]	0.1703 (0.49) [0.030]	0.1414 (0.79) [0.033]			
Second highest caste	-0.7415 (0.16) [-0.048]	-0.3672 (0.14) [-0.050]	-0.3854 (0.54) [-0.050]	-0.5928 (0.25) [-0.041]	-0.2888 (0.23) [-0.048]	-0.2809 (0.37) [-0.042]
Third highest caste	-0.1656 (0.73) [-0.012]	-0.0872 (0.70) [-0.013]	-0.1273 (0.76) [-0.015]	-0.3718 (0.94) [-0.003]	-0.0204 (0.93) [-0.003]	-0.0260 (0.93) [-0.004]
Lowest caste	-1.7254 (0.05) [-0.083]	-0.8560 (0.05) [-0.086]	-0.8726 (0.27) [-0.090]	-1.6024 (0.08) [-0.081]	-0.7863 (0.07) [-0.085]	-0.7778 (0.31) [-0.085]

Table 16. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Potential suppliers of labor						
Females	-0.4119 (0.05) [-0.031]	-0.1964 (0.04) [-0.031]	-0.1942 (0.10) [-0.032]	-0.3383 (0.03) [-0.026]	-0.1615 (0.02) [-0.027]	-0.1595 (0.02) [-0.026]
Males	-0.2527 (0.37) [-0.019]	-0.1271 (0.34) [-0.020]	-0.1168 (0.63) [-0.019]			
Potential farm workers						
Females	0.1598 (0.56) [0.012]	0.0727 (0.56) [0.012]	0.0743 (0.61) [0.011]			
Males	0.4354 (0.17) [0.033]	0.2149 (0.16) [0.034]	0.2012 (0.45) [0.033]	0.2185 (0.20) [0.017]	0.1064 (0.17) [0.018]	0.1040 (0.18) [0.017]
Farm characteristics						
Dairy animals	0.1331 (0.15) [0.010]	0.1626 (0.14) [0.010]	0.0789 (0.07) [0.013]	0.1262 (0.16) [0.010	0.0572 (0.17) [0.010]	0.0699 (0.07) [0.012]
Dairy animals^2	-0.0054 (0.09) [-0.041]^a	-0.0026 (0.07) [-0.041]^a	-0.0030 (0.00) [-0.050]^a	-0.0052 (0.10) [-0.040]^a	-0.0024 (0.11) [-0.040]^a	-0.0027 (0.03) [-0.045]^a
Oxen	0.8578 (0.00) [0.065]	0.4235 (0.00) [0.067]	0.4344 (0.00) [0.072]	0.8302 (0.00) [0.065]	0.4098 (0.00) [0.067]	0.4211 (0.00) [0.070]
Irrigation equipment	-0.0001 (0.50) [-0.001]^a	-0.7×10^{-4} (0.44) [-0.001]^a	-0.0001 (0.43) [-0.001]^a			
Non irrigation equipment	0.0025 (0.02) [0.019]^a	0.0012 (0.02) [0.019]^a	0.0012 (0.02) [0.021]^a	0.0024 (0.02) [0.019]^a	0.0012 (0.02) [0.020]^a	0.0012 (0.01) [0.021]^a
Area owned	-0.1131 (0.00) [-0.009]	-0.0557 (0.00) [-0.009]	-0.0534 (0.00) [-0.010]	-0.1158 (0.00) [-0.009]	-0.0566 (0.00) [-0.009]	-0.0542 (0.00) [-0.010]
Irrigable area owned	-0.1983 (0.12) [-0.015]	-0.0985 (0.08) [-0.016]	-0.0920 (0.10) [-0.019]	-0.2494 (0.02) [-0.020]	-0.1241 (0.01) [-0.020]	-0.1195 (0.00) [-0.023]

Table 16. (Continued)

Explanatory Variables	MODEL I (a)	MODEL II (a)	MODEL III (a)	MODEL I (b)	MODEL II (b)	MODEL III (b)
Average value of own land	-0.0698 (0.00) [-0.005]	-0.0345 (0.00) [-0.006]	-0.0324 (0.01) [-0.006]	-0.0707 (0.00) [-0.006]	-0.0347 (0.00) [-0.006]	-0.0327 (0.00) [-0.006]
Rental rates						
Own land	0.0011 (0.72) [0.008][a]	0.0006 (0.66) [0.009][a]	0.0004 (0.82) [0.014][a]	0.0019 (0.53) [0.015][a]	0.0010 (0.46) [0017][a]	0.0007 (0.59) [0.021][a]
Hired land	-0.0024 (0.02) [-0.018][a]	-0.0012 (0.01) [-0.019][a]	-0.0011 (0.06) [-0.021][a]	-0.0026 (0.01) [-0.020][a]	-0.0013 (0.00) [-0.022][a]	-0.0012 (0.01) [-0.023][a]
Off-farm male wage	1.0677 (0.34) [0.081]	0.4782 (0.37) [0.076]	0.4892 (0.34) [0.027]	1.0823 (0.33) [0.084]	0.4669 (0.38) [0.078]	0.4619 (0.36) [0.076]
Off-farm female wage	-3.1612 (0.11) [-0.241]	-1.5092 (0.11) [-0.240]	-1.4928 (0.09) [-0.600]	-3.3314 (0.09) [-0.260]	-1.5707 (0.10) [-0.259	-1.5542 (0.07) [-0.262]
Year specific effect						
Year = 1976	0.4128 (0.23) [0.032]	0.2154 (0.21) [0.034]	0.2555 (0.32) [0.024]	0.4240 (0.22) [0.033]	0.2247 (0.15) [0.037]	0.2606 (0.12) [0.030]
Bivariate associations						
Supply labor			0.1749 (0.28)			0.1562 (0.07)
Hire-in labor			0.0892 (0.66)			0.0471 (0.69)
Hire-out land		-0.1400 (0.51)	-0.1212 (0.62)		-0.1989 (0.34)	-0.1996 (0.20)

NOTE: Figures in parentheses are p-values
The estimated responses are in square brackets.

