The Analytics of Labour Supply Under Alternative Risk Regimes

By

Sunil Kanwar

B.A. (Hons.) (University of Delhi) 1980
M.A. (University of Delhi) 1985

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

AGRICULTURAL AND RESOURCE ECONOMICS

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA at BERKELEY

Approved:

Chair: James A. Chalfant .... 9-17-91 ....

Date

Peter Berck .... 9-16-91 ....

PK Bardhan .... 9-17-91 ....

* *

The Analytics Of Labour Supply Under Alternative Risk Regimes

by

Sunil Kanwar

The Analytics of Labour Supply Under Alternative Risk Regimes

by

Sunil Kanwar

Abstract

In the context of agriculture, a potentially important variable that has continued to be overlooked till recently, is risk. This exercise analyses the impact of risk on farmers' off-farm labour supply decisions. Since it is not clearly established whether risk should be incorporated additively or multiplicatively, both specifications are considered.

Additive risk mimics risk neutrality in that farmers cannot insure against the risk by varying their input use. An important determinant of wage labour supply is the real price of the consumption staple, exhibiting a reasonably high elasticity of off-farm labour supply. How this translates into increased employment and wages depends, of course, on changes in the demand for labour and the existing labour market conditions. Off-farm labour supply is found to have a positive, albeit insignificant, relationship with the daily market wage rate. This is a reassuring difference from the results of earlier studies which reported "backward bending" off-farm labour supply curves even at abysmally low wage rates.

In the case of multiplicative risk the moments of the expected net revenue distribution impact on the input allocation decisions. "Nonseparability" dictates that we estimate the off-farm labour supply function as part of a system of equations. Increases in expected net revenue decrease the hiring out of labour. In contrast, increases in variance are insured against by an increased allocation of time to the certain alternative,

namely off-farm work. Thus, in the absence of well-developed insurance and capital markets, the household uses the labour market to hedge against uncertainty. This provides unambiguous evidence against the "disincentive effects" of multiplicative risk, a result that was ambiguous in the theoretical literature. Further, this adds a new dimension to our understanding of the effects of price stabilisation policies. Thus, stabilisation schemes will not only affect producer incomes from on-farm production, but also their incomes from the supply of off-farm labour. It is much more likely, therefore, that price stability may lead to a decline in producer incomes.

A comparison of results of the alternative risk specifications revealed many quantitative differences. Given the preference of the multiplicative risk specification over the additive one on theoretical grounds, and given the substantial quantitative differences between the two sets of results, it is clear that policies based on the assumption of no risk or else additive risk are most likely to be biased.

Much the same results were found to hold for female workers. Of course, the elasticities vis-a-vis the different explanatory variables varied considerably between female workers and all workers taken together.

Acknowledgements

With this has ended a small but very important part of my formal education. That several people have assisted me in its consummation would merely be stating the tacit. Jim Chalfant was indeed, in spirit, my principal supervisor. From my viewpoint, our conversations were always too few and too short. His decisiveness and encouraging demeanour are the two qualities that stand out most in my mind. Peter Berck's good humour and pragmatic approach were always a welcome change from the pressures of this effort. At one point he threw up his hands in despair and told me that I " ... should learn to write like the Brooklyn Gangster". Try as I might, I was unable to. Pranab Bardhan has always been a source of inspiration. I was glad when he provided me with the oppurtunity to assist him with his research for a brief period, enabling me to benefit from his experience and sagacity.

As members of my Orals Committee, Michael Hanemann and Alain de Janvry provided me with much food for thought. Their suggestions were very useful in fashioning my research effort in the present direction.

The excellent logistical support of the staff made my task that much easier. The efficiency of Gail, Sherry, Bessie and Louise, and their ever-smiling faces made even mundane dealings pleasurable. The knowledgable Grace proved an asset in the library. The patience and promptness with which Jim Bradley, Sam Scalise and Gary Casterline helped me out with, at times, difficult computations, made this production easier than it was.

The data set underlying this study was graciously provided to me by Tom

Walker, the principal economist at ICRISAT, Hyderabad. His first-hand knowledge of the Indian rural scene was impressive, given his American background. Of course, I do not speak for him or his organisation.

In addition to scholarship, my period of graduate study has also contributed to my development as an instructor. George Akerlof, Jim Chalfant and Jeff Perloff are the ones from which I have imbibed the most in this respect. Jeff's persistent efforts at providing a strong motivation to put in our best had, I feel, an exemplary effect on at least one individual in our class.

Finally, my friends and family were an important factor in helping me accomplish this goal in stride.

Table of Contents

Chapter 1

Introduction

1.1 Motivation

In their bid to improve the formulation of the decision-process of economic agents, and make it increasingly representative of the situations they seek to analyse, economists have, inter alia, sought to refine the specifications of their economic models. An added impetus in this direction has been the undesirable statistical implications of misspecified models, which have been much written about in the relevant literature.

In the context of agriculture, more so underdeveloped agriculture, a potentially important variable that has continued to be overlooked till recently, is risk. That farmers have always had to make decisions under various conceivable uncertain or risky conditions would be stating the obvious. The product prices farmers face may be quite different at the end of the cropping season than they were at the time the sowing decisions were made. Similarly, given the staggered use of some inputs such as labour and fertiliser over the cropping season, the costs of such inputs in the interim may differ quite significantly from what they were at the beginning of the production cycle. The production process itself is extremely susceptible to the caprices of the weather. The paucity of rainfall, or else its super-abundance, its lack of proper correspondence with the various stages of production, blight, frost, pestilence, and other such factors contribute greatly to an uncertain yield. Therefore, incorporating risk in the different aspects of agricultural decision-making has been recognised as being virtually imperative.

One such area of interest is that of farmers' off-farm labour supply decisions. It would be perfectly reasonable to assert that farm households base their decisions not merely on the information available to them at the relevant point in time, but also on how reliable they perceive that information to be. Thus, for instance, it is not sufficient to know the change in the market wage-rate in order to determine the farm households' labour supply response to that variable. It is also important to know how reliable (or risky) the households consider that wage change to be. Accordingly, one of the objectives of this exercise is to make a systematic empirical analysis of the impact of risk on farmers' off-farm labour supply decisions. Ignoring issues such as the staggered use of (some) inputs over the production cycle, and given that the input prices are known at the time the production decision is undertaken, we may assume away cost uncertainty. Experience shows that this is the least important form of risk, so that our assumption is probably fairly plausible. In other words, we shall only focus our attention on revenue risk.

The theoretical literature relating to the individual consumer and the farm household under risk has had few unambiguous results to present. Despite rather simple assumptions regarding the analytical framework, the results are found to turn critically on the third derivative properties of the utility function. Having no strong priors about these derivatives, assumptions relating to them are themselves testable hypotheses. In other situations, conclusions may be ambiguous as they depend upon the interaction of contradicting substitution, income and profit effects. Through empirical estimation we may be able to remove some of these ambiguities without necessarily having to make equally limiting assumptions.

In particular, we will be able to test for the "disincentive effects" of revenue uncertainty. Thus, will a decrease in revenue uncertainty leave unchanged, increase or decrease the wage labour supply of the farm households? While the theoretical literature is able to sign some of these responses in the case of "additive risk", it is unable to do so in the case of "multiplicative risk" even within the framework of rather simple models. When the model framework is expanded to allow for endogenous income and a multiple argument utility function (as in the case of a household production model, for instance), even the additive risk results mentioned above may become open to question.

Closely intertwined with this issue is the question whether some mechanism is available to the farm household whereby it may adjust to increases in revenue uncertainty in the face of imperfect insurance and capital markets. Thus, could it be that the household hedges against uncertainty through variations in its wage labour effort?

The answer to this query will also serve to reveal the broader implications of price stabilisation schemes. Hitherto, the impact of price stabilisation policies has been analysed in terms of efficiency gains and changes in producer revenues from on-farm production. But, given that producers may also supply off-farm labour, such policies will also impact on their secondary sources of income.

Finally, there remains the question whether inclusion of the risk variables in the model will alter quantitatively and/or qualitatively the effect of the other explanatory variables on the hiring out of labour. For instance, it would be interesting to note the off-farm labour supply response with respect to the wage rate in the specific Indian context. Of the earlier studies, Bardhan [1979] finds a significantly negative wage response for his sample of cultivators in rural India. Rosenzweig [1980] reports a similar result for male labour, using another sample of Indian farm households. Considering the predominant proportion of males in the total labour force, this result leads us to expect an inverse association between total (male and female) off-farm labour supply and the wage rate. However, in view of the near subsistence condition of the bulk of the labour supplying farmers, we find these results to be somewhat disconcerting. Could it be that the omission of the risk variables biased the wage response of off-farm labour supply by an amount large enough to change its sign?

1.2 Dissertation Overview

Chapter 2 commences with a review of the received literature on off-farm labour supply. The preponderant proportion of this research deals with the issue of agricultural labour supply without acknowledging the presence of risk as potentially pertinent and important to decision-making. Treating this omission as a specification error serves to bring home (some of) the implications of ignoring this factor from our analysis. Even though a small part of the previous research does attempt to include the impact of risk, we find that it falls short of taking up the issues that we are interested in.

When analysing the supply of labour, due allowance should be made for the fact that the economic units at the source of this supply are not homogeneous. Very broadly, we may classify the labour market as consisting of labourers and the self-employed. In general, we cannot assume the labour supply response of either category to represent the aggregate labour supply response. This is particularly true of underdeveloped agriculture, which has been traditionally characterised by a very large percentage of farm households. Given their small resource base, a significant proportion of these households supply their labour for off-farm wage jobs. As a consequence, in addition to the labour-leisure choice which the labourers have to make, the farm households must also make a choice between on-farm and off-farm work. The latter is obviously significant insofar as farm households consume a part of what they produce, so that any (ceteris paribus) change in the proportion of on-farm to off-farm work will affect production of the household commodity, and thereby affect utility. This effect will obviously govern the off-farm supply of labour in part. In view of the substantive differences between the two categories of labour-supplying units, we feel that the appropriate framework of analysis for cultivators would be the so-called household production model. With a view to facilitating a rigourous discussion of the relevant issues, therefore, we construct a decision-theoretic household production model under risk. Alternative assumptions about the prevalent risk regimes finally lead us to alternative estimable models.

Chapter 3 discusses the data for the models to be estimated. It stresses the need for household-level data for estimating models at this decision level. A rough sketch of the sample units is provided by the mean levels of statistics characterising them. Some evidence is furnished in support of the approximation that net returns accruing to the farmers are distributed normally. This simplifies enormously the task of capturing revenue risk in our models. The specification of the economic models is completed with a detailed discussion of the factors exogenous to, and potentially important for, the system.

Chapters 4 and 5 take up the issues involved in, and the results of, estimating the alternative models. Whereas chapter 4 concerns itself with the off-farm labour effort of all the working members in the household, chapter 5 relates to the female working members only.

Finally, chapter 6 presents a brief summary and further interpretations of the estimation results, some aspects of which may have been discussed at greater length in the previous chapters.

Chapter 2

Decision-Theoretic Model Of Farm Behaviour

2.1 Introduction

It is interesting, that although several generations of "models of economic development" were premised on a variety of assumptions about the mode of (agricultural/rural) labour supply response to various economic and non-economic factors, there was little hard evidence to support or disprove these labour supply theories till recently. No doubt these models were ostensibly concerned with labour supply flows across sectors rather than labour supply responses within the rural sector per se, but that does not make it difficult to infer the latter from a model dealing manifestly with the former.

Although several empirical studies concerning this issue are now available, the bulk of this research ignores the impact of risk. In section 2.2 we briefly critique this literature. In the recent past, though, some authors have attempted to consider the impact of risk on farmers' labour supply. Section 2.3 discusses these studies, and how far they achieve this objective. From the above critique emerges the justification for our present research. Accordingly, in section 2.4 we develop a decision-theoretic household model for cultivators. In section 2.5, we identify the crucial elements of our model. We point out that the conclusions from the model turn on the particular assumptions we make about the risk attitudes of the farmers in question, and the manner in which risk is incorporated into the model structure. We observe that as regards the former, the burden of evidence points towards risk aversion on the part of cultivators. This leaves us with the task of specifying an appropriate risk regime. Not having any strong priors as to what this should be, we develop estimable models based on alternative specifications of the risk regime. It is found that, under "additive risk" (and when risk is absent), we may estimate the labour supply equation by itself. However, given "multiplicative risk", the labour supply parameters must be extracted from a system of equations concerning the various decisions made by the household. A priori, one may justifiably expect the results to be different in the two cases.

2.2 Antecedents - Models without risk

Pranab Bardhan [1979] used cross-section data relating to some 4900 households in rural West Bengal to econometrically estimate labour supply functions in agriculture. He found that while the wage response was significantly positive for the set of landless labourers, and the set of landless labourers and small cultivators[1] taken together, it was significantly *negative* for the set of cultivators[2] per se. Moreover, even though the wage response was positive for the former two groups, it was not very large -- the elasticity of labour supply being around 0.2 to 0.3 . This evidence, he construes, is contrary to "... the infinite elasticity perceived in the horizontal supply curve of farm labour used in a large part of the development literature" (p. 81)[3].

He further goes on to observe that "... it seems labour supply is primarily determined by other economic, social, and demographic constraints ..." (p. 81). Thus, he finds hiring out behaviour to be consistently negatively related to plot size and

[1] Where small cultivators are defined as households operating less than 2.5 acres, and having cultivation as their major occupation.

[2] Where cultivators are defined to include households operating 0.1 acres or more, and having cultivation as their major occupation.

[3] At the same time, he is careful to note that perhaps the development literature assumption pertains to an ex-post aggregate supply curve, whereas the supply curve estimated by him is an ex-ante one.

educational level of adults in the family.

It is interesting to note that Bardhan's study (partially) substantiates an important point that we stressed above -- namely, that landless labourers and farm households are not homogeneous categories, so that the labour supply response of neither should be presumed representative of the overall labour supply response. Thus, the sample of landless labourers exhibited a significantly positive wage response (Bardhan's equation 1), whereas the wage response of the set of cultivators was significantly negative[4] (Bardhan's equation 5)[5]. For this reason, a simple clubbing together of the two groups (as in Bardhan's equations 2, 3 and 4), may not be quite appropriate. This is further underscored by our observation that, given the different nature of farm households vis-a-vis landless labourers, the former group's decisions should be analysed in the context of a farm household model.

A somewhat interesting result of this study is that off-farm labour supply is found to be significantly negatively related to education. Bardhan does not find this unusual at all. He writes "The coefficient[s] of ... X7, the number of adult males having higher than primary education is [are] *appropriately* negative ..." (p. 78, emphasis added). But nowhere does he explain or justify this relationship. It could very well happen, however, that those with, say, a bachelor's degree may work off-farm at least in the slack (agricultural) season[6]; in which case we would find education to be *positively* related

[4] Bardhan does not interpret the significance of the cultivators' significantly negative wage response in his study. Some researchers, however, take this to imply a backward-bending supply curve (e.g. see Rosenzweig later in this discussion). In any case, our purpose was merely to note the possibility of widely divergent responses across these labour groups.

[5] Of course, the comparison is vitiated by the fact that all the other variables in these two equations were not the same.

[6] In fact, this is often the case in some developed countries.

to wage labour[7].

Barnum and Squire [1979] econometrically estimate a household production model, using a Cobb-Douglas specification for the production side and a modified linear expenditure system for the consumption side of the model. The data employed relate to a Malaysian cross-section of farm households for the year 1972-73. They find that the elasticity of per capita household labour supply with respect to the wage rate is small and positive (0.12), although with respect to the number of earners in the family it is fairly high (0.62). Again, the labour supply elasticities with respect to the price of paddy and neutral technical change (as measured by the "efficiency parameter") are found to be negative and fairly large in absolute value (- 0.58 and - 0.65, respectively). Note that they define labour supply to include both on-farm and off-farm labour supply.

Wallace Huffman [1980] used a static, household production model to analyse the off-farm labour supply decisions of farmers in 276 counties in Iowa, North Carolina and Oklahoma. In this 1964 sample, the data are county averages per farm and per household.

The wage labour response is measured in terms of two alternative specifications -- one making use of the "proportion participating", and the other using "off-farm work days". The former is specified as a logit model, and the latter as a mixed

---

[7] It may be pertinent to note that Bardhan considered off-farm *farm work* only, and not off-farm work in all activities. Since the available option in his case was working on somebody else's farm, he felt that a relatively educated person may find it unpalatable to avail of this option, thereby leading us to expect an inverse relationship between off-farm work and education (personal communication). However, we feel that the relevant variable in the present context is total off-farm work in the daily, casual labour market, and not (off-farm) farm work only. In this case, the association between off-farm work and education may go either way.

geometric/exponential functional form. Both equations are estimated by weighted least squares.

The operators' wage elasticity turns out to be significantly positive in both equations, being about 0.34 . However, while the coefficients of the wife's wage and education are negative and significant in the logit equation, they are found to be insignificant in the other one. Huffman claims this to mean that " ... these variables play a greater role in explaining switching from zero to positive off-farm work than in explaining the intensity of off-farm work". Finally, education and extension are found to have a significantly positive impact on off-farm labour supply. This is in direct contrast to Bardhan's finding[8]. Moreover, Sumner [1982] argues that, given the Cobb-Douglas form of Huffman's production function, a ceteris paribus increase in schooling will necessarily imply a reduction in off-farm labour supply[9].

Mark Rosenzweig [1980] uses NCAER's[10] 1970-71 cross-section data pertaining to Indian households to econometrically estimate a household production model. He finds the *net* labour supply of male farmers to be backward bending, the wage elasticity of off-farm labour days being - 0.18. The male education variable is significantly negatively correlated with male off-farm labour supply; which, he explains, implies that schooling improves their on-farm marginal value productivity. The wives' education seems to enhance this relationship. However, the age variables, husbands or

---

8 At the same time, we should not lose sight of the LDC context of Bardhan's study as opposed to the DC context of Huffman's study. Unfortunately, both author's treat their results as "only to be expected", and do not care to outline the possible underlying mechanism at work.

9 This follows from the fact that in such a production function, $\partial Q/\partial(\text{farm days})\partial(\text{education}) > 0$. Therefore, schooling shifts up the demand for farm labour and hence the farm-wage function. Given the wage rate, this implies a decline in off-farm labour (unless leisure declines by a large enough magnitude).

10 National Council of Applied Economic Research

wives', are not significant, although they have the right signs. Thus, the quadratic, life-cycle relation discovered in other studies is not corroborated. The coefficients for the asset variables (namely, those for exogenous income, cultivated area and irrigation) have the expected negative signs, and are significant. Finally, the equations for females display much the same results, except that the wage response is positive and significant.

Daniel Sumner [1982] derives reduced form labour supply equations by comparing the marginal values of time devoted to different activities (namely, farm work, off-farm work and leisure). This approach is equivalent to constructing the usual static, household production model, and deriving the labour supply equations therefrom. Off-farm labour supply is measured, alternatively, as the participation rate and off-farm work hours. In both cases, the results accord with expectations. The labour supply response exhibits a quadratic age pattern, and is significantly negatively related to farm experience and training. Two points are worth noting. First, the education variable has a positive, although insignificant, coefficient. Sumner interprets this to mean that " ... schooling and farm operator labour are slight substitutes or are independent over at least some ranges of hours". Secondly, the wage elasticity of off-farm hours supplied exceeds 1. This stands out against all the earlier results which reported very small wage elasticities. One final comment about this study relates to the participation equations. Sumner does not include the wage rate as a R.H.S variable; nor does he clarify whether this variable was included but found to be insignificant, or else, was not included at all for some reason.

As we mentioned briefly at the beginning of this chapter, some of the recent research in this area does allow for the impact of risk on farmers' labour supply decisions. To gauge the extent to which it has been successful in this objective, we now look at these studies in some detail.

2.3 Antecedents - Models with risk

Claudia Parliament [1984] analysed the supply of labour on an Israeli kibbutz, or agricultural production cooperative. She seeks to determine the impact of changes in the cooperative-setup parameters on the supply of labour to the cooperative.

With regard to her analysis, several points are in order. First, she postulates a single argument utility function. This amounts to assuming away all the interesting possibilities of substitution and complementarity that one may wish to consider in the context of labour supply. To wit, the labour-leisure choice confronting the members.