[a]These responses are to be multiplied by 10 to obtain estimated responses in percentage points. All others are to be multiplied by 100.

leasing in land increased by 77 percent for domestic servants, 12 percent for permanent servants and only 8 percent for farm experience indicator.

As discussed in the theoretical model, farming and other experience such as a permanent or as a domestic servant, as a fixed or non-tradeable factor in one's farm production, raises the shadow price of hired land and hence increases the probability of leasing in land. This result tends to support the hypothesis that such experience and hired land are complementary inputs in farm production. It is also consistent with the hypothesis in the tenancy literature that landlords prefer tenants with some managerial skills (Bell, 1977 and Bell and Zusman, 1976).

Education was hypothesized to increase the probability of leasing in land. But the estimated results did not support the maintained hypothesis. In this sample, illiterates were more likely to lease in land as compared to the literates. But none of the dummies were statistically significant even at 20 percent level.

The caste indicators also did not display the expected signs. In both the specifications for MODEL I and MODEL II, the coefficients on the lowest caste indicator were statistically significant but not in MODEL III. Assuming that MODEL III is the correct model, these results do not support the hypothesis on caste discrimination or controlling for other endowments caste seems to play a minor role in the households ability to lease in land in these villages.

Potential suppliers of labor: An increase in potential suppliers of labor, male or female, increased the propensity to lease in land. However, only the coefficient on potential female suppliers of labor was statistically significant at 10 percent. This result provides additional support to the presence of potentially binding constraints on female labor supply and, consequently, evidence of spillover effect on the land lease decisions from such constraints. Recall that similar results were also found with respect to the decision to supply own land.

Potential own farm workers: The total number of own farm workers did not have any statistically signficiant influence on the decision to lease in land especially the availability of females in the household. There was, however, some indication that the changes in potential own male workers influences the decision to lease in land (see column 6).

Why this result is different than that observed with respect to the decision to lease out land is not clear. This may be indicative of the fact that only males are observed leasing in land rather than the presence of any 'supervision constraint.' For example, female heads of household are not able to or are not observed leasing in any land. Also, most female heads of household in absence of any male member in the house are observed to be leasing out land rather than cultivating it on their own. Since self cultivation involves many tasks such as plowing, which is rarely performed by females due to social customs, female heads of household do not lease in land.

Farm Characteristics: Total number of dairy animals on the farm increased and then decreased the probability of leasing in land. Both these coefficients had low standard errors and were statistically significant at less than 10 percent level.

Households with less than 13 dairy animals on the farm were more likely to lease in land while those with greater than 13 were less likely to lease in land, a result that reflects the time intensive nature of dairy farming. Overall, a unit increase in dairy animals on the farm increased the probability of leasing in land by 0.7 percent.

Total number of oxen also increased the probability of leasing in land as hypothesized. The statistically significant positive sign supports the hypothesis that oxen and hired land are complementary inputs in farm production and that the decision to lease in land is a response to more efficient utilization of this resource. This result is consistent with that found by Bell (1977) and Bliss and Stern (1982) in the state of Bihar and also as documented by Jodha (1979) for these villages. The estimated response due to a unit change in the number of oxen on the probability of leasing in land was 7 percent.

Comparing this result with that obtained under the decision to supply land indicates that the demanders of land are adjusting to an inelastic supply of farm power in these villages which is fixed in

the short run.[11] The importance of this factor for the decision to lease in land and not for the decision to lease out land also supports the hypothesis that the demanders of land are adjusting to a different set of constraints than suppliers of land.

Non-irrigation farm equipment increased the probability of leasing in land. Hence, non-irrigation farm equipment and hired land are complementary inputs in farm production. The ownership of farm equipment coupled with the absence or rental market for farm equipment therefore lowers the shadow price of hired land and increases the propensity to lease in land. An increase of Rs. 1000 in the value of non-irrigation equipment increased the probability of leasing in land by 21 percent.

The coefficient on area owned was negative and statistically significant at less than 1 percent level. However, a unit increase in owned area decreased the probability of leasing in land by only 0.9 percent. Such a small response to a change in this variable

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[11] A word of caution is in order here. The implied assumption throughout the discussion is that the resource endowments are exogenous to this short run behavior. In the long run, the choice of resources owned and these decisions are endogenous. So in such a context, the ownership of oxen and the choice to lease in land are simultaneous or the causality may in fact run in the other direction, i.e., the number of oxen owned may be determined by individuals preference to lease in land or to be a tenant. This is not investigated in this research.

indicates that the decision to lease in land is less likely to be an adjustment towards an optimal operational size of the farm but more likely to be a response to fuller utilization of the other non-tradeable farm resources.

The amount of irrigable area owned by the household decreased the propensity to lease in land. This result is consistent with that obtained by Bardhan (1979a) using interstate cross sectional data for India. The negative sign reflects the fact that households owning irrigable area are more likely to farm their own land more intensively and hence less likely to lease in land. The intensity effect of irrigation dominating over the complementarity effect of irrigation with hired land.

Households with higher valued land are also more likely to farm their land more intensively than others and hence decrease the propensity to lease in land. Although, statistically, this variable was an important determinant of the decision to lease in land, the estimated response on the probability of leasing in land was only 0.6 percent.

Rental Rates: The coefficient on LRENTS and LRENTD was positive and negative, respectively. The negative sign with respect to LRENTD was as expected as is the rental rate on hired land and by maximization principle was predicted to be negative. Further, an increase of Rs. 100 in payments on hired land decreased the probability of leasing in land by 2 percent.

The response due to a change in the male or in the female wage rate on the probability of leasing in land was much higher than that due to a change in the rental rate on land. For example, a one ruppee increase in female wage decreased the probability of leasing in land by 60 percent. This response was nearly 10 times higher than an identical increase in the male wage. Such large responses to changes in characteristics of the female labor market relative to male wage labor market again reflects the relative importance of female labor in agricultural production as discussed earlier. The statistically significant negative sign on the female wage rate supports the hypothesis that hired female labor and hired land are complements while the positive sign with respect to the male labor indicates tendencies of substituability between male labor and hired land.

The next section discusses a set of likelihood ratio tests for selected hypotheses. These are all undertaken using Model III.

5.4 Likelihood Ratio Tests for Selected Hypotheses

The results of the likelihood ratio tests for selected hypotheses are presented in Table 17. Columns 1 and 2 contain restricted and unrestricted values of the negative of the log of likelihood function, respectively. Column 3 shows the number of parameters restricted from the main effects. If the hypothesis

Table 17. Likelihood ratio tests for selected hypotheses (MODEL IIIa)

	Negative of the log of the likelihood function		Number of parameters restricted (d-f)	Chi-square values
	Restricted	Unrestricted		
1. All parameters are zero	973.2	369.9	106	1206.6**
2. No constraints in labor market	380.0	369.9	8	20.2* (15.5)
3. No constraints on labor supply	373.7	369.9	4	7.6 (9.5)
4. No constraints on hired labor	371.2	369.9	4	2.6 (9.5)
5. No constraints in female labor market	373.81	369.9	4	7.8 (9.5)
6. No constraints in male labor market	371.46	369.9	4	3.2 (9.5)
7. Nontradeables have no influence on land lease decisions	416.72	369.9	12	93.6**
8. All caste parameters are zero	375.72	369.9	9	11.6 (16.9)
9. All education parameters are zero	374.11	369.9	8	8.4 (15.5)
10. All parameters except intercepts and rental rates are zero	611.7	369.9	85	483.6**
11. All parameters except fixed factors are zero	510.2	369.9	77	280.6**

NOTE: Figures in parentheses are Chi-square values at five percent level of significance.
*: significant at five percent level.
**: significant at one percent level.

pertains to the land market then the parameters restricted to zero are from the land market choices only. If the hypothesis is general, i.e., with respect to the entire system as a whole then the values of parameters for all the effects are set to zero. Finally, the last column presents the computed chi-square values and in parenthesis the table values at 5 percent level of significance.

The hypothesis testing was done with reference to MODEL III(a). The negative of the log of the likelihood function at the maximum for the fully specified model was 369.9. Assuming that this is the true model, the other hypotheses were set up as nested hypotheses in this model. Hence, a chi-square test was employed.

To test for the presence of potentially binding constraints in the labor market as a whole or absence of any spillover effects from the labor market on the land market, the coefficients on the potential suppliers of labor (male and female) and the potential own farm workers (male and female) in the land market were restricted to zero. The resultant chi-square was 20.2 and statistically significant at less than 5 percent level indicating that the presence of constraints in the labor market as a whole has significant spillover effects on the land lease decisions in these villages. Chi-square tests were also conducted separately to test for presence of potentially binding constraints on labor supply and in the hired labor market. But, none of these separate tests were statistically significant at 5 percent level.

The results by sex rejected the hypothesis of any spillover effects or the presence of constraints from the male labor market. The Chi-square value with respect to the female labor market was greater than that with respect to the male labor market. These results suggest that the land lease decisions respond to the availability of female labor more than the male labor. Alternatively, these results imply that females are less likely to be able to supply the desired amount of labor in the market as compared to the males.

To test whether participation in the land market is a response to the absence of a market for managerial talent and other farm fixed factors or nontradeables, the parameters in the land market decisions with respect to the experience dummies, farm equipment, i.e., irrigation and nonirrigation equipment and with respect to the number of oxen owned were set to zero. The Chi-square value with respect to this hypothesis was 93.6 and statistically significant at less than 1 percent. This result provides support to the hypothesis that tenancy is an adjustment to more efficient utilization of these resources by the households. This test is much more general and rigorous than that undertaken by Jodha (1979).

The hypotheses that caste or education has any significant effect on these decisions after controlling for the other determinants of these decisions was rejected. The Chi-square values were 11.6 and 8.4., respectively. None were statistically significant even at 20 percent level.

Two other hypotheses, namely: (1) that all the other determinants except the rental rates are zero, and (2) that all the other parameters except farm fixed factors with respect to all the decisions were zero are rejected at less than 1 percent level.

From the test of these hypotheses one can conclude that: (1) the females in these villages are unable to supply the desired amount of the labor to the market and that the land lease decisions respond to these constraints; (2) the households do not face the 'supervision constraint' as hypothesized in the tenancy literature; (3) tenancy is a response to the nontradeables or farm fixed factors owned by the households, namely farm experience, number of oxen and farm equipment; and (4) controlling for the household resource endowments, caste and education do not have any statistically significant influence on these decisions.

The next section provides the estimated responses by landholding classes. These responses on the marginal propensity to participate in the market were estimated at the mean values of explanatory variables for each landholding class.

5.5 Responses by Landholding Class

The estimated responses by landholding class is discussed here. The average size of landholding for the small class was 2.45 acres while that for the medium class was 9.4 acres. The mean for the large landholding class was 29.2 acres. This discussion is presented

separately for the labor market and for the land market choices. Only important differences across landholding classes are highlighted.