Secondly, the empirical part of her research does not really put to test the propositions which she develops in the earlier, theoretical section. In fact, one might say that the economic models underlying the two sections of her dissertation are themselves dissimilar. In the theoretical section, members are assumed to allocate their time between private and cooperative production so as to maximise the expected utility of uncertain income. She then considers comparative-static changes in: (i) the "cohesion conjecture", which measures the cohesion or emulation on the part of other members to a change in the labour supply of the member in question; (ii) the proportion of cooperative income distributed; (iii) the correlation between private and cooperative income; and (iv) cooperative income variability. She finds that none of these changes lead to an unambiguous increase in the members' cooperative labour supply.

For her empirical analysis, she uses data relating to an Israeli kibbutz. Two notable features of a kibbutz are that, the cooperative income is shared equally between the members, and there is no private production. As a consequence, as she is quick to point out, it is not possible to determine the impact of changes in parameters such as the income distribution rule, correlation between private and cooperative income, and cooperative income variability, on the supply of labour. However, she goes on to add that "... it is possible to isolate the effect of the cohesion conjecture on labour supply". She then proceeds to estimate the model using the Tobit, Logit and Heckman estimation procedures.

It is clear that the model she estimates is very different from the one she develops in the theoretical portion of her dissertation. Not only does the estimated model not include the income distribution rule, private and cooperative income covariance, and cooperative income variability, it also fails to include the members' risk attitudes (as measured by the coefficient of absolute risk aversion in the theoretical model). Thus, the estimated model contains no variables pertaining to the uncertainties in the cooperatives' operating environment. Clearly, the estimated model(s) could have been derived by a simple, deterministic utility-maximising exercise. In other words, the economic models underlying the theoretical and empirical sections are not the same.

Terry Roe and Theodore Graham-Tomasi [1986] incorporate yield risk into a dynamic version of the agricultural household model. They propose to study the impact of yield risk variations on various production and consumption decisions of the household.

The household is assumed to maximise the expected utility from the consumption of a home produced good, a market produced good, and leisure. The utility function is additively separable and time invariant. Yield risk is introduced multiplicatively in the production of the home produced good; and the production shocks (causing yield variations) are assumed to be distributed independently over time.

They find that the resulting model no longer makes for the separability of production and consumption decisions, except in a special case. The reason for this is that risk aversion in consumption induces risk aversion in production as well. To gain some insight into the magnitude of difference that the introduction of risk would make to the household's decisions, a simplified model is hypothesized and explicit output-supply and input-demand equations are worked out. This model is then initialised using household data from the Dominican Republic for the year 1975-76. Simulation experiments are then conducted by letting yield variance be ± 25% of what it is assumed to be in the base solution. This gives us the "low risk" and "high risk" scenarios. Comparing these situations with the base solution, they find that the introduction of risk makes for a very significant change in the decision variables. Thus, an increase in risk leads to a very significant decline in production and consumption. From our specific view-point, the amount of labour hired-in is reduced, and at the same time the amount of leisure consumed is also reduced. Thus, in an attempt to reduce the disutility from a higher yield (and hence income) variance, the household decreases the scale of activity in the home produced good, leading to a consequent decline in the net demand for labour.

It is important that this empirical example not be confused with an outright empirical study. As the authors point out "It is apparent from the first-order condition

... that general comparative-static results ... can be obtained in the usual fashion. At the same time, obtaining these results will be tedious because many choice variables and parameters exist in our model. To see the issues more clearly, we focus on a specific functional form of the general model presented above. In this case, unambiguous results can be obtained and problems of empirical application are more apparent" (p. 263). Thus, given the extreme complexity and tedium of deriving comparative-static propositions in the context of a full-blown dynamic model, the authors resort to several simplifications and assumptions as to functional form, in order to be able to present unambiguous results. In so doing, while they employ some statistics relating to the Dominican Republic, they assume others, such as the parameters of the utility and production functions (see p. 267).

Further, if their equations were used for "direct estimation", the results would most surely be biased. Notice that the factor-demand equations (eqns. 9-24, p. 267), and hence the labour supply equation in their model, contain only the price and risk variables. Surely, labour supply depends on other important factors as well. In fact, for some labour groups (rural women in India, for instance), some researchers feel that non-price, caste factors may well be the dominant explanatory factors[11]. Lastly, simulation experiments merely provide us with the percentage change in the L.H.S variable for given percentage changes in the R.H.S variables, *contingent on the assumed parameter values*. This does not establish, however, whether the changes in the two sets of variables bear a statistically significant relationship to each other.

[11] Prof. Pranab Bardhan felt that, given the ultra-conservative social norms in the Indian villages, where it is not considered particularly honourable that the household women be exposed to extra-mural labour, caste factors may be relatively important in explaining female labour supply response [personal communication; also see Bardhan 1984].

Marcel Fafchamps [1989] studies the production and technology adoption behaviour of farmers in the African Semi-Arid Tropics. He observes, that for most of the agricultural season there does not exist a market for hired labour. As a result, the households must rely almost totally on their own labour resources. Further, labour is the only factor that may be adjusted over the course of the season, so as to cope with the uncertainties as they manifest themselves. Given these facts, the households must decide not only on their current labour supply, but on the entire labour calendar.

By the same token, when confronted with the choice of new technology, it is not enough to consider its profitability. It is also important to know whether the new technology is flexible enough; whether it exacerbates or eases the labour shortages over the production cycle; and the relative penalties in terms of the output foregone if the requisite output is not forthcoming.

To study these issues, he constructs a two-period, non-separable household model incorporating uncertainty. His preferred model specification is one where both the utility function and the production function are nested CES. He estimates what he calls a "stochastic model", using a maximum-likelihood approach. The "stochastic model" essentially amounts to estimating the reduced form subject to all the restrictions imposed by the underlying structural model. The data used relate to six villages in Burkina Faso, for the years 1981-86. The model so estimated is then used for various simulation experiments.

The results of the estimated model show that substitutability in production is much lower than that in consumption. Thus, while the direct elasticity of substitution in production between period 1 and period 2 labour supply is around 0.5, that for leisure in period 1 vis-a-vis leisure in period 2 is around 3.5-4.0 . Fafchamps concludes that "... with values of σ that high, the household labour supply becomes extremely sensitive to minute changes in the wage or marginal returns to labour between periods, too sensitive to make sense". This result is clearly out of line with those available from the received literature, which have tended to yield very small elasticities. His explanation is that possibly the stochastic model is unable to distinguish between substitutability in production and substitutability in consumption.

With regard to the impact of changes in risk on labour supply, the simulation experiments reveal that the households tend to increase their effort when the random shocks are positive, and vice versa. He explains that this occurs despite the assumption of risk aversion for the households, because when the initial shocks are large, they cause two other concomitant effects. First, they raise the expected marginal returns to labour, and second, the expected incomes increase. While the former leads to the usual substitution away from leisure, the latter (income) effect tends to increase the demand for leisure. Also, the risk aversion effect is to increase the demand for leisure. It so happens in this model, that the substitution effect dominates both the income and risk aversion effects, causing a positive relationship between risk and labour supply.

While these results are no doubt illuminating, we must not forget that they pertain to *on-farm* labour supply only. To reiterate, Fafchamps observes that for much of the agricultural season there does not exist a market for hired labour. In effect, then, we are really in the realm of the subsistence farm (from the view-point of inputs anyway), which must rely almost totally on its own resources.

To recapitulate, in the above section we considered several studies which allow for the presence of risk in farm household decision-making. We found, however, that all of the studies fall short of meeting the objective of the present research. Therefore, without reiterating the shortcomings of the above-mentioned research, we find that there is ample motivation and justification for carrying out a systematic empirical exercise concerning the impact of alternative risk regimes on the wage labour supply of farmers.

2.4 Decision-Theoretic Household Model

In chapter 1 we had argued that the framework of analysis should be suited to the particular labour group we were interested in studying. This had led us to aver that, given our interest in cultivators' off-farm labour supply, the appropriate framework would be the household production model. Accordingly, in the following sections we develop such a model and then use it to derive estimable functional relationships.

The standard, static household production model is well expounded in the literature. The household (head) is assumed to maximise a utility function:

$$U = U(a, m, l\ ; Z_1) \qquad U_i > 0\ ; U_{ii} < 0\ ;\ i = a, m, l \tag{1}$$

where a is the consumption of the agricultural staple,

m is the consumption of the market produced good,

l is the consumption of leisure time, and

Z_1 is a vector of exogenous variables to be discussed later.

Optimal utility is obtained subject to an income constraint:

$$p_m m = p_a(Q - a) - w(L - F_1) + wF_2 + E$$

where p_a is the (exogenously fixed) price of a,

p_m is the (exogenously given) price of m, w is the (exogenously determined) nominal wage rate,

Q is the household production of the staple,

L is the total labour input in the production of Q,

F_1 is the on-farm labour supply input,

F_2 is the off-farm labour supply input, and

E is exogenous income.

This constraint merely says that expenditure on the market purchased good is constrained by (and, in equilibrium, will equal) the household's total income (comprising profits, wage income and exogenous income).

We may re-write this constraint as follows:

$$p_m m \;=\; p_a(Q - a) - wL^h + wF_2 + E \tag{2}$$

where L^h is hired labour.

The production function for the household staple is:

$$\begin{aligned} Q &= Q(L; Z_2)\,\varepsilon \\ &= Q(L^h + F_1; Z_2)\,\varepsilon \qquad Q_j > 0\,;\ Q_{jj} < 0\,;\ j = L^h, F_1 \end{aligned} \tag{3}$$

where Z_2 represents exogenous variables to be discussed later, and

ε represents multiplicative yield risk, such that $E(\varepsilon) = \bar{\varepsilon}$ and $Var(\varepsilon) = \sigma^2$.

Finally, the time constraint is:

$$l + F_1 + F_2 \;=\; T \tag{4}$$

where T is the total time available to the household. Thus, the household's allocation of time to on-farm production activities, off-farm activities and leisure is constrained by the total amount of time at its disposal.

Substituting (2), (3) and (4) into (1), and assuming the household to maximise its expected utility, the maximand becomes:

$$\Omega = \underset{a, F_1, F_2, L^h}{Max.} \quad EU \left\{ a, [p_a(Q\varepsilon - a) - wL^h + wF_2 + E]/p_m, T - F_1 - F_2 \right\}$$

Differentiating the maximand with respect to each of the arguments a, F_1, F_2 and L^h in turn, the first-order conditions are, respectively:

$$E\left\{ U_a - U_m p_a / p_m \right\} = 0 \qquad (5a)$$

$$E\left\{ U_m \varepsilon Q_L p_a / p_m - U_l \right\} = 0 \qquad (5b)$$

$$E\left\{ U_m w / p_m - U_l \right\} = 0 \qquad (5c)$$

$$E\left\{ U_m [\varepsilon p_a Q_L - w] / p_m \right\} = 0 \qquad (5d)$$

Using the rule that $E(x_1 x_2) = E(x_1)E(x_2) + Cov(x_1 x_2)$, we may re-write the above equations as[12]:

$$E(U_a)/E(U_m) = p_a/p_m \qquad (6a)$$

$$\bar{\varepsilon} Q_L p_a/p_m - E(U_l)/E(U_m) = -\left[Cov(U_m, \varepsilon Q_L)/E(U_m)\right](p_a/p_m) \qquad (6b)$$

$$E(U_l)/E(U_m) = w/p_m \qquad (6c)$$

$$\bar{\varepsilon} Q_L p_a - w = -\left[Cov(U_m, \varepsilon Q_L)/E(U_m)\right]p_a \qquad (6d)$$

The first-order conditions may be interpreted as follows. Equation (6a) tells us that the agricultural staple is consumed up to the point where the expected marginal rate of substitution between the consumption staple and the market purchased good equals their relative price ratio[13]. Equation (6b) tells us that the difference between the

---

12 See Horowitz [1970].

13 The L.H.S of (6a) is not exactly the expected marginal rate of substitution, but is actually the marginal rate of expected substitution. However, the discrepancy is likely to be small and may be overlooked.

expected marginal rate of substitution between leisure and the market purchased good[14], and the expected value of the marginal product of labour is proportional to the risk premium associated with the covariance of U_m and εQ_L. Clearly, risk enters the determination of on-farm labour supply. Equation (6c) says that off-farm labour supply is determined by the condition that the expected marginal rate of substitution be equal to the real wage. On the face of it, it seems that risk factors do not enter the determination of off-farm labour supply in equation (6c). Note, however, that on-farm labour supply, off-farm labour supply and leisure are tied together via the time constraint facing the household. Consequently, given that risk considerations do enter the determination of on-farm labour supply through equation (6b), we know that risk considerations will also affect the determination of off-farm labour supply. This may, alternatively, be seen by setting up this maximisation problem without distinguishing between the household's on-farm and off-farm labour supply. The endogenous variables will then be a, l and L^h. Solving for the first-order-conditions as above, we find that the demand for leisure (or the supply of labour) by the household, is a function of the risk factors. Since the household's labour supply may be employed on or off the family farm, we know that hiring-out by the household is thereby influenced by risk considerations. Finally, (6d) says that the difference between the expected value of the marginal product of labour and the wage rate is proportional to the risk premium.

2.5 Critical Elements Of The Model

The impact of the presence of risk on the household's decisions turns, presum-

[14] From (2) above we know that the "net monetary accretions" are equal to p_m m. Therefore, we may think of m as net real income, and $E(U_l)/E(U_m)$ as the expected marginal rate of substitution between leisure and (real) income.

ably, on the interplay of two factors -- first, the household's risk attitudes; and second, the risk regimes (i.e. the manner in which risk enters the production function). The ensuing analysis takes up these issues.

2.5.1 Evidence On Risk Attitudes

With regard to the first factor, the pertinent question is: what is a plausible, reasonably representative assumption about the agricultural households' risk attitudes ? Are they risk averse, risk neutral, or risk preferring[15]? The past couple of decades have seen several attempts at eliciting farmers' risk preferences. These attempts may be categorized as follows: (i) the interview method with hypothetical payoffs; (ii) the interview method with actual payoffs; (iii) the indirect method using observed data. We now consider the evidence thrown up by these studies.

(i) The Interview Method with hypothetical payoffs

The basic idea underlying this approach is to determine points of indifference between risky options and their certainty equivalents. Given a series of such points, the whole indifference curve may then be mapped out. The indifference map so obtained yields the necessary information on risk preferences.

Most of the studies employing this approach pertain to farmers in developed agriculture (McCarthy and Anderson [1966]; Officer and Halter [1968]; Francisco and Anderson [1972]; Lin, Dean and Moore [1974]; Webster and Kennedy [1975]; Conklin, Baquet and Halter [1977]; Halter and Mason [1978]). Therefore, their results are not directly related to our study, since we intend to focus on underdeveloped, semi-arid

---

[15] In so posing the question we are, of course, assuming that the household head's risk attitudes correspond with those of the household per se.

agriculture. However, these results may still be instructive. For if developed country farmers are found to be risk averse, then it stands to reason that LDC farmers may be presumed to be risk averse (given the absence of well developed credit and insurance markets, and other risk-mitigating institutions).

Reviewing the above-mentioned studies, Young [1979] observes that "... approximately 50% of the sampled individuals manifested risk *preferring* attitudes over at least some ranges ... ". It is not clear how he reaches this figure; but, in any case, the risk preferring percentage seems to lie in the range of 20%-50% for most of these studies. Further, the sample sizes in these studies are very small, lying between 6 and 21 (farmers) in six out of seven cases. Thus, even though the predominant percentage of the farmers seem to be risk averse, there is need for further research before any such conclusion is established with a reasonable degree of confidence. One such study is that conducted by Dillon and Scandizzo [1978].

Dillon and Scandizzo [1978] employ the interview method to determine the risk attitudes of farmers in a semi-arid tropical region of Brazil.[16] Using a sample of 130 share-owners and sharecroppers, they confronted their subjects with choices involving hypothetical (but realistic) alternatives between risky and certain outcomes. For each group of peasants, two subsets of responses were collected. In the first subset, while total income was risky, the minimum subsistence needs were covered. In the second subset, even the subsistence needs were at risk. Both subsets of responses involved only two outcomes -- the probability of the "good outcome" being 0.75 and that of the "bad outcome" being 0.25.

---

[16] Robison [1982] calls this the "experimental approach".

They find that most peasants are risk-averse, with risk-aversion being more pervasive and more pronounced amongst small-owners than amongst sharecroppers.

This approach could, however, be a potential prey to several shortcomings:

(a) It could be subject to interviewer bias. (In fact, this was found to be true in a small experiment carried out by Binswanger [1980] in the Indian context).

(b) Individuals may not have sufficient incentive to reveal their true preferences.

(c) Even if they have incentive enough to do so, they may be *unable* to reveal their risk attitudes vis-a-vis situations they have neither experienced nor contemplated.

(d) The concept of probability is hardly intuitively obvious. While a college student may use the stated probabilities in working out the relevant expectations, the "layperson" may, at best, merely use these as indicators of the "relative likelihood" of the different outcomes.

(e) The individuals' responses may be affected by the manner in which the questions are posed.[17]

(f) The individuals may well derive different degrees of utility or disutility from gambling, the very method in question.

(g) The individuals may exhibit probability preferences. The psychology literature provides ample evidence that individuals' subjective probabilities may diverge from the objective probabilities of the outcomes they face. Juxtaposing this with the lack of a systematic relation between subjective and objective probabilities, we may find that individuals attach different subjective probabilities to the same objective probability.

[17] Kahneman and Tversky refer to this phenomenon as "framing effects" (although in a different context).

(ii) The Interview Method with actual payoffs

In an attempt to overcome some of these shortcomings, Binswanger (1980, 1981, 1982, and in Quizon et. al. 1984) conducted an experiment involving actual payoffs.[18] An important aspect of his experiments was that the payoffs were "large enough to induce participants to reveal their preferences". For instance, the highest payoff exceeded the monthly income of an unskilled worker.

His study covered 330 individuals selected at random from 6 villages in (rural) Maharashtra and Andhra Pradesh, in India. The individuals were offered 8 alternative choices involving a trade-off between high expected return and high standard deviation. Each alternative consisted of a "good" and "bad" outcome, with associated probabilities of one-half. The various alternatives were arbitrarily labelled to indicate the associated degree of risk aversion.

The experiments were conducted seven or eight times, over a period of six weeks or more. They were spread out over time, so as to facilitate familiarisation and reflection.

The results were as follows. For small payoff levels, some 50% of the peasants fall in the "intermediate" and "moderate" risk aversion categories. For higher payoff levels, the distribution becomes more concentrated, with the proportion of individuals in the above-mentioned categories rising to 80%.

While his approach seems to overcome the first three shortcomings of the interview method that we noted above, it is still susceptible to at least some of the others. Moreover, as Robison points out, not all experiments can involve significant payments

[18] Robison (op. cit.) calls this the "experimental approach with significant outcomes".

to respondents. Thus, for instance, even in Binswanger's study, the "Rs. 500 experiments" involved hypothetical payoffs.

(iii) The Indirect Method using observed data

An approach which is not subject to the shortcomings that we noted above with regard to the experimental approaches adopted by Dillon and Scandizzo and Binswanger, is the econometric approach to eliciting risk attitudes. The advantage of this approach stems from the fact that it makes use of the actual decisions made by individuals.

One of the earliest empirical studies using the econometric approach was carried out by Moscardi and de Janvry [1977]. Defining risk in terms of Kataoka's [1963] safety first principle, they estimated a risk aversion parameter by comparing the optimum and actual fertilisation levels of the sampled farmers in Peubla, Mexico. They found that the distribution of risk aversion was highly skewed towards the risk averters, thereby discouraging nitrogen fertilisation rates to suboptimally low levels.

Brink and McCarl [1978] construct a LP portfolio choice model for 38 U.S. cornbelt farmers, wherein risk is defined as negative deviation from an expected return. They found that the predominant proportion of the farmers (66%) exhibited risk aversion. However, they felt that the risk aversion coefficient for this group (ranging between 0 and 0.25) was rather small, and therefore risk aversion may not be an important determinant of the acreage decisions of the cornbelt farmers.