5.5.1 Labor market: Table 18 contains the estimated responses for the labor market decisions. The first three columns pertain to the decision to hire out labor while the last three are for the decision to hire labor on the farm. The first column corresponds to the small landholding class followed by the medium and the large landholding class.

Comparing the estimated responses by land holding class for the decision to supply labor, the overall response to changes in its determinants is much larger in absolute sense for the heads of households in the medium class than in the other classes. The lowest response is observed for the large owners. For example, male heads of household with farm experience had a 12 percent probability of supplying labor in comparison to those without farm experience. This response was three times that of the small households and nearly six times to that of the large households. (Compare columns 1, 2 and 3.)

Male heads of household in the medium class with labor market experience had also a higher probability of participation of 46 percent in relation to those without any labor market experience. The same in the small and large classes was 26 percent and 20 percent, respectively. The relative responses across medium and

Table 18. Estimated responses on the participation decisions in the labor market by landholding classes MODEL III(a) (expressed as percentage change in the probability of participation)

Explanatory Variables	Hire out labor			Hire in labor		
	S	M	L	S	M	L
Characteristics of the household head						
Age	-0.26	-0.34	-0.06	0.89	0.27	0.00
Farm experience	3.95	11.61	1.67	28.69	11.16	0.11
Permanent servant experience	-18.87	-26.41	-2.83			
Labor market experience	25.85	46.23	19.92	7.98	1.85	0.01
Domestic servant experience	5.80	15.40	3.87			
Trading experience	-33.58	-39.47	-3.83			
Other occupational experience	7.86	17.29	4.61			
Illiterates	0.35	0.58	0.01	-6.69	-1.75	-0.02
Primary education	5.58	11.95	2.28	-4.76	-1.57	-0.01
Second highest caste	4.30	8.86	1.86	5.97	1.56	0.01
Third highest caste	2.93	7.04	1.44	12.38	3.08	0.02
Lowest caste	2.65	4.78	1.10	4.02	0.97	0.01
Potential own farm workers						
Females	-1.00	-1.70	-0.29	0.45	0.07	-0.00
Males	0.54	1.09	0.18	-0.31	-0.16	-0.00
Farm characteristics						
Number of farm animals	-4.42	-8.93	-1.49			

Table 18. (Continued)

Explanatory Variables	Hire out labor			Hire in labor		
	S	M	L	S	M	L
Square of farm animals	-.09	0.18	0.03			
Value of non-irrigation equipment in Rs 1000	-8.00	3.00	1.00	124.00	31.00	1.00
Area owned in acres	-0.89	-1.91	-0.30	0.86	0.32	0.00
Irrigable area owned in acres	-3.57	-7.07	-1.13	4.33	1.33	0.01
Average value of own land in Rs 100	-0.64	-1.36	-0.22	0.33	0.12	0.01
Rental rates						
Rent received on own land[a]	0.57	1.21	0.20	0.50	0.14	0.00
Rent paid on hired land[a]	-0.25	-0.55	-0.09	-0.11	-0.04	-0.00
Average male and female wage				9.17	2.62	0.02
Male wage only	-10.45	-18.49	-3.11			
Female wage only	8.64	11.58	2.12			

[a]These percentages are multiplied by 10.

S: Small landholding size, 0 ≤ area owned in acres ≤ 5.

M: Medium landholding size, 5 ≤ area owned in acres ≤ 15.

L: Large landholding size, area owned in acres > 15.

small classes with respect to trading experince was, however, very similar. Traders had a lower probability of participation by 40 percent in the medium class and 34 percent in the small class. It was only 4.0 percent for the large class. Such relative patterns are also observed with respect to the other determinants across the landholding classes. This nature of results suggest that the male heads of household from the medium class are most likely to seek adjustments to changing resource position through participation in the labor supply market than the other two classes.

The responses with respect to the decision to hire in labor on the farm displayed a different pattern. Here the small landholding class households had higher absolute changes in probability of hiring in labor followed by the medium and large landholding class.

The predicted probability of hiring in labor on small farms was 88 percent while this was 100 percent on large farms. Since, the demand for hired labor on large farms is likely to be more stable than the other two classes, the large land holding households are less likely to move in and out of the market due to changes in the determinants than the small and medium landholding households. The demand for hired labor on the small farm, however, is more unstable and hence small farmers are more likely to respond to the changing resource patterns.

The probability of hiring in labor for the small landholding class with farm experience was 29 percent more than those with no farm experience in the same class. The corresponding difference for

the medium and large owners was only 11 and 0.1 percent, respectively. Similarly, those with labor market experience in the small class had a higher probability of hiring in labor by 8 percent while in the medium class it was only 2 percent.

The response to an increase in one unit of irrigable area increased the probability of hiring in labor on the small farm by only 4 percent and around one percent on the medium farm. The estimated responses do not provide support to the existing view in the literature that irrigation increases the demand for hired labor on the small farm. However, given the low demand and supply elasticities for labor, such small shifts in the demand and supply of labor will exert considerable upward pressures on wages (see Evenson and Binswanger, 1979 and Rosenweig, 1980).

5.5.2 Land market:

The estimated responses by landholding class on the probability of leasing out land and on the probability of leasing in land are presented in Table 19. The first three columns correspond to the decision to lease out land and the next three columns to the decision to lease in land. The responses with respect to the small landholding class are in column 1, followed by the medium and the large landholding classes.