Antle [1987] estimates the distribution of risk attitudes for a population of 30 farmers from a village in south-central India. He uses a moment-based approximation to the joint distribution of profits and risk pertinent to these farmers, within an expected utility context. Since the fertiliser input equation is found to be misspecified (possibly due to credit constraints), the labour input equation is used to estimate the producers' risk attitudes. He finds that farmers are both Arrow-Pratt (Arrow [1971], Pratt [1964]), and downside risk averse (Menezes, Geiss and Tressler [1980]). Further, these (absolute) risk measures have large standard deviations, indicating fairly heterogeneous risk attitudes in the population. Finally, he finds (near) perfect correlation between the Arrow-Pratt and downside risk aversion measures, implying that an individual who is more Arrow-Pratt risk averse is also more averse to downside risk[19].

Bardsley and Harris [1987] construct a simple model unifying the production and consumption decisions of farmers via their financing decisions. This results in a nonlinear system of two equations; which is solved on the assumption that farmers choose the optimal mean-variance combination on the efficiency frontier. Using Australian grazing industries data spanning the period 1977-78/81-82, they find that Australian farmers are pervasively risk averse, rather than risk-neutral or risk preferring.

Antle [1989] observes that his earlier approach, as indeed all "structural" approaches, make very heavy demands on the data required. To remedy this, he proposes a "nonstructural" approach. Under the assumption that producers make optimal production decisions, he argues that their attitudes towards risk result in (consistent) changes in the moments of the distribution of net returns. By estimating these changes over time, the producers' underlying risk attitudes may be discerned. Using Indian data on three villages, he finds the prevalence of Arrow-Pratt and downside risk aversion in the sample farmers.

---

[19] In fact, the estimated correlation coefficient is 1.054; which, explains Antle, could be because the estimate is unconstrained and therefore exceeds 1 due to sampling error.

Barshira [1989] sets up a portfolio-choice model where utility is a function of risk and leisure, and risk is defined in terms of the coefficient of absolute risk aversion. Using a Taylor series approximation of the first order conditions, he compares the optimum and realised values of land allocations of 101 farmers in an Israeli co-operative. He finds the elasticity of absolute risk aversion to be - 0.3, implying decreasing absolute risk aversion and increasing relative risk aversion.

Although this approach is superior to the previous two on a number of counts, it is subject to an important criticism. As a number of authors have pointed out (e.g. Moscardi and de Janvry [1977], Young [1979]), since this approach seeks to measure risk aversion in terms of the difference between actual and optimal decisions, it ascribes to risk attitudes this entire difference. In fact, however, a number of diverse causes such as imperfect capital markets, imperfect information, restricted access to inputs etc. could be at the root of such differences.

The above analysis reveals that there is ample room for improving the measurement of (farmers') risk preferences. Nevertheless there is sufficient reason to conclude (albeit tentatively) that the burden of evidence points in favour of risk aversion on the part of farmers in underdeveloped agriculture.

2.5.2 The Risk Regime

The second factor of significance is the risk regime hypothesized in the model. It seems to matter greatly whether risk enters the (household) production function additively or multiplicatively. It is difficult to say, a priori, which of the two is the more plausible assumption. Newbery and Stiglitz (1981) interpret additive risk as implying that "Rain destroys a constant *amount* regardless of the size of the total crop ... " and multiplicative risk as implying that "Rain at harvest time leads to spoilage which is a constant *fraction* of the crop, regardless of its size ... " (emphasis added). But this is not instructive in telling us whether, for a given farmer, we should start off by assuming an additive risk structure or a multiplicative one. Suppose, for instance, that a given farmers' plot is struck by blight, as a result of which a certain amount of the crop is destroyed, irrespective of whether the total crop size is x or 100x. Posed in this way, an additive risk structure would seem appropriate. However, we know that the farmer's total crop size is either x or 100x. Suppose it is x. Then the *amount* of output destroyed by the blight may be expressed, alternatively, as a *fraction* of the total output. Thus, it becomes impossible to determine whether the true underlying structure was additive or multiplicative[20].

Further, Newbery and Stiglitz point out that even if we assume additive risk at the micro-level, when we aggregate to obtain total output for all the farmers, we are in effect making total risk proportional to the total output. But this brings us back to a multiplicative specification. For this reason, they recommend the latter.

The literature on household production models serves to focus on other important aspects of this problem. We look at some of these in the following analysis.

2.6 Towards Estimable Models

Making, alternatively, the assumptions of additive and multiplicative revenue risk, we explore what effect these assumptions might have on the structure of the household production model and the specification of the off-farm labour supply function derivable

[20] While these arguments have been couched in terms of negative risks, they should also hold in the case of positive risks (which, for example, result in a bumper crop).

therefrom.

2.6.1 Proposition 1 In the presence of additive revenue risk, the household production model is separable, irrespective of whether the household is risk neutral or not[21]. (Of course, our interest lies in risk averse households).

Proof As Fabella shows, given additive revenue risk, the first-order-conditions reduce to:

$$E\left\{U_a - U_m p_a / p_m\right\} = 0 \tag{7a}$$

$$E\left\{U_m p_a Q_L / p_m - U_l\right\} = 0 \tag{7b}$$

$$E\left\{U_m w / p_m - U_l\right\} = 0 \tag{7c}$$

$$E\left\{U_m [p_a Q_L - w] / p_m\right\} = 0 \tag{7d}$$

Thus, the first-order-conditions are the same as before, but with $\varepsilon = 1$. The term $\mathrm{Cov}(U_m, \varepsilon Q_L)$, which is now equal to $\mathrm{Cov}(U_m, Q_L)$, degenerates to 0 since Q_L is deterministic. As a result, (7d) gives us $Q_L p_a$ - w = 0. But this is the usual static efficiency condition for the employment of factor L. Since this condition is independent of the consumption parameters, the model is separable. **(Q.E.D.)**

From our immediate view-point, we note that additive risk impacts the system in the same way as risk neutrality. Given additive risk, the household is unable to mitigate risk through variations in factor use. This is reflected by the fact that the optimisation conditions above do not contain any terms in ε, the risk element. While this seem to be an advantage for estimation purposes, as Fabella (op. cit.) points out, it also

21 See Fabella [1989].

destroys the homogeneity property of the production function, thereby preventing the use of any duality techniques that are predicated on this property.

In any case, using the above equations, the farmers' off-farm labour supply function may be specified as:

$$F_2 = F_2\,(p_a/p_m, w/p_m, E, Z_1, Z_2) \qquad (8)$$

2.6.2 Proposition 2 In the presence of multiplicative revenue risk, risk aversion (as indeed, non-risk neutrality in general) implies that the household production model is not separable[22].

Proof Fabella points out that under risk aversion $U_{mm} \neq 0$. Therefore, $\mathrm{Cov}(U_m, \varepsilon Q_L) \neq 0$. This may, alternatively, be seen as follows. Note from (3) that Q_L is a function of ε. Indeed, $\partial Q_L/\partial\varepsilon > 0$. Consequently, when ε increases, so does εQ_L. Also, an increase in Q_L increases (expected) profits, and therefore decreases U_m (given risk aversion or a strictly concave utility function). In other words, $\mathrm{Cov}(U_m, \varepsilon Q_L) < 0$.

As a result, from (6d), $\bar{\varepsilon} Q_L p_a$ - w $\neq$ 0. Moreover, in expression (6d), $E(U_m)$ is also a function of the consumption parameters a and l. Therefore, the system (6a) - (6d) must be solved simultaneously for a, F_1, F_2 and L^h.

Quite obviously, the lack of separability has made matters much worse than in the case above. But, more importantly, ignoring the fact of non-separability and therefore considering the off-farm labour supply equation by itself, may clearly lead to biased results and incorrect policy conclusions.

---

22 See Fabella [1989].

The reduced form system of equations may be specified as:

$$a = a\ (p_a/p_m, w/p_m, E, Z_1, Z_2, \varepsilon) \quad (9a)$$

$$F_1 = F_1\ (p_a/p_m, w/p_m, E, Z_1, Z_2, \varepsilon) \quad (9b)$$

$$F_2 = F_2\ (p_a/p_m, w/p_m, E, Z_1, Z_2, \varepsilon) \quad (9c)$$

$$L^h = L^h\ (p_a/p_m, w/p_m, E, Z_1, Z_2, \varepsilon) \quad (9d)$$

The effect of revenue risk is captured in terms of the moments of the net revenue distribution pertaining to the farmers in question. Tentatively, let us consider the net revenue expectation (q^e) on the part of the farmer, and the net revenue variance (σ_q^2) to be the relevant moments. The expectation and variance of the net revenue distribution may be jointly estimated using the appropriate econometric model. We look at the appropriateness of this approach, and the attendant problems of estimation, in the ensuing chapter. Substituting these estimates in (9) above, we get

$$a = a\ (p_a/p_m, w/p_m, E, Z_1, Z_2, q^e, \sigma_q^2) \quad (10a)$$

$$F_1 = F_1\ (p_a/p_m, w/p_m, E, Z_1, Z_2, q^e, \sigma_q^2) \quad (10b)$$

$$F_2 = F_2\ (p_a/p_m, w/p_m, E, Z_1, Z_2, q^e, \sigma_q^2) \quad (10c)$$

$$L^h = L^h\ (p_a/p_m, w/p_m, E, Z_1, Z_2, q^e, \sigma_q^2) \quad (10d)$$

Of course, of specific interest to us are the parameter estimates of equation (10c). Even though the above system is a reduced form, equation (10c) can be estimated separately only if the regressors in all the equations of the system are the same. For if they are not, ignoring the exclusion restrictions on some parameters of the system will lead to relatively inefficient estimates. These issues are discussed at greater length in chapter 4.

Chapter 3

Farm Household Data For This Study

3.1 Introduction

Estimation of the household decision-theoretic models developed above requires, ideally, farm-level household data[23]. Accordingly, for our empirical exercise, we use farm-household data from ICRISAT's[24] village level studies.

This chapter is structured as follows. Section 3.2 discusses some of the broader aspects of this data set, attempting to establish its more general representativeness. For a number of reasons, not all the data observations are suitable for inclusion in the relevant data set. Section 3.3 discusses why it may be advisable to drop these observations from our sample. It then goes on to describe and analyse the prominent characteristics of this sample. Since we are expressly interested in off-farm labour supply, this section also compares the characteristics of the entire sample with those of the sub-sample of households exhibiting a positive off-farm labour supply. For the models developed in the previous chapters to be estimable requires the estimation of the factors representing revenue risk. This is done in terms of the moments of the net revenue distribution, as described in section 3.4 . Finally, in the process of developing the models in chapter 2, we left unspecified the exogenous factors that may potentially influence the system. What these exogenous factors are, and how they may be expected to impact the system, are the issues taken up in section 3.5 .

[23] Of the studies reviewed earlier, Huffman (op. cit.) is the only one not to use farm-level data. Instead, he uses county averages per farm and per household.

[24] International Crops Research Institute for the Semi-Arid Tropics.

3.2 Broader features of the data set

The data set pertains to three villages -- Aurepalle, Shirapur and Kanzara -- in diverse agro-climatic zones in the Indian semi-arid tropics. The villages were chosen so as to represent the typical characteristics of the corresponding taluka[25]; which, in turn, had been chosen so as to be representative of the corresponding district[26]. To ensure the representativeness of the sample unit at each stage, a large number of relevant characteristics were considered[27]. (Therefore, the conclusions holding for these three villages may, quite justifiably, be taken to apply to very large tracts of the semi-arid regions). Further, in order to truly represent the rural setting, villages participating in special programmes, receiving extraordinary resource transfers, or located near towns and highways, were not selected. The location of the villages in question is indicated in figure 1.

In each of these villages, 40 households were randomly picked -- 10 from amongst the labour households or those operating less than 0.2 hectares of land, and 10 each from the groups of small, medium and large farmers. The land size classes defining these groups are given in Table 3.1 at the end of this chapter. Note that, on account of the variations in land-man ratios, the size of operational landholdings, and land-productivity differences between the sample villages, it was not desirable to have common land-size classes across all villages.

Of course, of this sample of 40 households (in each village), we shall be con-

---

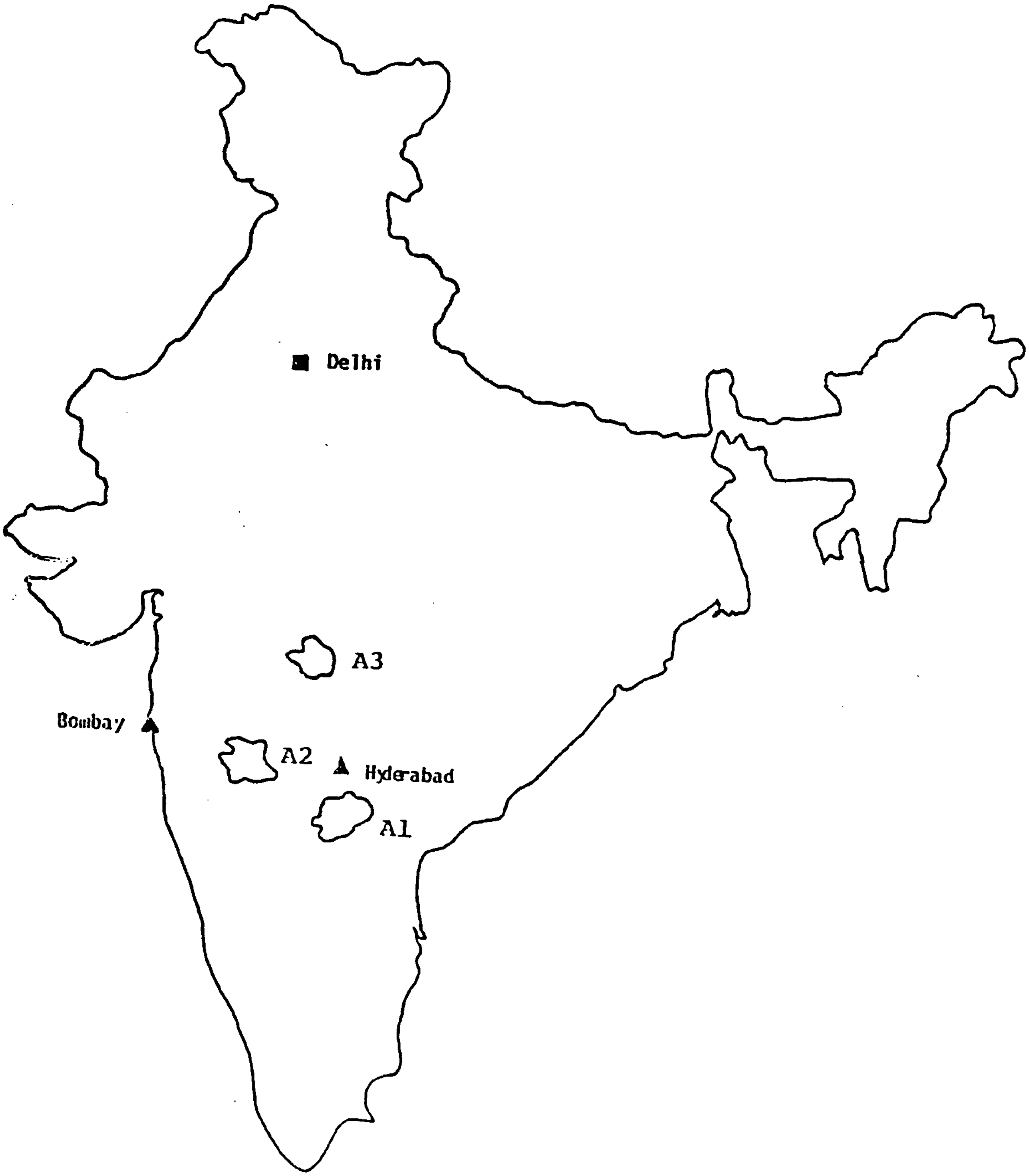
[25] A "taluka" is a sub-division of the district for purposes of revenue administration.

[26] A "district" is a sub-division of the state.

[27] A list of the characteristics is given in Singh et. al. [1985], Appendix II. Also see Walker and Ryan [1990].

Figure 1

India



The three sample villages are located in the districts shown on this map: Aurepalle in district Mahabubnagar (A1), Shirapur in district Sholapur (A2), and Kanzara in district Akola (A3).

cerned with the cultivator households only. Such households constitute the predominant proportion of all the households in the sample, as is typical of under-developed agriculture in general. Table 3.2 tells us that about 65% of all the households in these villages were farm households, whereas only some 31% were labour households. We must hasten to reiterate, however, that the latter is a rather large percentage in itself, so that the labour supply response of the cultivator classes should not be automatically assumed to reflect the overall labour supply response.

3.3 Characteristics of our sample

We stressed above, that the pertinent sample of interest to us was that of the cultivator households in each of the three villages. Given 30 such households in each village for each of the ten years of the survey, we should have 900 observations available to us. In actual fact, however, we had available to us a relatively smaller, although still fairly large, number of observations. As it turned out, the final sample size was dictated by the exercise of deriving the moments of the net revenue distribution facing the farmers. This question will be taken up in detail in section 3.3 below. At this point, we need merely point out that in carrying out this exercise, only those households for which full ten years of net revenue data were available were chosen. Given that there were 18, 13 and 22 such households in the villages of Aurepalle, Shirapur and Kanzara respectively, we were left with 530 observations. There were several reasons why so many households could not be included. Some households which were part of the study to begin with moved away from the mandated villages. While these were replaced with other randomly selected households in the villages, we decided to drop the corresponding observations from our sample; for if these observations *were* included, then observing these households over the ten year time period, one may notice abrupt changes in such variables of interest as the number of working members in the family, the number of children, the ages of the family members etc. And we would know that these changes had occurred not on account of the "normal growth process" in the family, but because of extraneous causes. Then again, while information for some of the households was available for the beginning and ending years of the study, it was not available for the interim. Again, we did not think it appropriate to fill in these gaps with data relating to other (albeit randomly selected) households. Finally, some households had to be excluded because although data on most of the variables were available in their case, not all the variables of interest could be so constructed. Consequently, we were left with 530 complete observations. Further, however, since the estimation of expected net revenue involved a lagged dependent variable, we were forced to drop one observation for each of the 53 households. This left us with 9 observations (from 1976 to 1984) for each of the 53 households in our sample, i.e. a total of 477 observations.

At this stage, it might be instructive to look at some of the principal characteristics of our sample, as well as those for the sub-sample of farmers with a positive off-farm labour supply. For reasons of convenience, we shall refer to the former as "the entire sample" and the latter as "the sub-sample". The means are taken over the entire available sample period from 1976 to 1984. Off-farm labour supply is measured as the number of rural labour days supplied in the daily, casual labour market. Labour days have been standardized to comprise 8 hours of labour time. It is important to note that "labour days supplied" are computed as the actually hired out labour days plus the days of involuntary unemployment, where the latter are defined as those days when the worker did not actually work, but was seeking work or was available for work at the going market wage rate. It is obviously important to include involuntary unemployment in total off-farm labour supplied, since we are considering the entire question of labour supply response from the view-point of the supplier. This issue is further taken up in section 4.2.3 . Since off-farm labour supply is zero for some households in the sample, this sub-sample is found to consist of 428 observations, as compared to 477 observations for the entire sample. Subsequently, we carry out statistical tests to determine if the mean levels of characteristics of the two samples differ significantly from each other.

It is interesting, and perhaps not very surprising, to note that there is very little variation between the two samples. The two-tail tests revealed an insignificant difference between the two samples at the mean levels of the variables in question. What these mean levels were is discussed below.

The average cultivated area (CULT), as Table 3.3 reveals, is about 16.8 acres for the entire sample and 15.7 acres for the sub-sample. Note that these figures relate to the gross cropped area, some of the plots being cultivated more than once. Of course, the incidence of multiple cropping is somewhat infrequent, since only a very small percentage of this area is irrigated. Thus, the irrigated area (IRRIG) amounts to a paltry 2.1 acres for the entire sample and 1.7 acres for the sub-sample.

Looking at the labour-use patterns, we find the number of on-farm labour days (FDAYS) to be about the same in both cases -- being 10.4 and 11.6, respectively. As regards the off-farm labour supplied (OFFDAYS), the average number of days for the sub-sample (116.2) is higher than that for the entire sample (104.2). But this only goes to show that there *were* some households which supplied zero off-farm labour days; so that this mean value is lower for the entire sample which includes such households.

The computation of the daily wage rate for off-farm work (W) presented a small difficulty, as it usually does in such studies. Since the dependent variable (in subsequent regression analysis) is "off-farm labour supplied", we cannot divide the wages earned from off-farm work by the number of (standard) days worked in order to arrive at the daily wage rate figures. For one, this would cause measurement errors in the R.H.S variable to be transmitted to the L.H.S variable (the two being inversely related if measured in the above-mentioned manner), raising estimation problems. Secondly, given that actual off-farm labour days are zero for some workers, the wage rate for such workers will be zero if measured by the above procedure, even though they may have been seeking or been available for work. Thirdly, if the labour market is non-competitive, the workers may be able to affect the determination of their wages in varying degrees. As Rosenzweig (op. cit.) and Bardhan (op. cit.) point out, in the context of U.S. labour supply studies these issues have been sought to be resolved by estimating the wage rate based on the personal characteristics of the relevant workers. Bardhan resolves this problem by computing a village-wide weighted average wage rate. Rosenzweig resorts to estimating the wage rate through regression analysis. However, instead of considering the workers' personal characteristics (which he finds to have low explanatory power anyway), he stresses the importance of geographical factors in the context of Indian rural labour markets given relative labour immobility across regions. He captures these factors in terms of dummy variables indicating the presence or absence of a local factory, or else local small-scale industry, the distance of the household from such facilities, and whether the household resides in a "farm development district" (i.e. areas under the purview of some special development programmes such as the IADP or Integrated Area Development Programme).

In our case, such an exercise would not be possible to begin with; assuming, a priori, the potential importance of such factors. For, as we mentioned earlier in this chapter, the mandate villages were purposively selected to ensure that they were not located near towns and highways, did not receive any extraordinary resource transfers, and did not participate in any special development programmes. Given this fact, we adopt the following way out. Observe that when an individual finds off-farm work, this may be in any of a number of labour markets in the rural sector. In our data set, off-farm work has been classified into 7 categories, each of which may be considered an individual labour market in its own right. These categories are: crop production; animal husbandry; building and other construction; repairs and maintenance; trade, marketing and transport; domestic work; and other work (such as handicrafts etc.). We, therefore, work out a weighted average wage rate based on employment in these individual labour markets[28]. The daily wage rate was found to be Rs. 16.5 for the entire sample, and Rs. 18.4 for the sub-sample.

There is no difference at the mean levels between the number of working members (WRKMEM) in the two samples, the figures for the entire sample and the sub-sample both being 5.4 . On the flip side, we have the number of children or dependents in the family. This has been defined to include all those members who are less than 10 years of age. For both samples, this figure is about 1.6 .

---

[28] As Rosenzweig (ibid., p. 43) avers "Due presumably to the geographical immobility of rural households ... individual wage rates thus may be determined by the interaction of aggregate labour demand and supply in individual labour markets ... ".

The average age of the head of the household (AGE) is found to be no different for the two samples, being just under 50 years in both cases. This would seem to conform to expectations, as the sub-sample relates to off-farm work in the local, rural daily market, rather than a phenomenon like migration which may be favoured by relatively younger workers. Both groups of workers are fairly illiterate, having less than three years of formal education (EDU). At these low levels of education, it would be difficult to hypothesize a priori whether this variable is positively related to the dependent variable (to the extent that formal education implies the garnering of non-traditional skills and gives rise to higher monetary expectations), or else is negatively related to the dependent variable (to the extent that education serves to increase a worker's on-farm productivity by increasing his all-round skills).

Coming to the land productivity factors, the average land value (LVAL) is about Rs. 2500 per acre for the entire sample, and about Rs. 2400 per acre for the sub-sample.

The average consumption (A) of the staples grown by the farm households is about 1553 kgs. p.a. for the entire sample, and is somewhat lower at 1446 kgs. p.a. for the sub-sample of labour supplying farms only. This is understandable in view of the fact that the former group includes the non-off-farm labour supplying farmers as well, which are mostly the large farmers. Since this category is richer and relatively well endowed with resources vis-a-vis the small and medium farmers, naturally one would expect this group to have a relatively higher consumption level. It may be pointed out that the households in Shirapur and Kanzara produced mostly sorghum, along with a small amount of pulses in the case of Shirapur, and a small amount of pulses and millets in the case of Kanzara. In the case of households in Aurepalle, however, while the small and medium farmers produced mostly sorghum (and some pulses), the large farmers were also big rice producers. Accordingly, therefore, these production patterns were accounted for in determining the total consumption of staples by the households in the three villages. Since the mean level of total consumption covered several crops, the implicit price of staples consumed (p_a) was derived as a weighted average price, using the value shares in consumption as the relevant weights. For both samples, the mean level of this price turned out to be about Rs. 1.85 per kilogramme.

Finally, coming to the "uncertainty variables" in our model (the estimation of which is explained in detail in the following section), the mean levels of the expected net revenues (EXPNR) for the two groups were about Rs. 5217 p.a. and Rs. 4988 p.a., respectively. Interestingly, not only did the sub-sample of labour supplying farmers have a smaller expectation of net revenues, the associated variability (SIGNR) measured in terms of the standard deviation of net revenues was also higher at Rs. 7481 p.a. as compared to Rs. 7200 p.a. for the entire sample. Perhaps the lower expectation of net revenues and its lower reliability did have a significant impact on off-farm labour supplied.

3.4 Moments of the Net Revenue distribution

For the models developed over the previous chapters to be estimable, we need information on the moments of the expected net revenue distribution. In truth, these expectations are some fuzzy beliefs in the minds of the farmers, formed on the basis of years of experience. To make this approach functional, however, we must translate these beliefs into some observed variables. To this end, we approximate expected net returns by the arithmetic expectation of actual net revenue. The underlying logic is that, just as the latter relates to a probabilistic situation, so does the former involve the use of (subjective) "probabilities". This allows us to jointly estimate the mean and variance of the net revenue distribution using the appropriate econometric model. At first instance such a task seems somewhat daunting, for agricultural output/revenue[29] appears to be affected by a host of important factors over the course of the cropping season. However, this need not prevent us from hypothesizing an approximate functional form based on a priori theoretical considerations. The subsequent estimation of the hypothesized model, and hence the final model hypothesized are, of course, empirical matters.

3.4.1 It seems reasonable to argue that the (absolute or percentage) change in output is related to the preceeding period's output. Then the appropriate functional form would be[30]

$$\log q_t = \alpha + \beta t$$

It may be confirmed that the above function implies that dq/dt = βq, thereby vindicating our hypothesis.

Note that the above function implies a constant rate of change of output over time. To test whether this does in fact hold, we may postulate the relation

$$\log q_t = \alpha + \beta t + \gamma t^2$$

This equation implies that dq/dt = (β + 2γt)q, thereby incorporating our hypothesis.

---

[29] We shall use the terms "output" and "revenue" interchangeably, in this section at least. What we are concerned with are the outputs of the various crops grown by the farmers, but for purposes of aggregation we must deal in value or revenue terms.

[30] For an excellent discussion of the related methodological issues, see Dandekar [1980], as well as "Part I" of this citation.

At this point, we must emphasize that the dependent variable of interest is *net* revenue, and not gross revenue. That it is the former and not the latter quantity that is pertinent to the farmers' decision-making, should need no persuasion. But the problem is that, since the harvest may fail for many a reason, net revenue can be negative. Indeed, it often is in our sample. For this reason we are precluded from estimating the models above.

To circumvent this difficulty, we adopt the following line of approach. Note, again, that the second model proposed above implies the first-order differential equation $dq/dt = (\beta + 2\gamma t)q$. Implicit in the use of derivatives is a continuous-time view of the world. On the other hand, if we were to treat time as a discrete variable, changes in q would be expressed in terms of differences rather than differentials.

More explicitly, the change in q between any two time periods may be expressed as $\Delta q/\Delta t$, where the operator "Δ" represents discrete changes or differences. When, further, we are referring to changes in q between consecutive time periods, $\Delta t = 1$; so that the difference quotient may simply be written as Δq.

Taking the cue from the first-order differential equation mentioned above, we may, alternatively, postulate the same relationship in terms of a first-order *difference* equation. Thus, we have

$$\Delta q_t = q_t - q_{t-1} = \alpha + \beta t + \gamma' q_{t-1} + \delta t q_{t-1}$$
$$q_t = \alpha + \beta t + (1 + \gamma')q_{t-1} + \delta t q_{t-1}$$
$$q_t = \alpha + \beta t + \gamma q_{t-1} + \delta t q_{t-1}$$

Or, instead, we may even wish to estimate the relation

$$q_t = \alpha + \beta t + \gamma t^2 + \delta q_{t-1} + \lambda t q_{t-1}$$

3.4.2 In each of the villages, we selected those cultivator households for which full ten years of net revenue data were available. Since there were 18, 13 and 22 such households, this allowed us 180, 130 and 220 observations for the villages of Aurepalle, Shirapur and Kanzara, respectively. In the next sub-section, we shall trace the derivation of the net revenue distribution for each of these villages in turn.

But before we do that, we must make an important digression. Implicit in our inference procedures is the assumption of a normally distributed error process. Given that the explanatory variables are non-stochastic, this amounts to the assumption that revenue is normally distributed. Is this a reasonable maintained hypothesis?

Making a careful assessment of the situation, Walker and Subba Rao [1982] indicate that it may well be. In their study pertaining to five ICRISAT villages (of which three villages are the ones comprising our sample), over the shorter time-period 1975-76/80-81, they find that net revenue variations are majorly explained by farm management (or farmer), temporal (or cropping year) and spatial (or soil) effects. Using binary variable regression techniques, they derive the adjusted net revenue series. Analysing these data, they conclude that "A normal distribution is probably a sufficiently close approximation to reality to describe the shape of net revenue distributions for most improved and some traditional cropping systems. Therefore, the assumption of normality ... may not be unduly restrictive" (p. 34)[31]. A traditional cropping system to which this statement relates is found in Aurepalle. As the authors explain "A diversity of components, and multiple sources of risk ... enforce normality on the net return distri-

[31] For descriptive purposes, the authors categorize the various cropping systems into three broad groups based on the use of improved inputs, particularly inorganic fertilizer. The three groups are: (i) traditional, (ii) semi-improved, and (iii) improved.

bution" (p. 26). Again, an improved cropping system to which the above statement refers is to be found in Kanzara. However, for other crop combinations in Kanzara, and particularly in the village of Shirapur, the authors suggest that the net returns distribution is skewed to the right.

An important factor tempering the above observation is that, the crop combinations considered to be "common" or representative of a given village are merely the ones most frequently found in that village (i.e. the ones grown by the predominant number of farmers in that village). However, these cropping systems are by no means dominant in those villages, occupying less than 50% of the cropped area on average, in any cropping year. Unfortunately, the authors do not provide us with any figures as to the importance of these cropping systems in terms of the percentage of revenues that they account for. Walker and Subba Rao explain that this lack of predominance of any given crop combination in the sample villages may be attributed to diverse intercropping combinations and a heterogenous resource base. These are very important factors, which, as we saw above, were instrumental in imparting normality to the net returns distribution for Aurepalle. On the basis of all the above arguments, we feel that the assumption of normally distributed net returns distributions in the sample villages, may be a reasonable first approximation[32].

3.4.2a Using the data for Aurepalle, initial Ordinary Least Squares estimation gave us the following equation

$$q_t = \underset{-(1.208)}{-\,0.231}\, q_{t-1} + \underset{(2.579)}{1428.5t} - \underset{-(2.873)}{135.77}\, t^2 + \underset{(4.946)}{0.127}\, tq_{t-1} - \underset{-(1.067)}{1514.7}$$

[32] Indeed, it may be seen as a lower bound in assessing the risk in a given situation; so that its significance in explaining decision-making may well imply that the effect of risk might have been even more pronounced under the assumption of a returns distribution skewed to the right.

N = 162 ; Bracketed figures are t-statistics.

where the set of explanatory variables comprised lagged net returns (q_{t-1}), a time trend (t), the trend squared (t^2) and an interaction term (tq_{t-1}). All the variables were highly significant, except q_{t-1}. We must recognize, however, that in the presence of autocorrelation and heteroscedasticity, the OLS estimates of the slope parameters may be significantly inefficient, and may therefore yield incorrect estimates of the regressand. Therefore, further investigation in this direction is in order before we select the final estimated equation.

In testing for the presence of autocorrelation, we must realize that our model contains a lagged dependent variable. Therefore, we cannot rely on the Durbin-Watson statistic. Further, Durbin's h-statistic cannot be computed since TV(b) > 1 in the formula h = $\hat{\rho}[T/(1-TV(b))]^{1/2}$, where b is the estimated coefficient of the lagged variable. As a result, we must employ Durbin's asymptotic test. Regressing the least squares residuals e_t, on e_{t-1} and the explanatory variables in the model, we get

$$\underset{}{e_t} = \underset{-(4.313)}{-\ 0.884\ e_{t-1}} + \underset{(4.099)}{1.384\, q_{t-1}} - \underset{-(4.439)}{3924.5\ t} + \underset{(4.313)}{300.94 t^2} - \underset{-(3.493)}{0.114\ tq_{t-1}} - \underset{-(4.181)}{9821.7}$$

The coefficient of e_{t-1} is highly significant, strongly indicating the presence of autocorrelation. It is interesting to note that e_{t-1} has a *negative* coefficient, implying the presence of negative (first-order) autocorrelation. Thus, it seems that when the Durbin-Watson statistic is inapplicable in a given situation, it does not even help us in determining whether the autocorrelation is positive or negative.

The presence of autocorrelation may be accounted for by re-estimating the models using a GLS estimation procedure. The new equation is

$$q_t = -\underset{-(1.220)}{0.229}\, q_{t-1} + \underset{(2.333)}{1446.5}t - \underset{-(2.640)}{138.34}\, t^2 + \underset{(5.101)}{0.128}\, tq_{t-1} - \underset{-(0.958)}{1539.9}$$

Notice that the estimated coefficients are hardly any different from the ones in the earlier estimated equation. Since our purpose is only the limited one of deriving the estimates of the regressand, for all practical purposes we are no worse off in assuming the absence of autocorrelation.

Testing for the presence of heteroscedasticity raises some difficult issues. Many of the proposed tests pre-suppose the manner in which heteroscedasticity enters the model (for details see Judge et. al. [1985]). Further, since each of these tests pertain to a specific heteroscedastic structure, we can only hope that it applies under alternative specifications. What is required, therefore, is some general test for heteroscedasticity, which makes no such limiting assumptions. Although several such tests are available, they are not bereft of problems. Again, the interested reader may consult the above reference for details on the shortcomings of the Goldfeld-Quandt, Bartlett and the Breusch-Pagan tests. Based on some Monte Carlo experiments, MacKinnon and White [1985] aver that "Perhaps the most interesting result is that ... the power of all tests is fairly low even though ... there is enough heteroscedasticity in the errors to cause serious errors of inference when using OLS t-statistics". This pessimistic observation leads them to conclude that, the strategy of first testing for the presence of heteroscedasticity, and then accounting for it on the basis of the outcome of the test, may not be appropriate. Quite to the contrary, Judge et. al. (op. cit.) opine that " ... testing for heteroscedasticity and using LS if the test is negative and an alternative ... otherwise appears justified". As we shall see, this problem was resolved for us by the method that we employed to correct for the presence of heteroscedasticity, in case we found any.

The presence of heteroscedasticity implies that E(uu') = Ω. The resolution of the problem of heteroscedasticity hinges on our ability to derive acceptable estimates of Ω. The problem, of course, arises from the fact that only T observations are available to estimate the T variances $\sigma_1^2, \sigma_2^2, \cdots, \sigma_T^2$.

Some notable attempts at tackling this problem have been made by White [1980], Horn, Horn and Duncan [1975], Hinkley [1977], and MacKinnon and White [1985]. For the specifics, the reader is referred to the original articles. For our purposes it suffices to note that the estimates of Ω suggested by these authors are all biased, or are unbiased only under certain special conditions. Moreover, their small sample properties are not well known. While Rao [1970] suggests an unbiased estimator (the "minimum norm quadratic unbiased estimator" or MINQUE), the problem is that the estimates of the σ_i^2 terms may turn out to be negative.

Given this situation, we considered the hypothesis that the error variances are different only between the group of the small and medium farmers on the one hand, and the group of large farmers on the other. However, within each of these groups, the respective variances are assumed to be constant.

If T_1 and T_2 are the numbers of observations in the two groups, respectively, the error covariance matrix becomes

$$E(uu') = \Omega = \begin{bmatrix} \sigma_1^2 I_{T_1} & 0 \\ 0 & \sigma_2^2 I_{T_2} \end{bmatrix}$$

The estimates of σ_1^2 and σ_2^2 may be obtained as

$$\hat{\sigma}_i^2 = \frac{\hat{u}_i'\hat{u}_i}{(T_i - K)} \quad ; \qquad i = 1, 2$$

These estimates are unbiased, and the corresponding GLS estimator will be consistent, and asymptotically efficient (given normality). Moreover, Taylor [1977, 1978] derives exact, finite sample results for the "two-group case"; where he shows that the EGLS is almost as efficient as the GLS, thereby obviating the need to know the exact variances.

In this case, the test for heteroscedasticity reduces to the test of equality of the two variances, for which we may use the usual F-test.

Dividing our sample into the above-mentioned two groups, we have 110 observations in group 1 (comprising the small and medium farmers) and 70 observations in group 2 (consisting of the large farmers). Running separate regressions for each group, and estimating the corresponding error variance, we find that the test statistic is S = $\hat{\sigma}_1^2/\hat{\sigma}_2^2$ = 7.699, which far exceeds the relevant F-value from the tables, F(0.99, 58, 94) = 1.713, at the 1% level. This establishes the presence of significant heteroscedasticity.

Using the estimates of σ_1^2 and σ_2^2 in the EGLS estimation of our model, we found the presence of heteroscedasticity to be overwhelming, insofar as the new set of parameter estimates is very different from the one presented above. The final estimated equation for the farmers of Aurepalle, then, is[33]

$$q_t = \underset{(1.572)}{0.440}\, q_{t-1} + \underset{(3.066)}{1941.1}\, t - \underset{-(3.432)}{167.47}\, t^2 + \underset{(1.648)}{0.052}\, tq_{t-1} - \underset{-(1.662)}{3288.8}$$

[33] We were coerced into adopting the above procedure in correcting for the presence of a non-scalar error covariance matrix on account of the dilemma that tests for autocorrelation are based on the presumed absence of heteroscedasticity, and tests for heteroscedasticity are based on the presumed absence of autocorrelation. Since there seems to be no definite solution to this dilemma, we decided to ignore the presence of autocorrelation on the reasonable plea that its correction did not make any appreciable difference to the estimates. Correcting for heteroscedasticity, on the other hand, was found to be much more important and rewarding.

N = 162 ; Bracketed figures are t-statistics.

3.4.2b Following a similar line of argument, the estimated equation for the village of Shirapur is

$$\underset{}{q_t} = \underset{(1.562)}{0.392\, q_{t-1}} + \underset{(0.052)}{136.3\, t} - \underset{-(0.436)}{68.54\, t^2} - \underset{-(0.671)}{0.052\, tq_{t-1}} + \underset{(0.656)}{6983.7}$$

N = 117; Bracketed figures are t-statistics.

3.4.2c For the village of Kanzara, the estimated equation is

$$\underset{}{q_t} = \underset{(6.818)}{1.557\, q_{t-1}} + \underset{(1.759)}{1802.2t} - \underset{-(1.868)}{130.84\, t^2} - \underset{-(2.538)}{0.066\, tq_{t-1}} + \underset{(1.138)}{4348.7}$$

N = 198; Bracketed figures are t-statistics.

Using the above three equations we can derive joint estimates of the mean and variance of the (expected) net revenue distribution for each of the three villages. The averages of these estimates over the entire sample period were reported in section 3.3 above as EXPNR (expected net revenue) and SIGNR (standard deviation of expected net revenue).