The pattern of observed responses with respect to the decision to lease out land among the three landholding classes revealed that the small farmers are the most active participants as suppliers of

Table 19. Estimated responses on the participation decisions in the land market by landholding classes MODEL III (a) (expressed as percentage change in probability of participation)

Explanatory Variables	Lease out land			Lease in land		
	S	M	L	S	M	L
Characteristics of the household head						
Age	-0.08	-0.01	0.00	0.44	0.98	0.51
Farm experience	-5.66	-1.08	-0.03	5.65	12.77	5.89
Permanent servant experience	-3.29	-0.67	-0.12	9.21	18.32	13.22
Domestic servant experience	-2.97	-0.71	-0.13	71.63	79.10	75.95
Illiterates	3.98	1.02	0.25	2.84	7.38	4.44
Primary education	0.67	0.13	-0.00	1.76	4.96	2.13
Potential labor suppliers						
Females	1.80	0.44	0.08	-2.19	-5.07	-2.57
Males	0.07	0.02	0.00	-1.29	-3.04	-1.55
Potential own farm workers						
Females	-1.01	-0.26	-0.05	0.81	1.78	0.96
Males	-0.98	-0.26	-0.05	2.23	5.24	2.66
Farm characteristics						
Number of dairy animals	-1.59	-0.39	-0.07	0.91	2.07	1.05
Square of dairy animals	0.03	0.01	0.00	-0.03	-0.08	-0.04
Number of oxen	-0.96	-0.25	-0.04	4.81	11.31	5.75
Value of non irrigation farm equipment in Rs 1000	-70.00	-15.00	-3.00	0.02	0.03	0.02
Area owned in acres	0.54	0.15	0.03	-0.61	-1.53	-0.73

Table 19. (Continued)

Explanatory Variables	Lease out land			Lease in land		
	S	M	L	S	M	L
Irrigable area owned in acres	-0.24	-0.00	0.02	-1.04	-2.90	-1.28
Distance to owned plots in miles	-1.95	-0.47	-0.09			
Average value of land in Rs 100	0.13	0.04	0.01	-0.37	-0.94	-0.44
Rental rates						
Rent received on own land[a]	0.04	0.02	0.01	0.07	0.21	0.07
Rent paid on hired land[a]	-0.06	-0.02	-0.00	-0.13	-0.32	-0.15
Male wage	-10.23	-2.54	-0.47	5.36	11.17	6.28
Female wage	15.12	3.75	0.70	-16.58	-37.58	-19.60
Predicted probability of participation						
	3.0	1.0	0.0	5.0	14.0	8.0

[a]These percentages are multiplied by 10.

S: Small landholding size, $0 \leq$ area owned in acres ≤ 5.

M: Medium landholding size, $5 \leq$ area owned in acres ≤ 15.

L: Large landholding size, area owned in acres > 15.

land. Although an increase in area owned for the sample as a whole increased the probability of leasing out land (see the discussion in the earlier section), the estimated probability of leasing out land decreased by land holding class. This probability was 0.03 for the small class, 0.01 for the medium and almost zero for the large owners of land. Thus, it is the small owners of land who shift in and out of the supply side of the land market as a response to changing socio-economic conditions than the other classes. Hence, the relative magnitude of the impact due to changes in the determinants is much higher for the small class than the other two classes. The medium and large owners of land own more resources that are complementary with farm land and hence are less likely to exit and enter the market as suppliers of land. Instead, they are more likely to be active as demanders of land.

Farm experience decreased the probability of leasing out land by nearly 6 percent in the small class , while it decreased it by only one percent in the medium class. Experience as a domestic or as a permanent servant decreased the probability of leasing out land by 3 percent in the small class and only 0.01 percent for the medium.

An increase in one potential female supplier of labor in the household increased the probability of leasing out land by 2 percent for the small class. Again, the corresponding response for the other classes was almost negligible. Since it is mostly the females from the small class of households that participate actively in the labor market, they are more likely to face potentially binding constraints in the labor market than the females from the other two classes.

The estimated responses with respect to potential own farm workers provides no evidence of the 'supervision constraint' for the large owners of land. Instead, these responses indicate that the small owners of land may be facing the inelastic supply of family labor to the farm.

An increase in Rs. 1000 worth of farm equipment in the small class decreased the probability of leasing out land by 70 percent. This response was nearly five times more than that observed for the medium class and 23 times more than that observed for the large class. The relative magnitude of these impacts across the three classes suggest that the small farmers lease out land as an adjustment to inadequate rental market for farm equipment. Thus, efforts to subsidize farm equipment to the small farmers may well be worth considering on economic grounds.

A unit increase in area owned increased the probability of leasing out land by only 0.5 percent for the small class and had practically no impact on the other two classes.

The estimated responses with respect to irrigable area differed in direction across landholding classes. At the sample mean, i.e., in Table 19, an increase in irrigable area increased the probability of leasing out land. Across the landholding classes, a unit increase in irrigable area owned decreased the probability of leasing out own land in the small and medium classes but increased the probability of leasing out land with respect to the large class. Although the estimated responses were small, the nature of the results indicates

that small and medium farmers are more likely to farm any additional increase in irrigable area than the large class. In other words, across these two classes, irrigation displays the expected complementarity effect with own farm land. But, for the large farmers, the effect of potential binding constraints with respect to other farm resources overrides the underlying complementarity effect.

An increase in male and female off-farm wages also had a very high response in the small class as compared to the other classes. These predicted responses were consistent in sign across the three landholding classes.

A unit increase in the average village male wage decreased the probability of leasing out land by 10 percent for the small class, 3 percent for the medium and only 0.5 percent for the large owners. Similar relative ratios to changes in probability, though in the oppposite direction, were also observed for a unit change in the average village female wage.

The relatively greater response in the small class in relation to the other classes as noted before indicates that the small owners of land enter and exit from the market more frequently than the other two classes as a means to efficiently allocate their scarce resources. Hence, a ban on tenancy is most likely to adversely affect the welfare of the small landholding class.

Take a look at the next three columns. The pattern of responses with respect to the decision to lease in land across the landholding classes indicates that most of the leasing in of land is undertaken by the medium owners of land. The predicted probability of leasing in land by the three classes was 0.05, 0.14 and 0.08 for the small, medium and large classes, respectively.