3.5 Exogenous factors influencing the system

In developing the models in Chapter 2, we introduced the variables Z_1 and Z_2 as representing various exogenous factors which impact on the (endogenous and exogenous) variables in the system. We now expatiate on which exogenous variables may potentially be important. Although we had introduced Z_1 and Z_2 through the utility and production functions, respectively, such a dichotomy is neither desirable nor always possible. In the case of many a variable, it may be possible to argue a priori that the exogenous variable in question enters both the utility and production functions. Therefore, when we discuss the influence of a particular variable in the context of a particular function, this should be viewed more in terms of pedagogic convenience, than as a statement of the fact that this is the only (or even the most important) way in which this variable may enter the system.

In specifying the production function above, we had not mentioned the fixed factors which make production feasible. An important fixed factor is the total cultivated area or the *gross cropped area.* The larger the area under cultivation ceteris paribus, the heavier the requirements on the household's labour time, and hence, the less the hiring-out of labour.

We need not include the amount of *area irrigated* as a separate variable, since the above variable already accounts for the multiple cropping that irrigation can afford.

It may be hypothesized that the *average value of assets per household* delimits the scope for the utilisation of the available labour and other endowments. A priori, therefore, the larger the asset base, the larger the production potential. Thus, we would expect a relatively larger asset base to discourage off-farm labour supply. Since figures for the total assets per household are not available to us, as a proxy we use the *land value* per household. Land is arguably the most important asset in the household's portfolio, and probably bears a very high correlation with the household's total asset base; for the larger the farmer, the richer he is likely to be in terms of other possessions as well.

Further, the income-generating capacity and the level of consumption that can be so sustained depend also on the productivity of the asset base. To model this factor, we include the *average revenue per acre* of the crops grown by the farmers, as a proxy. Of course, the higher the productivity, the lower we would expect hiring-out by the household to be.

Given the typically small and low productivity asset base of rural LDC households (especially those in the semi-arid regions), an important factor determining incomes and hence the pressure to hire-out, may be the *number of working age members* in the household. In defining this variable, we take age 10 rather than 15 as the lower limit, since children are put to work earlier on farms, and especially when the families in question are at the lower end of the income-distribution scale.

But even when the number of working age members is the same for any two households, their levels of living may be widely divergent depending on the *number of dependents* in the families. Therefore, this variable should be included as another explanatory variable.

With regard to the working members in the household, it is often held that the older the decision-maker, the more experienced is he likely to be. Given that entrepreneurial ability cannot be hired out, we would expect a negative relationship between hiring-out and *age*.

Another implication of a small asset base with low productivity is that, non-agricultural or *exogenous income* could be an important contribution to total farm revenues. Thus, a household with a smaller asset base may be able to compensate through a larger exogenous income. Unfortunately, this is one variable of interest on which data is not available to us; nor is an appropriate proxy immediately obvious. Therefore, we are forced to drop this variable from further consideration.

Another factor that is held important in determining the farmer's entrepreneurial ability is education. This is usually measured in terms of the number of years of formal education that the head of the household has had. This is clearly unsatisfactory, since the average level of the farmer's formal education is likely to be minimal. Clearly, a more well-defined measure of the farmer's exposure to "logical, open thinking" (attributes that are ascribed to formal education) is necessary. However, how such an index should be computed is not quite obvious, forcing us to fall back on the *number of years of formal education* as a rather imperfect proxy. Further, how this factor influences hiring-out behaviour is difficult to hypothesize a priori. To the extent that education increases the marginal product of labour in the present occupation (or improves entrepreneurial/managerial skills), we would expect it to have a negative relation to wage-labour supply. However, to the extent that it increases the awareness of the higher paying alternatives to farming it may induce increased hiring-out.

Finally, it seems that a rather important factor in the rural Indian context is *caste*. There is much evidence to show that many occupations are determined along caste lines. This is especially true of women, given that extra-mural labour by them, at least in certain occupations, is not considered very respectable. Our data set provides us with three alternative definitions of the caste index. The index prepared by V.S. Doherty (see Singh et.al. [1985], p. 36) is based on the household's social, economic and religious status in the village, with a somewhat larger weight placed on the religious rank. The index proposed by Jere Behrman (ibid, p. 37) takes note of the fact that different castes may appear with different frequencies in a given population. Therefore, he computes the index by rank ordering the castes in a sample, allowing for the relative frequency of castes. The third index, constructed by J. G. Ryan, is based on the occupational and socio-economic condition of the household (ibid., p. 37). A simple correlation analysis of these indices, based on Pearson's correlation coefficients

(Table 3.4), suggests that there is little to gain in statistical terms, in preferring any particular index over the other. Therefore, we choose Doherty's index, because it is relatively comprehensive as to the underlying factors determining caste.

TABLE 3.1

Farm Size Classification Based Upon Operational Landholdings

UNITS: Hectares

Village	Small Farmers	Medium Farmers	Large Farmers
Aurepalle	0.20 - 2.50	2.51 - 5.26	> 5.26
Shirapur	0.20 - 2.50	2.51 - 5.87	> 5.87
Kanzara	0.20 - 2.26	2.27 - 5.59	> 5.59

Note: Operational landholding was defined as owned land minus land leased out/sharecropped out plus land leased in/sharecropped in.

Source: Based on Table 3, p.12, Singh et.al. [1985].

TABLE 3.2

Composition of the total number of households in the selected villages

	Number Of Households			
Village	**Labourers**	**Cultivators**	**Others**	**Total**
Aurepalle	146	322	8	476
	(30)	(68)	(2)	(100)
Shirapur	97	183	17	297
	(32)	(62)	(6)	(100)
Kanzara	54	109	6	169
	(32)	(64)	(4)	(100)

Notes: (i) "Others" includes artisans, traders, shopkeepers etc.

(ii) The figures in parentheses are percentages of the total.

Source: Based on Table 2, p.10, Singh et.al. [op. cit.].

TABLE 3.3

Mean Levels Of Prominent Characteristics Of The Sample Households

Variable	Units	The Entire Sample	"The Sub-sample"
CULT	acres	16.79	15.73
		(15.99)	(15.64)
IRRIG	acres	2.07	1.73
		(3.28)	(3.08)
LVAL	Rs.'00/acre	24.97	24.18
		(14.76)	(14.83)
NRA	Rs./acre	263.28	255.60
		(401.34)	(414.91)
FDAYS	std. days	10.39	11.57
		(33.92)	(35.62)
OFFDAYS	std. days	104.24	116.18
		(100.36)	(99.18)
W	Rs./std. day	16.50	18.39
		(81.77)	(86.13)
HIRLAB	std. days	1839.88	1567.09
		(2667.29)	(2467.41)
WRKMEM	number	5.43	5.36
		(2.36)	(2.34)
DEPMEM	number	1.62	1.62

		(1.58)	(1.57)
AGE	years	49.62	49.73
		(11.04)	(11.17)
EDU	years	2.65	2.24
		(3.74)	(3.46)
A	Kgs.	1552.77	1465.99
		(1156.61)	(1116.75)
p_a	Rs./kg.	1.86	1.85
		(0.57)	(0.58)
p_m	Rs./kg.	3.36	3.24
		(2.20	(1.78)
EXPNR	Rs. p.a.	5216.50	4987.99
		(7847.41)	(7976.62)
SIGNR	Rs. p.a.	7199.66	7480.87
		(6276.18)	(6384.25)

Notes: (i) The variables are defined in the text in section 3.3 .

(ii) The "entire sample" relates to 477 observations over the years 1976-1984.

(iii) The "sub-sample comprises 428 observations relating to only those individuals who actually exhibited a positive off-farm labour supply.

(iv) The figures in parentheses are the standard deviations of the corresponding variables.

(v) None of the variables were found to be significantly different at the mean levels, across the two samples.

Source: Computed figures.

TABLE 3.4

CORRELATION ANALYSIS OF CASTE INDICES

Pearson Correlation Coefficients

	CASTED	**CASTEB**	**CASTER**
CASTED	1.00000	- 0.98424	0.97400
	(0.0)	(0.0001)	(0.0001)
CASTEB	- 0.98424	1.00000	- 0.94109
	(0.0001)	(0.0)	(0.0001)
CASTER	0.97400	- 0.94109	1.00000
	(0.0001)	(0.0001)	(0.0)

NOTE: (i) "Casted" is the caste index suggested by V.S. Doherty.

(ii) "Casteb" is the caste index suggested by Jere Behrman.

(iii) "Caster" is the caste index suggested by J.G. Ryan.

(iv) The bracketed figures give us: Prob > |R| under Ho: Rho=0

Source: Computed.

Chapter 4

The Hiring-Out Behaviour Of Farm Households

4.1 Introduction

The preceeding chapters have presented a step-by-step development of the estimable models. While we have attempted to define the various elements of the models before we undertake their estimation, some issues still need to be settled. These issues become properly highlighted only in the context of, and even during, the process of estimation itself.

One such issue crops up in view of the fact that the different villages in the survey were chosen with the express purpose of representing the diverse soil-climate conditions that exist under the semi-arid tropical regions under study. On the presumption that our data set has indeed been successful in capturing this diversity, would it be appropriate to hypothesize the same regression relationship for all three villages in our sample? Section 4.2.1 uses the Chow test to determine if this is advisable. The test reveals a highly significant difference in the regression relationship for the sample villages, necessitating the use of dummy variables to represent the differential impact of the soil-climate conditions, and indeed of other omitted variables, across these villages. Section 4.2.2 focuses on the fact that a non-negligible number of observations on the dependent variable are censored at zero. Consequently, we are confronted with the task of explaining not merely the magnitude of response of the dependent variable, but also the probability of its attaining the limit value of zero. This problem is handled by employing one of a class of "qualitative dependent variable models". Section 4.2.3, then presents and interprets the estimation results for the additive risk case. Finally, section 4.3 takes up the estimation issues and results pertaining to the multiplicative risk model.

4.2 The Additive Risk Case

We had shown in Chapter 2 above, that in the case of additive revenue risk confronting the farmers, the off-farm labour supply function may be specified as:

$$F_2 = F_2(p_a/p_m, w/p_m, E, Z_1, Z_2)$$

A careful definition of each of the regressors has been presented above, and need not be presented here.

We also mentioned that our sample comprised 477 observations relating to farm households in the villages of Aurepalle, Shirapur and Kanzara. Before we use these data to estimate the above model, a valid question that arises is whether the same relationship holds across all three villages.

4.2.1 Consider the Aurepalle sample by itself. If y is the dependent variable of interest, and X the matrix of k explanatory variables, then the (classical) general linear model may be written as

$$y_1 = X_1\beta_1 + \varepsilon_1$$

where the subscript 1 relates to the Aurepalle sample size T_1 (= 162).

The least squares estimator of β_1 from this sample may be written as

$$b_1 = \beta_1 + (X_1'X_1)^{-1}X_1'\varepsilon_1$$

Now consider the Shirapur sample of size T_2. These additional observations on the dependent variable may be specified according to the relation

$$y_2 = X_2\beta_2 + \varepsilon_2$$

where the subscript 2 denotes the Shirapur sample of size T_2 (= 117).

Then, the difference between the vector y_2, and the estimated values of y_2 based on the parameter estimates from the first regression, is given by

$$\begin{aligned} d &= y_2 - X_2 b_1 \\ &= X_2\beta_2 - X_2\beta_1 + \varepsilon_2 - X_2(X_1'X_1)^{-1}X_1'\varepsilon_1 \end{aligned}$$

such that

$$E(d) = X_2\beta_2 - X_2\beta_1$$

and, given the independence of ε_1 and ε_2

$$V(d) = \sigma^2[\,I + X_2(X_1'X_1)^{-1}X_2'\,]$$

If the two samples considered above do indeed "come from the same regression", then one would expect d to be small relative to its standard error. But, as Chow [1960] points out, the average value of d (since d is a vector) may be small not because the new T_2 observations come from the same regression, but because their deviations cancel out on average. Therefore, he suggests that we use the quadratic form $d'[V(d)]^{-1}d$. Under the null hypothesis that $\beta_2 = \beta_1$, he shows that

$$d'[V(d)]^{-1}d = d'[\,I + X_2(X_1'X_1)^{-1}X_2'\,]^{-1}d\frac{1}{\sigma^2}$$

where the bracketed expression on the R.H.S is a T_2 x T_2 matrix. It follows, therefore, that under the null hypothesis, $d'[V(d)]^{-1}$d follows a χ^2 distribution with T_2 degrees of freedom. Further, we know that (T_1 - k)$\hat{\sigma}_1^2/\sigma^2$ is distributed as χ^2 with T_1 - k degrees of freedom, where $\hat{\sigma}_1^2$ is the estimated variance from the first regression. Given that b_1 and $\hat{\sigma}_1^2$ are independent random variables, Chow points out that under the null hypothesis, the ratio

$$\lambda = \frac{\dfrac{d'[V(d)]^{-1}d}{T_2}}{(T_1 - k)\dfrac{\hat{\sigma}_1^2}{\sigma^2}\dfrac{1}{(T_1 - k)}} = \frac{d'[\, I + X_2(X_1'X_1)^{-1}X_2' \,]^{-1}d}{T_2\hat{\sigma}_1^2}$$

is distributed as the F-distribution with (T_2, T_1 - k) degrees of freedom. This test statistic (the so-called Chow statistic), may then be compared to the pertinent critical value to test the null hypothesis.

Estimating the least squares regressions for the villages of Aurepalle and Shirapur, we find that λ = 4.133 . Given k = 11, including the intercept, the relevant F-value from the tables is F(0.99,117,151) = 1.496 . Therefore, we reject the null hypothesis at the 1% level.

Stacking the data for the villages of Aurepalle and Kanzara and repeating the above procedure, we get λ = 2.587 . Since this exceeds the critical value of F(0.99,198,151) = 1.435, we reject the null hypothesis at the 1% level of significance.

Similarly, stacking the data for Shirapur and Kanzara, the above calculations give us λ = 5.076 . This exceeds the critical value of F(0.99,198,106) = 1.505, leading to the rejection of the null hypothesis.

The above results seem justifiable in view of the fact, that the sample villages were purposely chosen so as to represent the diverse agro-climatic and edaphic features of the semi-arid tracts. In order to allow for these differences across the villages, we introduce three dummy variables which are defined as follows:

D1 = 1 for village Aurepalle

= 0 otherwise;

D1 = 1 for village Shirapur

= 0 otherwise;

D1 = 1 for village Kanzara

= 0 otherwise.

Using these dummy variables amounts to using a separate intercept term for each of the villages[34].

4.2.2 A second point of interest stems from the fact, that for a large number of observations, the regressand in our model takes on the limit value of zero. As we saw in section 3.3 above, hired labour supply assumes the value of zero in 49 of the total of 477 observations. In such a situation, the explanatory variables may be hypothesized to govern not merely the size of the non-limit responses, but the probability of the limit responses as well. Although a multiple regression model would account for the former, it would fail to account for the latter. This is because, underlying a multiple regression framework is the assumption of a continuous density of the conditional distribution of the regressand. However, this assumption is inconsistent with the fact that the regressand takes on the limit value for several observations.

A model which appropriately handles this problem is attributed to Tobin [1958]. If y_t denotes the dependent variable of interest, and x_t the set of explanatory variables, then this model may be specified as:

$$y_t = \begin{cases} x_t'\beta + \varepsilon_t & \text{if } y_t > 0 \\ 0 & \textit{otherwise} \end{cases} ; \qquad t = 1, \ldots, T$$

[34] We feel that the differences in agro-climatic and soil characteristics across villages will manifest themselves in terms of different "mean effects" of the other regressors, and not in terms of differences in the "marginal effects" of these variables.

where the error term is assumed to follow the classical least squares assumptions.

From this model, it is intuitively obvious that the least squares estimator applied to the complete set of observations is biased. This follows from the fact that the sample is censored at the limit value of zero, so that the errors are constrained to be greater than - $x_t'\beta$ for at least part of the sample. This destroys the zero expectation property of the errors, thereby causing the least squares estimator to be biased. More formally, it may be shown that the unconditional mean of y_t using all the observations (see Tobin [op. cit.]) is:

$$E(y_t) = \Phi(x_t'\beta/\sigma)x_t'\beta + \sigma\phi(x_t'\beta/\sigma)$$

where ϕ(z) denotes the probability density function of z and Φ(z) its cumulative distribution function. Thus, the least squares estimator is biased. Since this bias persists in large samples, this estimator is also inconsistent.

Further, least squares estimation of the positive observations by themselves does not help either. Apart from the fact that throwing away information on the regressand would be inefficient, we also know that the error process has a non-zero expectation. Consequently, the conditional mean of y_t may be shown to be

$$E(y_t/y_t > 0) = x_t'\beta + \sigma\frac{\phi(x_t'\beta/\sigma)}{\Phi(x_t'\beta/\sigma)}$$

Again, this bias persists in large samples, so that the least squares estimator is not only biased but also inconsistent.

Several notable attempts have been made at resolving this issue, for a discussion of which the reader is referred to Amemiya [1985]. Basically, the various alternative approaches may be categorized into "two-step procedures" and "maximum-likelihood techniques". While both yield consistent and asymptotically normal estimators, there is some evidence (see Nelson [1984]) that the latter are significantly more efficient than the former. Therefore, we prefer to estimate our model using (Tobit) maximum likelihood. This involves the maximisation of the likelihood function

$$L = \prod_0 [\, 1 - \Phi(x_t{'}\beta/\sigma)] \prod_1 \sigma^{-1}\phi[(y_t - x_t{'}\beta)/\sigma]$$

Since this function is highly non-linear, the maximum likelihood estimators must be computed iteratively. An important result in this connection is that of Olsen [1978], who shows that log L is globally concave in the transformed variables β/σ and $1/\sigma$, implying that the likelihood function is well behaved and has a unique, global maximum. Therefore, any iterative procedure which converges, will lead to the global maximum of the likelihood function. In this way, we can obtain maximum likelihood estimates of the normalized coefficients. Multiplying the normalized coefficients by the estimated regression standard error, we may obtain the regression coefficients vector.

The asymptotic t-statistics reported with the maximum likelihood procedure explained above, pertain to the normalized coefficients and not the regression coefficients. However, this need not hamper hypothesis testing, since we are only interested in knowing whether the regression coefficients are significantly different from zero. For, note that when $\beta = 0$ under the null hypothesis, so is the normalized coefficient β/σ. Therefore, the significance of the regression coefficients may be established by comparing the above-mentioned t-values to the critical values from the standard normal distribution (since, asymptotically, these values are distributed as a N(0,1) random variable). It may be mentioned that, in testing the significance of the dummy variables we use two-tail tests since we have no strong priors on the direction of their relationship with the dependent variable. On the other hand, theory leads us to expect the other variables to have a certain directional relationship with the dependent variable. Therefore, in the case of these variables, a one-tail test is more appropriate.

In addition to the asymptotic t-tests, we may also employ likelihood ratio tests of significance (see Tobin [op. cit.]). If L^u be the unrestricted likelihood function with k parameters, and L^r the restricted likelihood function with k - r parameters, the likelihood ratio test statistic is defined as:

$$\lambda = -2ln\left[\frac{L^r}{L^u}\right]$$

where λ is asymptotically distributed as a χ^2 random variable with r degrees of freedom. If the estimated value of λ exceeds the pertinent critical value from the tables, we reject the null hypothesis that the variable in question is zero.

4.2.3 Before we get down to estimating the model, one last issue needs to be addressed. The regressand in our model is supposed to be the *desired* supply of labour; for, as we pointed out in section 3.3, we are considering the issue of labour supply response from the viewpoint of the supplier. In the absence of any demand constraints, the actual labour days supplied by individuals would also be their desired supply of labour. However, given the presence of considerable unemployment and underemployment (as is true for our sample), Ham [1982] finds that the use of actual days of work in estimation leads to inconsistent parameter estimates.

Traditionally, a variety of approaches have been adopted to redress this problem. Some workers simply assume that the workers are not constrained in their choice. Others argue that unemployment actually represents leisure. Third, one may argue that the constrained workers are only a small part of the sample; which, of course, is an empirical question. A different approach is to remove the underemployed (Wales and

Woodland [1976, 1977]), or the unemployed (Da Vanzo, de Tray and Greenberg [1976]) from the sample. However, Heckman [1979] shows that if the probability of being underemployed/unemployed is correlated with the error term or the regressor variables, this technique will yield inconsistent parameter estimates. Finally, Ham [1980, Ch. 1] explicitly introduced an upper-bound on the labour that could be supplied by the workers. But, as he points out, this would lead to inconsistent estimates if the constraint is not binding.

In the context of our sample, we are fortunate in that we have information not merely on which workers were unemployed, but also on the number of days for which they were (involuntarily) unemployed. The question asked in our survey was not regarding the additional hours an individual would be prepared to work at the going wage rate, the answer to which would be hypothetical and subject to substantial error. Instead, the question asked of the respondents was: On how many days since the last interview (a period of 2 - 3 weeks) were you available and/or looking for work, and failed to find any? Clearly, the answer to such a question would be much more plausible. Therefore, the desired off-farm labour supply (OFFLAB) is derived as the sum of the actual number of labour days worked by the household (OFFDAYS) and the number of days of involuntary unemployment (IUE)[35].

The results of the Tobit maximum likelihood estimation are presented in Table 4.1, and are discussed in this section. Table 4.2 carries the results of the OLS estimation, only for the sake of comparison. Although OFFLAB is our preferred dependent variable, these exercises were also carried out using OFFDAYS as the regressand.

[35] While this definition of wage labour supply may be a slight over-estimate, omitting involuntary unemployment altogether, we feel, will lead to a *gross* under-estimate.

These results are reported in Table 4.3 .

From Table 4.1, we find that none of the dummy variables D1, D2 and D3 are significant. Given that the intercept represents the average effect of the regressor variables on the regressand, this result implies that the average effect is not significantly different between the three villages. Although these villages were purposely chosen to reflect the diverse agro-climatic and edaphic characteristics of the mandate villages, it seems that such differences across villages were not pronounced enough to make for a significantly different mean influence of the independent variables on the farmers' off-farm work effort.

An increase in the price of the agricultural staple is found to have a very significant positive impact on hired labour supply. On the consumption side, such a price increase would unambiguously hurt the households through both a negative substitution and a negative income effect. However, on the production side, it would lead to a positive profit effect. By not using a household production model for the cultivator class, we would overlook this potentially important effect. The profit effect serves to increase the overall demand for labour; which, in turn, induces an increase in hired labour supply. The elasticity of the regressand with respect to the (real) price of the staple commodity is 0.60 . It is worth pointing out that, although this is rather small in numerical terms, and may be termed an inelastic response in a strict technical sense[36], this need not necessarily imply that this variable is useless from the policy viewpoint. In support of this argument, mention may be made of various studies documenting the price responsiveness of acreage, output and marketed surplus in underdeveloped

[36] Technically, if the elasticity is less than 1, the response of the dependent variable is said to be "inelastic" with respect to the independent variable in question.

agriculture (e.g. Krishna [1962, 1967] and Behrman [1966]). These studies consistently found the relevant price elasticities to be rather small, generally in the range of 0.2 - 0.3 . Despite this, however, a positive agricultural price policy has been the corner-stone of successful "green revolutions" in several countries. Therefore, we may interpret the above result to imply that a positive agricultural price policy leads to a significant increase in hired labour supply. To what extent this translates into increased employment and incomes will, of course, depend on the increment in the demand for labour and the existing labour market conditions.

Hired labour supply is found to be positively related to the (real) wage rate, as expected, but this relationship is not statistically significant. In fact, the wage elasticity of off-farm employment is as low as 0.001 . This result is in sharp contrast to Rosenzweig's (op. cit.) finding, in that he finds the wage rate to be highly significantly related to the cultivators' (net) labour supply. However, while he finds the relationship to be positive in the case of female labour supply, it turns out to be negative in the case of male labour supply. Rosenzweig attributes the latter to leisure being a normal good in the case of males, but does not explain why this should not hold for females. Again, our result differs from that of Bardhan [1979], who finds the (male) wage rate coefficient to be negative (albeit insignificant) for the cultivator households.

One implication of the insignificant wage-elasticity of labour supply is that the "shifter variables", or the variables that cause a shift of the labour supply curve rather than a movement along it, may be the ones of interest from the policy view-point. Of course, not all the shifter variables need be "non-price" variables. Indeed, we have already seen that a change in the real price of the consumption staple may be an important instrument. We now consider the other such variables in our model.

The age variable is found to have a statistically insignificant negative relation with hired labour supply. There could be several reasons for this inverse relationship. On the one hand, employers would expect a certain minimum level of productivity and promptness from the hired hands. A knowledge of this expectation may discourage the older workers from offering their services off-farm. On the other hand, while age implies experience, which may compensate for the loss in productivity on account of physical decline, the potential employers may feel that experience is not a perfectly marketable attribute, and may therefore, opt to hire relatively younger workers. At the same time, the "discouragement effect" of age may not be very strong, as we are looking at the local, daily casual labour market; which may account for the statistical insignificance of this relationship. Interestingly, the age-elasticity of labour supply (-0.19) is on the higher side vis-a-vis many other variables in the model. This should serve to underscore an important point: Which variable may serve as a potent policy instrument does not necessarily depend on the magnitude of the concerned elasticity. Of course, given that a certain variable may be employed as a policy instrument, the pertinent elasticity vis-a-vis this variable is clearly a relevant issue.

The number of years of education of the household head is negatively related to the regressand, the relationship being significant at the 1% level. We had pointed out earlier that it is difficult to ascribe a sign to this relationship a priori. In the present context, it seems that education serves to improve the farmers' entrepreneurial ability, which gets reflected in a higher on-farm marginal product. This discourages the off-farm supply of labour. Of course, implicit in this explanation is the hypothesis that entrepreneurial ability is not fully marketable.

The number of working members has a strong positive impact on wage labour supply. This is as expected since, ceteris paribus, the larger the number of working members in the household, the larger the amount of available labour. Given on-farm labour demand, naturally the excess labour supply will tend to be channelled off-farm. The elasticity of this variable vis-a-vis the dependent variable (0.71) is the highest for any variable in the model.

As expected, the number of dependents turns out to be positively (albeit insignificantly) related to hired labour supply. This seems to uphold the hypothesis that, ceteris paribus, the greater the number of dependents in the household, the greater would be the necessity to supply off-farm labour in order to provide adequately for the family.

Gross cropped area has a statistically significant negative influence on the supply of wage labour. Clearly, the larger the land area available for cultivation, the greater would be the demand on the family's labour time. In this context, what is relevant is the *gross* area and not the *net* area available to the farmer. In other words, this result subsumes the inverse relation between land augmenting factors such as irrigation and the hiring out of labour. Note that the elasticity of labour supply with respect to gross cropped area is - 0.22. Therefore, even large increments in the gross area available for cultivation will absorb only small incremental amounts of family labour. More specifically, even a 50% increase in gross area (on account, say, of a change from single-cropping to multiple-cropping on half the land area), would cause the labour supply to decrease by only 10%. This points to the very low productivity of semi-arid agriculture in these areas.

Somewhat surprisingly, the hiring out of labour is positively influenced by the per acre average revenue earned by the household, although this relationship is statistically insignificant. We had argued earlier that this factor may be taken to reflect the productivity of the household asset base. However, this seems not to be the case; with this factor representing, perhaps, land productivity only.

But, of course, land may not be the only asset in the farmers' portfolios. Therefore, to properly assess the production (and employment) potential of these farmers, we had included average land value as a proxy for their asset base. This variable is found to have a highly significant, negative relation with off-farm labour supply. Further, the relevant elasticity is - 0.26, which is somewhat higher than that of gross cropped area. This could be because, average land value indeed reflects the productivity of the entire asset base (since we expect landholdings to be highly correlated with the holdings of other assets); whereas the previous two elasticities related to the productivity of land per se. One implication we may draw from this is, that if alternative productive work (in the form of handicrafts, spinning, weaving etc.) is available within the household, then this will serve to absorb substantial amounts of family labour.

Finally, the household's caste seems to be a very important variable in its ability, and hence its decision, to hire out labour. Quite expectedly, this variable has a positive relation with wage labour supply[37], the elasticity of the latter with respect to the former being 0.24 . This implies that the higher the caste status of the household in

[37] Of course, our expectation is subject to the caveat that individuals of a certain caste will generally not hire out their labour to employers of a relatively lower caste.

question, the more easily will it be able to locate off-farm employment[38].

4.2.4 We now briefly look at the results of the Tobit maximum likelihood estimation using off-farm days (OFFDAYS) as the dependent variable. These results are presented in Table 4.3 . The results with regard to the real price of the staple (p_a/p_m), number of years of education (EDU), caste (CASTED), the number of working members in the household (WRKMEM), gross cropped area (CULT), net revenue per acre (NRA), and land value (LVAL) are unchanged in comparison to those reported in the previous section. Further, although the coefficients of the variables DEPMEM (the number of dependents in the family), and D1 (the dummy for Aurepalle) now have a negative sign, they are statistically insignificant. Thus, for the most part, the results from these two regressions are virtually the same. But, in the case of two variables there is an important difference between the two sets of results. While the variable age is statistically significant in "this" regression, we found it to be insignificant in the previous one. A possibles reason for this could be a significant positive association between age and involuntary employment. When we use OFFLAB as the dependent variable, although we expect the number of off-farm days to be negatively associated with the age variable, we expect involuntary unemployment to be positively associated with it. Therefore, the latter relation "weakens" the former, so that if it is strong enough, even though OFFLAB may still be negatively associated with age, this relationship may no longer be significant. However, given that the Pearson correlation coefficient between involuntary unemployment and age turned out to be a mere 0.09, the empirical validity

---

[38] An interesting hypothesis in this regard would be to consider whether relatively low caste workers find work more often as "permanent servants", rather than as casual labourers who are not attached to any employer in particular.

of this explanation is dubious.

But the most important difference consists of the result that, the variable OFF-DAYS is significantly positively related to the (real) daily wage rate. Recall, that we had found the latter to be positively but insignificantly related to the variable OFFLAB. Despite this difference, economic theory suggests OFFLAB as the preferable variable. We feel that the negative relationship between off-farm labour and the wage rate reported by some studies (also conducted in the rural LDC context) is implausible. Given the abysmally low income levels and standards of living in these countries, the hypothesis of a backward-bending supply curve is somewhat difficult to comprehend. It is in this context, that we find our results of an upward-sloping supply curve to be reassuring.

4.3 The Multiplicative Risk Case

Progressing to the case of multiplicative risk, we had shown that the parameters of the off-farm labour supply function of cultivators must now be estimated simultaneously with the other parameters endogenous to our model. We had shown the reduced form system of equations to be:

$$
\begin{aligned}
a &= a\,(p_a/p_m,\, w/p_m,\, E,\, Z_1,\, Z_2,\, q^e,\, \sigma_q^2) \\
F_1 &= F_1\,(p_a/p_m,\, w/p_m,\, E,\, Z_1,\, Z_2,\, q^e,\, \sigma_q^2) \\
F_2 &= F_2\,(p_a/p_m,\, w/p_m,\, E,\, Z_1,\, Z_2,\, q^e,\, \sigma_q^2) \\
L^h &= L^h\,(p_a/p_m,\, w/p_m,\, E,\, Z_1,\, Z_2,\, q^e,\, \sigma_q^2)
\end{aligned}
$$

where each of the variables has been defined earlier.

Since the above simultaneous equations system is a reduced form system, we know that each equation in the system may be estimated separately to obtain unbiased and consistent estimators of the parameter vector (see Judge et. al. [1985]). Of course, the full efficiency of these estimates is dependent on the assumption that the error terms in the different equations are not correlated with each other. Given that the equations relate to decisions taken by the same household during the same time period, this assumption is not likely to hold. Even so, however, the estimation of this system as a set of seemingly unrelated equations will not result in any gain in efficiency so long as the set of regressor variables is the same for each equation in the system (Judge et. al. [op. cit.]). It is obvious upon reflection, however, that all the regressors do not belong in each equation of the system.

Consider the first equation of the system, relating to total household consumption. From this equation, we drop the variables age, education and caste. In our models, the age variable refers to the age of the household head. What will be more pertinent with regard to total household consumption may be the average age of all the members in the household. However, we feel that household consumption is more likely to be affected by other factors of an economic nature. The variables education and caste are clearly unimportant in determining total household consumption[39].

In the second equation of the system, relating to on-farm employment of the household labour, we include all the independent variables excepting caste. To the extent that there is a trade-off between on-farm and off-farm work possibilities with regard to the household members' time, one would expect on-farm work effort to be influenced by much the same factors as off-farm work. However, one would hardly let one's own caste be of any consideration for purposes of self-employment.

---

39 Note that we are concerned with the consumption of the *staple* commodity, attitudes towards which are slow to change. Further, we are concerned with the staple consumption of the entire *family*, and not merely that of any single member.

The third equation, relating to off-farm work, will of course follow the same specification as before.

From the fourth equation, we exclude the variables relating to age, education, caste, and the number of dependents in the family. This is because these variables pertain to labour hired *out* by the sample farmers, and not to the labour hired *in*. Since data on these aspects of the hired workers is not available to us, we must perforce ignore them in our specification.

Finally, note that in addition to the variables used in the additive risk model, we have two other variables in this system. These are the expected net revenue (EXPNR), and the standard deviation of net revenue (SIGNR), which seek to capture the risk elements in the framework.

Since the set of independent variables is different for each equation of the system, there may be some advantage in estimating this system as a set of disturbance-related equations. Further, for reasons mentioned earlier, since each of the dependent variables is censored at zero, a Tobit estimation of these equations is preferable. In the first equation, however, the dependent variable does not attain the limit value for any observation[40]. Therefore, we estimate this equation by OLS, and the remaining three equations of the system by Tobit maximum likelihood.

Our attempts at estimating this system were thwarted by the fact that the matrix of independent variables turned out to be singular. We also found this to be true for each equation estimated separately. We discovered that this had been caused by the

---

[40] Naturally, we would not expect the total household consumption to be zero or negative for any household in any time period.

fact that although SIGNR (the standard deviation of expected net revenue) varied significantly across the three villages, it was constant within each village. This gave rise to a linear dependence between the variables D1, D2, D3 and SIGNR, for at least some of the observations.

One way of dealing with this situation is to drop one of these variables. Obviously, we would not like to drop the variable SIGNR, since the entire purpose of this exercise is to study the influence of risk. But, then, which of the dummies should be dropped from the model? A simple way of determining this is on the basis of the partial correlation coefficients between the regressors in question. Analysis of the simple correlation coefficients revealed, that the correlation between dummy D2 and the dispersion variable SIGNR exceeded 0.95, whereas it was fairly modest for the other cases. But we were not willing to drop D2 from the model either, for then it could be argued that the dispersion variable is in part picking up the effect of dummy D2. Therefore, only D1 or D3 could be dropped from the model. Now, however, the objection could be raised that the exclusion of any one of D1 or D3 could lead to a bias in the estimation of the other coefficients. To avoid this dilemma, we created a new variable D1D3 by clubbing together D1 and D3, i.e. D1D3 = D1 + D3. The only obvious drawback from this scheme would be our inability to test for the significance of D1 and D3 individually. But this need not detain us[41].

Of the estimation results, of specific interest to us are the parameters of the off-farm labour supply function. The Tobit (SUR) results for this equation are presented in

---

[41] It is worth mentioning that we found this set of variables (i.e. D1, D2, D3, and SIGNR) to be essentially orthogonal to the rest of the variables. Consequently, dropping either one of them from the model made no difference whatsoever to the coefficients of the other regressors.

Table 4.4, and are discussed below. As before, the OLS (SUR) results are also presented for the sake of comparison (also in Table 4.4). In both these cases, the regressand was the variable OFFLAB. Table 4.5 repeats these exercises using OFF-DAYS as the dependent variable.

Both the dummy variables, D1D3 as well as D2, are negatively, significantly related to the dependent variable. This is markedly different from the additive risk case, where none of the dummies were statistically significant. Given that our data set was purposively collected in a manner such that the different districts represent the diverse agro-climatic and soil characteristics of the semi-arid regions, the above result stands to reason.

The (real) price of the consumption staple (p_a/p_m) has a strong positive influence on wage labour supply, the elasticity of the latter with respect to the former being 0.54 . This supports the evidence from the additive risk model. It should be clear that, despite the lack of strong priors regarding the way in which risk enters the system, price policy will exercise an important influence on market labour supply by the cultivator households.

Hired labour supply is found to be positively, albeit insignificantly, related to the (real) wage rate. Thus, in the case of multiplicative risk also, it appears that the "shifter variables" are more important than the wage rate.

While our expectations are confirmed that increasing age discourages off-own-farm work, this relationship is only mildly significant.

Education is found to have a strong, negative impact on the hiring-out of labour. This result appears to support the hypothesis that education leads to an increase in the marginal product of on-farm effort, and this increase in productivity is an incentive to substitute farm work in place of off-farm employment.

The number of working members in the household, as well as the number of dependents, have a positive impact on wage labour supply. However, while the former variable is significant, the latter is not.

The productivity variable, gross cultivated area, exhibits a strong negative relation with the dependent variable. The associated wage labour elasticity is - 0.18. It stands to reason, that the larger the area available for cultivation, the larger will be the demand on the family's labour time.

The above result is further supported by the significant negative relationship between the regressand and the land value, the elasticity of the former with respect to the latter being - 0.23. Insofar as the latter captures total asset productivity, a more productive asset base will serve to divert labour supply from employment off the farm to activities on the farm.

However, a result that is out of character with the above explanation is the positive effect of the variable net revenue per acre. This echoes the result in the additive risk case, and, using the two-tail test[42], is again found to be insignificant.

The farm households' caste seems to have a very significant positive effect on its members' wage labour supply. This confirms the real life experience that, a higher caste status is advantageous to, and certainly does not militate against, being accepted for work.

---

[42] Since this regressor comes out with a counter-intuitive sign, we must resort to a two-tail test rather than use a one-tail test.

Finally, we come to the risk variables in the model. The expectations about net revenue have a significant negative impact on hiring-out behaviour. Thus, a higher expected net revenue provides the necessary incentive to put in more labour on the farm, vis-a-vis working off-farm. But of course, what is pertinent to decision-making is not merely the expectation of gain, but also the confidence which you place on that expectation. One way of capturing the latter is through the standard deviation of (expected) net revenues. The estimation results reveal that, the dispersion of returns positively and significantly affects wage labour supply. Therefore, the households would compensate for a ceteris paribus increase in the uncertainty attaching to expected gain, by increasing their off-farm effort. In this manner, they can insure themselves against the possibility of failure of on-farm enterprise.

When considering the impact of risk on farmers' (labour supply) decisions, it is not quite pertinent to consider either expected returns or the variance of returns by themselves. Experience shows that improvements in agricultural technology over time, have presented farmers with choices over situations that involve both increases in expected returns as well as increases in the associated variance. Therefore, what is relevant is the farmers' response given this trade-off. One way of allowing for this trade-off is to include the coefficient of variation of net revenue (rather than the expectation, and variance of the expected net revenue in our model). The results of this exercise are presented in Table 4.6 . Clearly, the change in specification have resulted in no qualitative change in the remaining coefficients. We find that off-farm effort bears a significant, negative relationship to the coefficient of variation of net revenue. This implies that, even if both expected returns as well as the variance of returns were to increase in tandem, as long as the former increase outweighs the latter, cultivators will move to decrease their off-farm work effort. The household time that thereby becomes available may, of course, be channelled into several directions. It could, for instance, be put into on-farm work. However, this seems not to be the case. Equation 2 (Table 4.6b) reveals that a change in the coefficient of variation will hardly affect the on-farm labour effort. The increased need for labour in response to the higher expected returns (relative to their variance, that is) will, instead, be met through an increase in hired labour. This becomes apparent from equation 4 (Table 4.6d). The implication of the above results taken together seems to be that the demand for leisure will go up. Note, however, that leisure has been defined as a residual variable; so that an increase in leisure could actually imply several different things. Since farm work has been narrowly defined as the labour allocated to the cultivation of the home grown staple, other productive activities undertaken on the farm have not been accounted for. Thus, for instance, an increase in "leisure" may actually imply an increase in labour allocated to spinning, weaving, handicrafts and other cottage industry; activities which are not insignificant for this set of farmers.