The estimated responses were greatest with respect to the medium class and almost identical between the small and large classes. These relative magnitudes of responses reveals that it is the medium class that is most likely to seek adjustments on the demand side of the land lease market. Thus, for the large class, the area owned is more or less equal to the optimal operational holding while this is not so in the case of small and medium classes.

Contrary to the existing tenancy models, the landlords are therefore small owners while the tenants are mostly the medium owners of land. This result has also been documented by Jodha (1979). The transaction therefore is not from the large owners to the small owners, but from the small owners of land to the medium owners of land. This is quite contrary to the models formulated by Braverman and Srinivasan (1979) that assume a dominant landlord and a weak tenant.

The pattern of signs on the estimated responses due to changes in the determinants of this choice across landholding classes were identical to the estimated responses at the sample mean level. In other words, there was no sign reversal across farm size. However, the estimated responses for the medium class were twice to those estimated for the small and large class (see Table 19).

5.6 Simulation

This section discusses the simulation results for some potentially interesting set of policies on the participation decisions. Although the estimated model may be used for analyzing the impact of changes in several exogeneous variables on the participation rates, this section provides only a flavor of the type of analyses that may be undertaken.

Some of the specific set of policies considered are the following: (1) a redistribution of land at the village mean, (2) a 100 percent increase in the value of non-irrigation equipment for small farmers only, (3) an addition of four oxen to the existing stock, (4) a 100 percent increase in the number of oxen owned, and (5) an addition of five dairy animals to the existing stock.

Very large increases were considered because individual response to entry and exit from the market was very small. Even such large increases had very little impact on the existing sorting of the households. Table 20 shows the actual and predicted percentage of male households with respect to each of the decisions by landholding class.

The simulation results show that a land redistribution policy would have very little impact on the percentage supplying labor or on the percentage hiring in labor on the farm. Such a policy would, however, increase the percentage of households supplying land in the small class by nearly nine percent with no change in the medium class. It would also decrease the percentage leasing in land both in

Table 20. Predicted participation rates due to selected policy instruments by landholding class

Factor	Land-holding Class	Actual participation Rate	Predicted Participation Rates				
			Policy Instrument				
			1	2	3	4	5
Hire out labor	S	76.2	77.0	79.4	73.0	79.4	66.7
	M	57.1	55.7	61.4	47.1	57.9	38.6
	L	22.3	25.9	15.3	9.4	10.6	7.1
Hire in labor	S	72.2	80.2	81.0	80.2	75.4	83.3
	M	87.1	92.1	91.4	97.1	91.4	97.9
	L	97.7	100.0	100.0	100.0	100.0	100.0
Lease out land	S	15.1	26.2	10.3	3.2	14.3	0.0
	M	12.1	12.1	6.4	2.1	6.4	0.7
	L	5.9	0.0	5.9	4.7	5.9	3.5
Lease in land	S	12.7	1.7	11.1	61.9	16.7	14.3
	M	23.6	17.1	17.9	79.3	39.3	28.6
	L	17.7	27.1	4.7	76.5	52.9	17.7

Land holding size:

S = small Area owned $\leq$ 5 acres

M = medium 5 < Area owned $\leq$ 15

L = large Area owned > 15

Policy:

(1) Redistribution of land at village mean

(2) A 100 percent increase in EQUIP for small farmers only

(3) An increase of 4 oxen

(4) A 100 percent increase in oxen

(5) An increase of 5 dairy animals on the farm

the small and medium class, but increase it in the large class (see column 2). This result is similar to that observed by Jodha (1979), who argues that land ceilings in general have, in fact, led to an increase in the small households leasing out land and the large households leasing in land.

A 100 percent increase in the value of non-irrigation farm equipment, on the other hand, would decrease the percentage of small and medium owners leasing out land.

Increase in the number of oxen would considerably increase the demand for tenancies for all the three classes. For example, the demand for tenancies would increase from 13 percent to 62 percent in the small class. The percentage leasing out land would decrease in all the classes, the largest relative decrease likely to occur in the small and medium class.

An increase in dairy animals on the farm would decrease the number of participants supplying labor, the maximum reduction coming from the medium class. It would also reduce the proportion leasing out land in the small and medium class, with some increase in percentage of households wanting to lease in land.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND IMPLICATIONS

This research investigated the determinants of the participation decisions in the land and labor markets of rural India using a constrained production consumption model of the farm household.

The broad objectives of this study were as follows: (1) to model simultaneously the land and labor market participation decisions — specifically the choice to supply labor, to hire in labor on the farm, to lease out land and to lease in land; (2) to test empirically the hypothesis that tenancy is a response to nontradeability of farm resources such as farm experience, oxen and farm equipment; (3) to test for the presence of "spillover" effects from the labor market on the land lease decisions; and (4) use the estimated model to simulate the impact of selected policy instruments on the participation behavior in these markets.

The specified economic model was the standard neoclassical farm household production consumption model subject to two types of inequality constraints: (2) lower bounds and (2) upper bounds.

The first order conditions from this model were used to define the corner solutions with respect to the input decisions under investigation. These conditions were then utilized to make

inferences on individual propensity to participate in the market due to changes in the characteristics of the household head, due to changes in household and farm endowments and due to changes in market related constraints.

The economic model was also used to obtain comparative static results to generate hypotheses on the presence of "spillover" effects from potentially binding constraints in the labor market on the land lease decisions. These comparative static results are similar to those of Tobin-Houthaker and in static disequilibrium macro-economic literature. This resemblance is evident from the inverse of the Hessian which contains the spillover submatrices.

A multinomial logit model was estimated for the set of four simultaneous decisions and consisting of 16 choices. The Nerlove and Press (1973) representation of the deterministic component was adopted.

The empirical model specified contained the determinants of the four participation decisions. Besides investigating the determinants of the participation decisions, this research tested: (1) the simultaneity of the land and labor market participation decisions, (2) the hypothesis that tenancy is a response to nontradeability of farm resources such as farm experience and farm equipment, (3) the presence of quantity constraints on labor supply, (4) the presence of quantity constraints in the hired labor market, and (5) the existence of the 'supervision' constraint.

The estimated results are summarized under three subheadings (1) general, (2) labor market and (3) land market.

General:

: The land market and the labor market decisions are simultaneous. This result confirms a basic hypothesis in the study.

: Age of the household head, controlling for the other characteristics, was not an important determinant of these decisions.

: From the estimated responses by landholding classes, one can conclude that the male heads of household from the medium class are most likely to seek adjustments to changing resource position through participation as suppliers of labor than the other two classes. It is the small landholding households that are most likely to enter and exit as hirers of labor. In the land market, the small farmers are the most active participatns as suppliers of land, while it is the medium class that is active as demanders of land. Thus, a ban on tenancy is most likely to have adverse effects on the earnings of these two classes instead of the large landholding class.

Labor Market:

: Labor market experience increased the probability of supplying labor by nearly 30 percent while trading experience decreased the same by 40 percent.

: An increase in the number of dairy animals on the farm increased and then decreased the propensity to supply labor to the market which may reflect the tradeoff between time intensive nature of dairy husbandry and associated risks from specialization.

: Increase in area owned, irrigable owned area and in owned land values, decreased the propensity to supply labor to the market, a unit increase in irrigable area decreased it by three times more than a unit increase in area owned by the household. Similar positive responses were also observed with respect to propensity to hire in labor on the farm.

: There was no evidence that higher caste members have an aversion to working on the farm, controlling for the other characteristics of the household.

: An increase in non-irrigation equipment increased the demand for hired labor reflectiong complementarities between these two inputs.

: On the presence of potentially binding constraints in the labor market, the likelihood ratio test was statistically significant at less than five percent level indicating that the presence of constraints in the labor market has significant spillover effects on the land lease decisions in these villages. Specifically, separate tests by sex indicate potentially binding constraints on female labor supply were more likely than on male labor supply.

: No evidence was detected on the presence of 'supervision' constraint for labor in these villages.

Land Market:

: The demanders of land are adjusting to different constraints than the suppliers of land and, hence, treatment of one of the decisions as inverse of the other is likely to result in biased estimates.

: Farm experience, permanent farm servant and domestic servant experience decreased the propensity to lease out land and increased the propensity to lease in land.

: Educated heads of household were less likely to lease out land as compared to the uneducated heads of household reflecting complementarity between education and own farm land. Contrary to expectation, illiterates were more likely to lease in land.

: The evidence on the presence of caste discrimination in the land lease market was very weak. A likelihood ratio test conducted to test this hypothesis was rejected at 20 percent level of significance.

: Number of oxen owned by the household was not an important determinant of the decision to lease out land but significantly influenced the decision to lease in land. This result indicates that the decision to lease in land and not the decision to lease out land is an adjustment to inelastic supply of farm power.

: Increase in number of dairy animals on the farm increased the opportunity cost of own farm land and decreased the opportunity cost of hired land. These results were statistically significant at less

than one percent level supporting the hypothesis that the presence of high transaction costs in the fodder market exerts considerable pressure on the land lease decisions.

: Most suppliers of land are small owners of land while most demanders of land are medium owners of land. The unequal distribution of farm equipment among these two classes seems to be an important determinant of the land allocation decisions. The estimated results suggest that inadequate rental markets for farm equipment reduces the marginal product of own farm land, especially for the small owners of land, while it raises the marginal product of hired land for the medium class. An increase in a thousand ruppees worth of farm equipment for the sample as a whole, decreased the probability of leasing out land by 10 percent and increased the probability of leasing in land by 21 percent.

: Land ownership was positively related to the decision to lease out land while it was negatively related to the decision to lease in land. Simulation results showed that a land redistribution policy without intervention in the other factor markets would increase the proportion of households supplying land in the small class by nearly nine percent. It would also decrease the portion leasing in land both in the small and medium class but increase it in the large class.

: Increase in irrigable area owned by the household increased the propensity to lease out land and decreased the propensity to lease in land. Since irrigable area is farmed intensively, this

result indicates that the intensity effect dominates the complementarity effect. The estimated responses with respect to irrigable area differed in direction across landholding classes. For example, a unit increase in irrigable area owned decreased the probability of leasing out own land in the small and medium classes but increased the probability of leasing out land with respect to the large class. Thus, across the two classes irrigation displayed the expected complementarity effect with own farm land.

: An increase in average value of land increased the probability of supplying land consistent with Cheung's hypothesis.

: Likelihood ratio test provided strong evidence to the hypothesis that tenancy is an adjustment to more efficient utilization of farm resources, especially farm experience, number of oxen owned and farm equipment.

The focus in this research has been exclusively on the set of participation choices. This study did not analyze the demand for these factors on a continuous scale. For example, the participation decisions as well as the amount of quantity of input transacted be modelled endogeneously using a flexible functional form for better understanding of resource allocation. Some additional work that is of interest is to determine factors affecting household choices among sharecropping, fixed rent tenancies and various other contracts that exist in these villages. Also, a study of allocation of time in the household activities by the females and the nature of substitution or complementary between different members of the household would aid our understanding of labor allocation within the household.

REFERENCES

Amemiya, T. "Qualitative response models: A survey." Journal of Economic Literature, 19(1981), 1483-1536.