TABLE 4.1

The Additive Risk Case: Tobit ML estimation

Dependent variable = OFFLAB

Variable	Regression Coefficient	Asymptotic t-statistic	LR-statistic	Elasticity of E(y)
D1	- 28.015	- 0.887	0.788	- 0.08
D2	30.282	0.986	0.973	0.06
D3	36.590	1.312	1.720	0.13
p_a/p_m	110.140	6.357***	40.656***	0.60
w/p_m	0.026	0.186	0.035	0.001
AGE	- 0.459	- 1.039	1.079	- 0.19
EDU	- 10.296	- 6.326***	40.317***	- 0.23
CASTED	9.411	3.502***	12.270***	0.24
WRKMEM	15.251	7.104***	50.483***	0.71
DEPMEM	3.435	1.163	1.353	0.05
CULT	- 1.506	- 4.741***	22.517***	- 0.22
NRA	0.011	1.034	1.069	0.02
LVAL	- 1.199	- 3.050***	9.326***	- 0.26

Notes: (i) *** denotes significance at the 1% level

(ii) ** denotes significance at the 5% level

(iii) * denotes significance at the 10% level

TABLE 4.2

The Additive Risk Case: OLS estimation

Dependent variable = OFFLAB

Variable	**Regression Coefficient**	**t-statistic 464 df**
D1	5.740	0.198
D2	42.138	1.474
D3	52.134	2.015**
p_a/p_m	91.319	5.786***
w/p_m	0.011	0.082
AGE	- 0.628	- 1.528*
EDU	- 9.131	- 6.200***
CASTED	7.594	3.033***
WRKMEM	15.301	7.851***
DEPMEM	2.504	0.914
CULT	- 1.357	- 4.661***
NRA	0.012	1.205
LVAL	- 0.901	- 2.486***

TABLE 4.3

The Additive Risk Case: Tobit ML and OLS estimation

Dependent variable = OFFDAYS

	Tobit ML results		OLS results	
Variable	**Regression Coefficient**	**Asymptotic t-statistic**	**Regression Coefficient**	**t-statistic 464 df**
D1	38.856	1.592	53.069	2.065**
D2	77.023	3.245***	62.743	3.126***
D3	88.130	4.082***	87.015	4.790***
p_a/p_m	51.951	3.938***	41.624	3.757***
w/p_m	0.170	1.642*	0.108	1.179
AGE	- 0.748	- 2.194**	- 0.783	- 2.715***
EDU	- 6.021	- 4.828***	- 4.928	- 4.766***
CASTED	2.704	1.326*	1.048	0.596
WRKMEM	8.528	5.229***	8.823	6.448***
DEPMEM	- 1.908	- 0.836	- 2.765	- 1.437*
CULT	- 1.337	- 5.365***	- 1.061	- 5.193***
NRA	0.0003	0.037	0.002	0.276
LVAL	- 1.475	- 4.757***	- 0.863	- 3.393***

TABLE 4.4

The Multiplicative Risk Case: Tobit (SUR) and OLS (SUR) estimation

Equation 3 of the system: Dependent variable = OFFLAB

	Tobit (SUR) results			OLS (SUR) results	
Variable	**Regression Coefficient**	**Asymptotic t-statistic**	**Elasticity of E(y)**	**Regression Coefficient**	**t-statistic 464 df**
D1D3	- 81.136	- 1.910**	- 0.52	- 61.604	- 1.465
D2	- 533.340	- 3.831***	- 1.11	- 488.680	- 3.535***
p_a/p_m	99.331	6.228***	0.54	102.030	6.423***
w/p_m	0.036	0.273	0.002	0.043	0.328
AGE	- 0.586	- 1.438*	- 0.25	- 0.662	- 1.640*
EDU	- 8.310	- 5.715***	- 0.19	- 8.537	- 5.923***
CASTED	5.337	2.165**	0.12	3.023	1.258
WRKMEM	15.123	7.774***	0.70	15.167	7.828***
DEPMEM	2.380	0.879	0.03	2.017	0.751
CULT	- 1.293	- 4.158***	- 0.18	- 1.334	- 4.306***
NRA	0.015	1.468	0.03	0.013	1.329
LVAL	- 1.058	- 2.928***	- 0.23	- 1.166	- 3.246***
EXPNR	- 0.001	- 1.693**	- 0.04	- 0.001	- 1.727**
SIGNR	0.032	4.570***	1.97	0.030	4.356***

TABLE 4.5

The Multiplicative Risk Case: Tobit (SUR) and OLS (SUR) estimation

Equation 3 of the system: Dependent variable = OFFDAYS

	Tobit (SUR) results		OLS (SUR) results	
Variable	**Regression Coefficient**	**Asymptotic t-statistic**	**Regression Coefficient**	**t-statistic 463 df**
D1D3	- 20.028	- 0.639	- 6.459	- 0.222
D2	- 384.530	- 3.745***	- 325.040	- 3.375***
p_a/p_m	47.347	4.028***	50.911	4.586***
w/p_m	0.125	1.299*	0.134	1.470*
AGE	- 0.715	- 2.367***	- 0.823	- 2.897***
EDU	- 4.447	- 4.123***	- 4.832	- 4.776***
CASTED	0.097	0.054	- 3.056	- 1.938**
WRKMEM	8.792	6.124***	8.879	6.540***
DEPMEM	- 2.934	- 1.459*	- 3.468	- 1.832**
CULT	- 0.934	- 4.068***	- 0.982	- 4.526***
NRA	0.006	0.762	0.004	0.524
LVAL	- 0.917	- 3.442***	- 1.058	- 4.222***
EXPNR	- 0.001	- 2.262**	- 0.001	- 2.446***
SIGNR	0.025	4.741***	0.022	4.582***

TABLE 4.6a

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 1 of the system: Dependent variable = A

Variable	Regression Coefficient	Asymptotic t-statistic
D1D3	- 334.096	- 2.599***
D2	- 129.988	- 0.757
p_a/p_m	23.340	0.154
w/p_m	4.510	3.553***
WRKMEM	167.952	8.984***
DEPMEM	29.544	1.168
CULT	7.066	2.515***
NRA	0.210	2.184**
LVAL	18.239	5.720***
CVNR	192.812	7.370***

TABLE 4.6b

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 2 of the system: Dependent variable = FDAYS

Variable	Regression Coefficient	Asymptotic t-statistic
D1D3	6.005	0.170
D2	- 6.299	- 0.157
p_a/p_m	24.007	0.963
w/p_m	- 0.027	- 0.133
AGE	0.033	0.054
EDU	- 1.395	- 0.619
WRKMEM	1.566	0.509
DEPMEM	- 1.996	- 0.465
CULT	- 0.122	- 0.245
NRA	- 0.006	- 0.389
LVAL	- 0.254	- 0.449
CVNR	- 1.016	- 0.238

TABLE 4.6c

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 3 of the system: Dependent variable = OFFLAB

Variable	**Regression Coefficient**	**Asymptotic t-statistic**
D1D3	73.984	2.859***
D2	82.681	2.897***
p_a/p_m	95.674	5.907***
w/p_m	0.109	0.826
AGE	- 1.149	- 2.934***
EDU	- 8.552	- 5.818***
CASTED	1.978	0.820
WRKMEM	16.231	8.285***
DEPMEM	2.622	0.955
CULT	- 1.241	- 3.888***
NRA	0.016	1.591
LVAL	- 1.202	- 3.245***
CVNR	- 5.046	- 1.855**

TABLE 4.6d

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 4 of the system: Dependent variable = HIRLAB

Variable	Regression Coefficient	Asymptotic t-statistic
D1D3	346.350	1.560
D2	- 1879.887	- 6.240***
p_a/p_m	- 856.437	- 3.220***
w/p_m	- 0.730	- 0.328
WRKMEM	- 118.554	- 3.885***
CULT	131.220	26.640***
NRA	0.245	1.456
LVAL	33.188	5.972***
CVNR	128.434	2.813***

Chapter 5

The Female Off-farm Labour Supply Response

5.1 Introduction

Interest in the issue of the off-farm labour supply of women has been more than a matter of mere detail. A host of reasons have contributed to focus attention on this particular sub-group within the household. While the contribution of women within the household has never been doubted, their respect in society has tended to be coloured, inter alia, by their income earning effort. Second, even when family prestige has been equated with womenfolk *not* working outside the household, sheer economic necessity often drives women into the labour market. This would be especially true in the rural LDC context. Third, during certain stages in the agricultural cycle, such as harvest time, there is often additional demand for prompt and efficient labour. At such times the slack in the male labour market is often very small, and female labour supply assumes more importance. In this context, it would be of interest to know whether, and to what extent, female labour supply responds to economic incentives. Finally, of course, given that the female participation rate *has* increased over time, it is of interest to know whether, women as a group, respond any differently from men.

In this chapter, we look into the influence of various economic, social and demographic factors on the female market labour response. Section 5.2 begins with a discussion of the changes that need to be made to the statistical model in view of the fact that we are focusing on a particular sub-group within the household. It then goes on to discuss the estimation results in the additive risk case. The multiplicative risk case is subsequently taken up in section 5.3 .

5.2 The Additive Risk Case

It is often argued that, traditionally, female participation in the work force has been seen as a supplementary source of income, the primary source being the male members of the family. Given this situation, the average male wage rate for the household (w^m/p_m) becomes a pertinent determinant of female wage labour supply. For if the male wage rate (and, therefore, the family income) were to go up sufficiently, the family may consider it unnecessary for the females in the household to supply the current amount of off-farm labour (or to supply any labour at all).

In the context of the household as a whole, we found the family wage labour supply to be inversely related to the age of the household head. Insofar as the labour force is predominantly male and so are the household heads, one may reasonably expect the above relationship to hold for male wage labour supply per se. Holding the females' age constant, an increase in the age of the male working members (AGEM) would increase the probability of female labour force participation.

Lastly, assuming the education of the male workers in the household to be complementary to that of the female workers, we would expect female wage labour to be negatively related to the education of the male members in the family (EDUM).

Expanding our statistical model along the above-mentioned lines, Table 5.1 reports the Tobit maximum likelihood results using OFFLAB as the regressand. These results are discussed in the ensuing analysis, in section 5.2.1 . For the sake of comparison, Table 5.2 presents the corresponding OLS estimation results. These exercises were then repeated using OFFDAYS as the dependent variable, the results being presented in Table 5.3 . How these results differ from those of the previous exercise is taken up in section 5.2.2 .

5.2.1 From Table 5.1, we find that the (real) price of the consumption staple (p_a/p_m) has a very significant positive impact on female wage labour supply; the elasticity of this response being reasonably "high" at 0.24 . It seems, therefore, that a positive price policy will be beneficial in creating labour demand (and, thereby, inducing labour supply) not only for the household as a whole, but also for the women in the household. While we have not looked at women-only households, or even at households with a female head, this result has important implications for these sub-groups. Citing evidence from various sources, Bina Agarwal [1986] concludes that there appears to be a link between female-headed households and poverty. Given our results, however, the benefits of a positive price policy need not accrue to the totally-male or male-headed households only. Further, this result also has implications to the extent that the process of development and rural-urban migration may result in the menfolk of the household migrating first. The de facto female-only or female-headed households would, as our results show, benefit from a positive price policy.

We find that female labour supply responds positively and significantly to wage incentives, even though the corresponding elasticity is very low (0.02). The coefficient of the male wage rate has the expected negative sign but is highly insignificant.

The variables age and education have the expected negative signs, although only the latter is statistically significant. We must point out that, in these exercises relating to female labour supply, the variables age and education do not pertain to the age and education of the head of the household. Since we are focusing on women only, we have redefined these variables to represent the average age and average years of education of the women in each household. Therefore, these variables pertain to the household head only insofar as the household head happens to be a woman, and she is the only woman in the family; which, we found, was true only in a small number of cases. Again, it seems that the relatively educated women have a higher marginal product of on-farm work, and therefore, curtail their off-farm services.

The age of the male workers turns out to possess a counter-intuitive sign. Perhaps it could be that a relatively aged husband implies more domestic duties for the spouse, reducing the time available for off-farm work. Using a two-tail test, we find this variable to be insignificant. The variable, number of years of male workers' education (EDUM), has the expected negative sign but is also statistically insignificant.

The coefficients of the number of working age members and the number of dependents have the expected signs, although only the former has a significant impact on the regressand. It only stands to reason that the higher the number of working age members in the household, the more would be the labour supply. Further, insofar as the burden of rearing children is seen as a female responsibility, our result squares up with the stylized facts.

Gross cultivated area has a negative association with the dependent variable the relation being highly significant at the 1% level. The associated elasticity is reasonably high at - 0.33 . Further, the asset productivity factor (LVAL) has a negative, highly significant impact on the regressand. The corresponding elasticity of - 0.55 is the highest amongst all variables. This has obvious implications for the employment potential of "cottage industry". The lone unexpected result is that of a significant positive association between the dependent variable and net revenue per acre. To the extent that this factor represents land productivity, one would have expected an inverse relationship. In the event, this result is somewhat baffling.

Finally, the household's caste seems to have a highly significant bearing on female labour supply. The positive coefficient would support the observation that, belonging to a higher caste is an advantage in finding employment.

The likelihood ratio test for the null hypothesis that all the regressors are no different from zero, strongly rejects the null hypothesis. The relevant likelihood ratio statistic is λ = 169.785, which far exceeds the critical value of χ_1^2 = 6.637, at the 1% level of significance.

5.2.2 A comparison of the above results with those using OFFDAYS as the regressand (Table 5.3), reveals that the coefficients of several variables take on counter-intuitive signs in the latter regression. Thus, the male wage rate (w^m/p_m), the female working members' age (AGE), the female workers' education (EDU) and the male members education all possess counter-intuitive positive coefficients. However, all four variables are statistically insignificant. Further, while the real price of the consumption staple retains its positive relationship with the dependent variable, it is no longer statistically significant in explaining female wage labour supply. These results should make clear the importance of using the appropriate definition for the dependent variable. Thus, we see that using OFFDAYS as the regressand yields a number of counter-intuitive results. Therefore, on both theoretical as well as empirical grounds, the total off-farm labour supply (OFFLAB) seems to be the more appropriate definition for the dependent variable.

5.3 The Multiplicative Risk Case

Taking up the multiplicative risk case next, the Tobit (SUR) results are presented in Table 5.4 . The same table also carries the corresponding OLS results. Alternatively, using OFFDAYS as the regressand, the relevant estimation results are reported in Table 5.5 .

A comparison of these results with those from the preferred equation in the additive risk case (i.e. where the dependent variable is OFFLAB), reveals no qualitative difference between the two scenarios. However, there are some quantitative differences in the coefficients of the two models. As we pointed out in chapter 4, what is of interest from the policy viewpoint is not the relationship between the dependent variable and either the expected net revenue or the variance of net revenue per se. Rather, of relevance is the association with the coefficient of variation of net revenue. The relevant results are presented in Table 5.6c . It is these results that we discuss below.

Both the village dummies are statistically significant, justifying the use of a separate constant term for the sample villages. The real price of the consumption staple is found to exert a significantly positive influence on the dependent variable. We have found this to be consistently true in all our exercises. The real female wage rate is also positively, though insignificantly, related to the regressand. The coefficient of the male wage rate had the expected negative sign but was highly insignificant. As in the additive risk case, age and education are found to exert a negative influence on female labour supply, although only the latter is statistically significant. Female wage labour is inversely related to both the male workers' age (AGEM) and their education (EDUM), although the former sign seems to be counter-intuitive. In neither case, however, are these variables significant. Similarly, the number of working members and the number of dependents have the expected direct and inverse relationships with the regressand, respectively. But only the former relationship is significant. Gross cropped area has a significant negative effect on the hiring-out of female labour, and so does the productivity variable land value. The only unexpected result is the direct relation between the dependent variable and net revenue per acre. It is surprising that this should be a significant association. The household's caste appears to affect the possibility and, therefore, the extent of hiring-out. Finally, considering the risk factors as represented by the coefficient of variation of net revenue, we find this variable to bear a negative influence on wage labour supply, the association being statistically significant[43]. This implies that, just as in the case of the household as a whole, an increase in the expectation of gain relative to its variance, will cause female off-farm labour supply to be curtailed. Equation 4 (i.e. Table 5.6d) reveals that the incremental labour demand resulting from the expectation of gain (relative to its variance) will be met by increased use of hired labour. Partly, this may also be necessitated by the fact that an increase in the coefficient of variation will cause on-farm labour to decline, albeit insignificantly (as is evident from equation 2, Table 5.6b). Of course, as we explained in the context of chapter 4, the above results taken together need not imply a "real" increase in leisure. What appears as an increase in leisure may well be an increased allotment of time to on-farm non-cultivation enterprise.

[43] Note that when the expectation and variance of net revenue were included as separate regressors, and the dependent variable was OFFLAB, these variables had the expected signs but only the latter was statistically significant (Table 5.4). When, alternatively, OFFDAYS was used as the regressand (Table 5.5), although the former variable was still insignificant, the latter variable turned out to be highly significant at the 1% level.

TABLE 5.1

The Additive Risk Case: Tobit ML estimation

Dependent variable = OFFLAB

Variable	Regression Coefficient	Asymptotic t-statistic	Elasticity of E(y)
D1	36.838	1.572	0.19
D2	77.638	3.021***	0.29
D3	54.928	2.356*	0.35
p_a/p_m	24.300	1.758**	0.24
w/p_m	0.772	1.379*	0.02
w^m/p_m	- 0.068	- 0.380	- 0.003
AGE	- 0.158	- 0.448	- 0.08
AGEM	- 0.539	- 1.511	- 0.26
EDU	- 3.202	- 1.438*	- 0.09
EDUM	- 1.004	- 0.611	- 0.06
CASTED	9.311	4.016***	0.42
WRKMEM	3.887	2.213***	0.32
DEPMEM	- 0.174	- 0.074	- 0.004
CULT	- 1.311	- 4.982***	- 0.33
NRA	0.015	1.837*	0.06
LVAL	- 1.451	- 4.519***	- 0.55

Notes: (i) *** implies statistical significance at the 1% level

(ii) ** implies statistical significance at the 5% level

(iii) * implies statistical significance at the 10% level

TABLE 5.2

The Additive Risk Case: OLS estimation

Dependent variable = OFFLAB

Variable	Regression Coefficient	t-statistic 464 df
D1	39.499	2.184**
D2	54.637	2.751***
D3	49.629	2.720***
p_a/p_m	19.836	1.865***
w/p_m	0.414	0.903
w^m/p_m	- 0.054	- 0.373
AGE	- 0.204	- 0.748
AGEM	- 0.477	- 1.682**
EDU	- 2.574	- 1.544*
EDUM	- 0.513	- 0.409
CASTED	7.636	4.178***
WRKMEM	4.604	3.391***
DEPMEM	- 0.222	- 0.123
CULT	- 0.892	- 4.605***
NRA	0.017	2.620***
LVAL	- 0.846	- 3.521***

TABLE 5.3

The Additive Risk Case: Tobit ML and OLS estimation

Dependent variable = OFFDAYS

	Tobit ML results		OLS results	
Variable	**Regression Coefficient**	**Asymptotic t-statistic**	**Regression Coefficient**	**t-statistic 464 df**
D1	37.998	2.674***	28.634	2.947***
D2	53.222	3.430***	31.272	2.931***
D3	60.346	4.257***	45.802	4.673***
p_a/p_m	6.767	0.799	10.277	1.799**
w/p_m	0.961	2.920***	0.534	2.165**
w^m/p_m	0.077	0.706	0.010	1.277
AGE	0.067	0.319	- 0.008	- 0.054
AGEM	- 0.750	- 3.463***	- 0.588	- 3.861***
EDU	0.232	0.174	- 0.110	- 0.123
EDUM	0.147	0.145	0.093	0.138
CASTED	4.897	3.483***	4.266	4.346***
WRKMEM	1.883	1.858**	2.488	3.412***
DEPMEM	- 1.038	- 2.824***	- 3.800	- 3.904***
CULT	- 0.928	- 5.783***	- 0.581	- 5.585***
NRA	0.008	1.688**	0.008	2.222**
LVAL	- 1.242	- 6.145***	- 0.568	- 4.401***