Bardhan, Pranab K. "Agricultural development and land tenancy in a peasant economy: A theoretical and empirical analysis." American Journal of Agricultural Economics, 1979a, 61,48-65.

_____. "Labor supply functions in a poor agrarian economy.," American Economic Review, 1979b, 69, 73-83.

Barnum, H. and L. Squire. "An econometric application of the theory of the farm household." Journal of Development Economics, February 1979, 6, 79-102.

Bell, Clive. "Alternative theories of sharecropping: Some tests using evidence from Northeast India." Journal of Development Studies, 1977, 13, 327-346.

Bell, Clive and Pinhas Zusman. "A bargaining theoretic approach to cropsharing contracts." American Economic Review, 1976, 66, 578-588.

Binswanger, H.P. and N.S. Jodha. ICRISAT Village Level Studies Manual. Economics Program, ICRISAT, Patancheru 502 324, A.P., India (mimeographed) 1977.

Binswanger, H.P. and M.R. Rosenweig. Contractual Arrangements, Employment and Wages in Rural Labor Markets: A Critical Review. Agricultural Development Council, New York, 1981.

Bliss, C.J. and N.H. Stern. Palanpur: The Economy of an Indian Village. Oxford:Clarendon Press, 1982.

Braverman, Avishay and T.N. Srinivasan. "Agrarian reforms in developing rural economies characterized by interlinked credit and tenancy markets." Paper presented to the conference on "Adjustment Mechanisms in Rural Labor Markets in Developing Areas," ICRISAT, Hyderabad, India, August 22-24, 1979.

Cheung, S.N.S. The Theory of Share Tenancy. Chicago:University of Chicago Press, 1969.

DaGanzo, C. Multinomial Probit. New York:Academic Press, 1979.

Evenson, Robert E and H.P. Binswanger. "Estimating labor demand functions for Indian agriculture." Paper prsented to the conference on "Adjustment Mechanisms in Rural Labor Markets in Developing Areas," ICRISAT, Hyderabad, India, August 22-24, 1979.

Fienberg, S.E. The Analysis of Cross-Classified Categorical Data. Cambridge, Mass.:MIT Press, 1977.

Goodman, L.A. "A modified multiple regression approach to the analysis of dichotomous variables." American Sociological Review, February 1972, 28-46.

Huffman, Wallace. "Decision making: The role of education." American Journal of Agricultural Economics, 56(1), February 1974, 85-97.

Jaynes, Gerald David. "Economic theory and land tenure." Paper presented to the conference on "Adjustment Mechanisms in Rural Labor Markets in Developing Areas," ICRISAT, Hyderabad, India, August 22-24, 1979.

Jodha, N.S. "Agricultural tenancy in semi-arid tropical parts of India." Paper presented to the conference on "Adjustment Mechanisms in Rural Labor Markets in Developing Areas," ICRISAT, Hyderabad, India, August 22-24, 1979.

Maddala, G.S. Limited Dependent and Qualitative Variables in Econometrics. New York:Cambridge University Press, 1983.

McFadden, D. "Conditional logit analysis of qualitative choice behavior." Frontiers in Econometrics, edited by P. Zarembka. New York:Academic Press, 1974, 105-142.

Nerlove, N. and Press, S.J. Univariate and multivariate log-linear and logistic models." Mimeographed. No. R-1306-EDA/NIH, Rand Corporation, Santa Monica, 1973.

Pant, Chandrasekar. "Tenancy in semi-arid tropical villages of South India: Determinants and effects on cropping patterns and input use." Progress Report-20, ICRISAT, Patancheru, A.P., India, May 1981.

Rao, C.H.H. "Uncertainty, entrepreneurship and sharecropping in India." Journal of Political Economy, May/June 1971, 79, 578-595.

Rosenweig, M.R. "Rural wages, labor supply and land reform: A theoretical and empirical analysis." American Economic Review, 1978, 68, 861-874.

_____. "Neoclassical theory and the optimizing peasant: An econometric analysis of market family labor supply in a developing country." Quarterly Journal of Economics, 1980, 95, 31-55.

Ryan, J.G. "Wage functions for daily labor market participants in rural South India." Economics Program ICRISAT, Patancheru 502 324, A.P. India (mimeographed) 1981.

Ryan, James G. and R.D. Ghodake. "Labor market behavior in rural villages in South India: Effects of season, sex and socio-economic status." Paper presented to the conference on "Adjustment Mechanisms in Rural Labor Markets in Developing Areas," ICRISAT, Hyderabad, India, August 22-24, 1979.

Samuelson, P.A. Foundations of Economic Analysis. Harvard University Press, 1947.

Sen, Abhijit. "Market failure and control of labor power: Towards an explanation of 'structure' and change in Indian agriculture. Part 1." Cambridge Journal of Economics, 1981, 5, 201-228.

Silberberg, Eugene. The Structure of Economics: A Mathematical Analysis. New York:McGraw-Hill, Inc., 1978

Stiglitz, J.E. "Incentives and risk sharing in agriculture." Review of Economic Studies, 1974, 41, 209-256.

Sumner, D.A. "The off-farm labor supply of farmers." American Journal of Agricultural Economics, 64(3), 1982, 499-509.

Sumner,D.A. "Wage functions and occupational selection in a rural less developed country setting." R E Stat, Vol. 53(4), November 1981, 513-520.

Sydsaeter, Knut. Topics in Mathematical Analysis for Economists. London, New York:Academic Press, 1981.

Theil, H. Principles of Econometrics. New York:Wiley, 1971.

Tobin, J. and H.S. Houthaker. "The effects of rationing on demand elasticities." Review of Economics Studies, 1951, 18, 140-153.

Walsh, Gordon R. Methods of Optimization. London, New York:Wiley, 1975.