TABLE 5.4

The Multiplicative Risk Case: Tobit (SUR) and OLS (SUR) estimation

Dependent variable = OFFLAB

Variable	Tobit (SUR) results			OLS (SUR) results	
	Regression Coefficient	Asymptotic t-statistic	Elasticity of E(y)	Regression Coefficient	t-statistic 463 df
D1D3	37.121	1.396	0.45	36.844	1.541
D2	- 51.633	- 0.532	- 0.21	- 46.676	- 0.539
p_a/p_m	25.169	2.310**	0.26	25.397	2.370***
w/p_m	0.425	0.828	0.01	0.422	0.923
w^m/p_m	- 0.037	- 0.230	- 0.002	- 0.036	- 0.251
AGE	- 0.236	- 0.782	- 0.13	- 0.228	- 0.849
AGEM	- 0.466	- 1.482	- 0.24	- 0.483	- 1.727**
EDU	- 2.880	- 1.557*	- 0.08	- 2.701	- 1.641*
EDUM	- 1.266	- 0.923	- 0.08	- 0.999	- 0.813
CASTED	3.676	2.112**	0.18	4.034	2.406***
WRKMEM	4.657	3.069***	0.41	4.600	3.402***
DEPMEM	- 0.572	- 0.282	- 0.01	- 0.593	- 0.328
CULT	- 0.815	- 3.532***	- 0.22	- 0.835	- 4.061***
NRA	0.017	2.266**	0.07	0.017	2.565***
LVAL	- 0.950	- 3.559***	- 0.38	- 0.964	- 4.046***
EXPNR	- 0.001	- 1.229	- 0.04	- 0.001	- 1.385*
SIGNR	0.007	1.299*	0.79	0.006	1.388*

TABLE 5.5

The Multiplicative Risk Case: Tobit (SUR) and OLS (SUR) estimation

Dependent variable = OFFDAYS

	Tobit (SUR) results		OLS (SUR) results	
Variable	**Regression Coefficient**	**Asymptotic t-statistic**	**Regression Coefficient**	**t-statistic 463 df**
D1D3	11.138	0.768	13.000	1.069
D2	- 162.732	- 2.953***	- 160.050	- 3.463***
p_a/p_m	13.432	2.288**	13.682	2.385***
w/p_m	0.554	1.891**	0.557	2.265**
w^m/p_m	0.115	1.234**	0.116	1.490*
AGE	- 0.050	- 0.287	- 0.055	- 0.378
AGEM	- 0.548	- 3.040	- 0.542	- 3.589***
EDU	- 0.417	- 0.394*	- 0.461	- 0.520
EDUM	- 0.621	- 0.819*	- 0.713	- 1.122
CASTED	0.831	1.974**	0.461	1.332*
WRKMEM	2.506	2.887***	2.510	3.448***
DEPMEM	- 3.972	- 3.422***	- 3.983	- 4.092***
CULT	- 0.573	- 4.339***	- 0.573	- 5.174***
NRA	0.006	1.467*	0.006	1.687**
LVAL	- 0.668	- 4.430***	- 0.677	- 5.358***
EXPNR	- 0.0001	- 0.535	- 0.0001	- 0.645
SIGNR	0.012	3.858***	0.011	4.578***

TABLE 5.6a

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 1 of the system: Dependent variable = A

Variable	Regression Coefficient	Asymptotic t-statistic
D1D3	- 338.222	- 2.590***
D2	- 114.864	- 0.660
p_a/p_m	40.884	0.265
w/p_m	2.629	0.385
w^m/p_m	1.651	0.776
WRKMEM	163.186	8.645***
DEPMEM	30.527	1.191
CULT	7.114	2.489***
NRA	0.205	2.108**
LVAL	19.245	5.986***
CVNR	197.316	7.451***

TABLE 5.6b

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 2 of the system: Dependent variable = FDAYS

Variable	Regression Coefficient	Asymptotic t-statistic
D1D3	47.222	3.542***
D2	34.594	2.210**
p_a/p_m	17.533	1.961**
w/p_m	0.724	1.891**
w^m/p_m	0.208	1.728**
AGE	- 0.001	- 0.001
AGEM	- 0.644	- 2.752***
EDU	- 0.836	- 0.608
EDUM	- 0.016	- 0.018
WRKMEM	2.612	2.312**
DEPMEM	- 4.231	- 2.788***
CULT	- 0.552	- 3.167***
NRA	0.003	0.632
LVAL	- 0.578	- 2.940***
CVNR	- 0.791	- 0.531

TABLE 5.6c

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 3 of the system: Dependent variable = OFFLAB

Variable	Regression Coefficient	Asymptotic t-statistic
D1D3	60.995	2.561***
D2	63.780	2.326**
p_a/p_m	27.776	1.866**
w/p_m	0.446	0.703
w^m/p_m	- 0.014	- 0.068
AGE	- 0.260	- 0.693
AGEM	- 0.407	- 1.048
EDU	- 3.231	- 1.414*
EDUM	- 0.772	- 0.479
CASTED	2.741	1.375*
WRKMEM	4.941	2.640***
DEPMEM	- 0.792	- 0.315
CULT	- 0.728	- 2.521***
NRA	0.018	2.018**
LVAL	- 0.936	- 2.840***
CVNR	- 4.682	- 1.899**

TABLE 5.6d

The Multiplicative Risk Case: Tobit (SUR) estimation

Equation 4 of the system: Dependent variable = HIRLAB

Variable	**Regression Coefficient**	**Asymptotic t-statistic**
D1D3	363.693	1.635
D2	- 1863.679	- 6.184***
p_a/p_m	- 845.317	- 3.172***
w/p_m	- 4.713	- 0.400
w^m/p_m	- 3.777	- 1.026
WRKMEM	- 119.448	- 3.928***
CULT	130.998	26.495***
NRA	0.246	1.461*
LVAL	33.151	5.997***
CVNR	126.320	2.770***

Chapter 6

Summing Up

This study was motivated by the fact that the overwhelming burden of previous research into the issue of farmers' off-farm labour supply ignored the presence of risk as a variable of potential importance. We find this to be an important omission, given the nature of agricultural production.

An additional reason for correcting this error of omission stems from the undesirable statistical implications of an omitted variable misspecification. Given that the "true underlying model" is likely to be complex, it is believed that the "representative model" is unlikely to be of low dimensionality. Structural analyses ignoring the presence of risk, therefore, are likely to lead to misleading inferences.

Yet another reason for undertaking this study stemmed from our observation that the theoretical analyses of the individual consumer and the farm household under risk had few unambiguous results to offer. Even on rather simple assumptions as to the underlying framework being analysed, the results are found to depend crucially on the third derivative properties of the utility function, about which we have no strong priors. In other cases, results may be ambiguous as they depend upon the interaction of opposing substitution, income and profit effects. In the event, recourse to empirical estimation at some stage becomes unavoidable.

We model the farm household's decision-making process within the framework of a household production model under risk, wherein the household is assumed to maximise the expected utility of a multi-argument utility function. Using this framework, it becomes evident that the conclusions from the model turn on the interplay between the household's risk attitudes and the risk regime. If the household is risk neutral, then irrespective of the way in which risk is modeled, it does not influence the household's decision-making. But the burden of evidence on risk attitudes supports the view that farmers are risk averse. In this case, the risk regime becomes significant. Taking revenue risk to be the more relevant risk confronting farmers, it is shown, following Fabella [op. cit.], that additive risk mimics risk neutrality in that it does not affect the optimisation conditions. On the other hand, multiplicative risk makes for non-separability between the consumption and production decisions of the household, so that the variables endogenous to the system have to be solved for simultaneously. In consequence, the farm household's off-farm labour supply decisions are now affected by risk considerations. Some evidence was presented to support the approximation that net revenue is reasonably normally distributed, so that the expectation and variance of (expected) net revenue may be taken to represent the risk confronting farm households.

6.2 Using ICRISAT's farm level data for the villages of Aurepalle, Shirapur and Kanzara, we first estimated the wage labour supply function under the alternative assumptions of additive and multiplicative risk for the household as a whole. The results of these estimation exercises are reported in Tables 4.1 and 4.4 . Since a detailed discussion of the individual results has already been presented above, it need not be repeated here. A few broad comments may, however, be in order.

First, our data set allowed us to include the (real) price of the consumption staple as an additional argument in the estimation equations. The previous studies employing the household model framework had omitted this variable at the estimation stage (e.g.

Rosenzweig, Sumner, Huffman), presumably because they used data from a single period cross-section for estimation. And those studies which did not use a household model framework (e.g. Bardhan), did not have the price variable in their model to begin with. As it turns out, this variable is found to be highly statistically significant in all the estimation exercises that we carried out. Further, the elasticity of labour supply with respect to this variable is positive and reasonably large. This is important in view of the fact that many a green revolution has been spurred by a positive price policy. Therefore, a positive price policy will serve to increase labour supply; and, perhaps, employment and incomes. This result differs from that of Barnum and Squire [op. cit.] who find the price elasticity of labour supply (on-farm plus off-farm) to be - 0.58 for a sample of Malaysian farmers. They attribute this result to an inelastic response of hired labour. In our context, the availability of labour for hire does not seem to be a problem. Therefore, it is possible that a given variable may have different policy implications in different contexts.

Second, in all our exercises we find the wage response of off-farm labour supply to be positive, unlike the results of previous studies pertaining to Indian farmers. These results are found to be statistically significant when OFFDAYS is used as the dependent variable, and (mostly) insignificant when OFFLAB is used as the dependent variable. Since the latter variable includes involuntary unemployment, we would expect the (supposedly) positive relation between involuntary unemployment and the wage rate to strengthen the positive relation between OFFDAYS and the wage rate. Therefore, the reason for the above result is not clear. In any case, in both cases the off-farm labour supply elasticities were very small.

Third, as we argued in chapter 2, the considered opinion seems to be in favour of incorporating risk into the decision framework in a multiplicative manner. Using the multiplicative risk model we find unambiguous evidence against the "disincentive effects" of revenue uncertainty. The theoretical literature found this effect to be ambiguous under multiplicative risk unless very limiting assumptions are made. Both in the case of all workers (Table 4.4) as well as that of female workers only (Table 5.4), we find the coefficient of the variable SIGNR (measuring the variability of net revenue) to be positive and significant. Thus, in the absence of well-developed insurance and capital markets, the household seeks to adjust to increases in net revenue uncertainty by moving away from the relatively risky prospect (namely, labour supply in household production) towards the relatively certain prospect (namely, labour supply in off-farm work activities). In other words, the household uses the labour market to hedge against uncertainty.

Fourth, our analysis adds a new dimension to studying the effects of price stabilisation schemes. The commodity price stabilisation literature (e.g. see Newbery and Stiglitz) discusses the impact of price stability in terms of efficiency gains and the gains in producer revenue, if any. But this fails to account for the fact that agricultural producers are not necessarily pure producers. At certain times of the year they may also enter the (daily, casual) labour market. In this case, price stabilisation schemes will affect not only producer incomes from on-farm production, but also their income from off-farm work activities. Indeed, we find that in the case of multiplicative revenue risk, decreased price and revenue risk will decrease the off-farm labour effort. This will decrease producer incomes, reinforcing the argument in the received stabilisation literature, that increased price stability may actually reduce producer revenues.

Fifth, there remains the question whether there is a significant difference between the results yielded by the models estimated under different risk formulations. Indeed, this seems to be the case. Table 4.4 reveals that both the expectation of net revenue as well as its variance are statistically significant in explaining changes in the dependent variable. Further, with regard to the other variables, although the qualitative results are no different under the additive and multiplicative risk cases, the quantitative results *are* different. A comparison of the elasticities in Tables 4.1 and 4.4 reveals that the off-farm labour supply elasticity with respect to the price of the staple is 10% smaller (in absolute terms) in the multiplicative risk model than it is in the additive risk model. Similarly, the (absolute) elasticities with respect to the variables education, gross cropped area and land value are, respectively, 17%, 22% and 12% smaller in the multiplicative risk model than they are in the additive risk model. The sole exception occurs in the case of the variable "number of working members", where the elasticities are approximately equal to 0.70 in both models. While these differences in the two sets of elasticities may appear to be small, we should keep in mind that they may well imply substantial changes in absolute numbers.

As we pointed out earlier, the Tobit model attempts to explain not only the magnitude of the response of the regressand, but also the probability of the limit (and thereby, the non-limit) response. It may be instructive, therefore, to know what fraction of the total response of y on account of a change in any of the regressors is due to the non-limit response. McDonald and Moffitt [1980] show that the total change in y on account of a change in any of the variables in X may be decomposed as follows:

$$\frac{\partial E(y)}{\partial X_i} = \Phi(z)\frac{\partial E(y^*)}{\partial X_i} + E(y^*)\frac{\partial \Phi(z)}{\partial X_i} \qquad (1)$$

where y^* are the non-limit observations on the dependent variable,

$z = X\beta/\sigma$ is a standard normal variate.

Therefore, the total change in y may be dichotomized into: (i) the change in y of the observations above the limit, weighted by the probability of being above the limit; and (ii) the change in the probability of being above the limit, weighted by the expected value of the non-limit observations on y. The authors show that:

$$\frac{\partial E(y^*)}{\partial X_i} = \beta_i\left[- z\frac{\phi(z)}{\Phi(z)} - \frac{\phi^2(z)}{\Phi^2(z)}\right] \quad (2)$$

and

$$\frac{\partial \Phi(z)}{\partial X_i} = \phi(z)\frac{\beta_i}{\sigma} \quad (3)$$

Substituting (2) and (3) into (1), they show that

$$\frac{\partial E(y)}{\partial X_i} = \phi(z)\beta_i$$

Then, dividing (1) throughout by $\Phi(z)\beta_i$, the fraction of the total effect on account of the non-limit response is shown to be equal to $[1 - z\phi(z)/\Phi(z) - \phi^2(z)/\Phi^2(z)]$. Estimating z at the mean levels of the regressors, we find this fraction to be 0.693 . In other words, almost 70% of the change in off-farm labour supply of the cultivator households resulting from a change in any of the regressors will be due to marginal changes in the number of days worked, and only 30% will be due to a change in the probability of being in the labour force. This is intuitively plausible, since the total labour force is overwhelmingly male in character, and males have traditionally been the primary earners in the family.

6.3 The female wage labour response was identified as especially interesting on several grounds, prompting us to estimate the additive and multiplicative risk models for the female workers in the household. The results are reported in Tables 5.1 and 5.4, and since they have been discussed earlier, they need not be repeated here. But, again, a few broad observations are called for.

A comparison of these results with the corresponding results for all working members shows that, qualitatively, the response patterns are similar for the two groups. The lone exception to this occurs with respect to the number of dependents in the household. As expected, we find that female wage labour supply is negatively related to this variable, whereas the total household off-farm labour effort is positively related to it. These results are reasonable in view of the fact that child rearing has traditionally been seen as a female responsibility. Quantitatively, however, the differences between these two sets of results are very striking.

Comparing the additive risk results for the two groups, we find the percentage change in the wage labour response of women (0.24) to be less than half that for all working members as a whole (0.60), for a given percentage change in the real price of the consumption staple. This shows that the effects of a positive price policy in terms of increased employment and incomes are likely to be a lot smaller in magnitude for women as a group than for the male workers. With respect to increases in the variables gross cropped area and land value, we find the decline in off-farm labour supply to be very substantially greater in the case of female workers. The result vis-a-vis the former variable is indicative of a relatively more prominent backward bend in the women's off-farm labour supply curve, which is plausible insofar as female wage labour is perceived as a secondary or supplemental source of family income. The result vis-a-vis the latter variable may be understood by recognizing the role of this variable as a proxy for asset productivity. Given that on-farm non-cultivation enterprises (mainly spinning, weaving, handicrafts etc.) are female-intensive in nature, an increase in asset productivity would lead to a much larger decrease in the off-farm labour effort of women than of the men of the household. One other difference may be of interest. The female wage labour elasticity with respect to the caste variable (0.42) is about 70% higher than the corresponding elasticity for all workers taken together (0.24). This indicates that the caste factor is much more important in the wage employment of women than it is in the case of the male workers. Indeed, it is the second largest elasticity value in the case of female workers. All of the observations that we have made above are also found to hold when we compare the wage labour responses of these two groups in the context of the multiplicative risk model.

Finally, employing the approach outlined in the previous section, we found that the fraction of the total change in the dependent variable resulting from a change in any of the regressors that is attributable to the non-limit response, is about 0.550 . Thus, about 55% of the change in the female wage labour supply will occur due to marginal changes in the number of days worked, and only 45% will be on account of a change in the probability of being in the labour force. Given the low female participation rates, one would naturally expect increased incentives to work to result in a higher participation rate and hence a higher probability of the non-limit response.

In conclusion, although a lot may be said in terms of ways to improve upon our research, two suggestions may be especially interesting. In the context of additive risk, it may be instructive to work in a multiple output framework. For, though additive risk may not be insured against through marginal changes in the allocation of inputs, it may be reduced through crop diversification. Secondly, a natural extension of the basic framework would be to introduce savings into the model. It would be of interest to see what impact, if any, the possibility of consumption smoothing would have on our results.

References

[1] Agarwal, Bina "Women, Poverty and Agricultural Growth in India", Journal of Peasant Studies, 13(4), July 1986, 165-220.

[2] Amemiya, T. "Advanced Econometrics", Harvard University Press, 1985.

[3] Antle, J. M. "Econometric Estimation of Producers' Risk Attitudes", American Journal Of Agricultural Economics, August 1987, 509-522.

[4] Antle, J. M. "Nonstructural Risk Attitude Estimation", American Journal Of Agricultural Economics, August 1989, 774-784.

[5] Arrow, K. J. "Essays in the Theory of Risk Bearing", Markham Publishing Co., Chicago, 1971.

[6] Bardhan, Pranab "Labour Supply functions in a Poor Agrarian Economy", American Economic Review, 69(March 1979), 73-83.

[7] Bardhan, Pranab "Land, Labour and Rural Poverty: Essays In Development Economics", Columbia University Press, 1984.

[8] Bardsley, P. and Harris, M. "An Approach to the Econometric Estimation of Attitudes to Risk in Agriculture", Australian Journal Of Agricultural Economics, 31(1987), 112-126.

[9] Barnum, Howard N. and Lyn Squire, "An Econometric Application of the Theory of the Farm-Household", Journal of Development Economics, 6(March 1979), 79-102.

[10] Barshira, Ziv "Behaviour Under Uncertainty: The Decision Criterion, the Attitude

Toward Risk, and the Choice of Labour Supply", Ch. 3, unpublished Ph.D. dissertation, University of California, Berkeley.

[11] Binswanger, Hans P. "Attitudes toward Risk: Experimental Measurement In Rural India", American Journal Of Agricultural Economics, August 1980, 395-407.

[12] Binswanger, Hans P. "Attitudes toward Risk: Theoretical Implications Of An Experiment In Rural India", The Economic Journal, December 1981, 867-890.

[13] Binswanger, Hans P. "Empirical Estimation and Use of Risk Preferences: Discussion", American Journal of Agricultural Economics, May 1982, 391-393.

[14] Brink, L. and B. McCarl "The Tradeoff between Expected Return and Risk among Corn Belt Farmers", American Journal of Agricultural Economics, 60(1978), 259-263.

[15] Conklin, F., A. Baquet and A. Halter "A Bayesian Simulation Approach for Estimating Value of Information: An Application to Frost Forecasting", Oregon State Univ. Agr. Exp. Sta. Tech. Bull. No. 136, May 1977.

[16] Dandekar, V. M. "Introduction", Indian Journal Of Agricultural Economics, 1980(2), 1-12.

[17] DaVanzo, J., D. deTray and D. Greenberg "The Sensitivity of Male Labour Supply Estimates to the Choice of Assumptions", Review of Economics and Statistics, 58(1976), 313-325.

[18] Dillon and Scandizzo "Risk Attitudes Of Subsistence Farmers in Northeast Brazil; A sampling Approach", American Journal Of Agricultural Economics, 1978, 425-435.

[19] Fabella, Raul V. "Separability and Risk in the Static Household Production Model", Southern Economic Journal, 55(4), April 1989, 954-961.

[20] Fafchamps, Marcel "Sequential Decisions Under Uncertainty and Labour Market Failure: a model Household behaviour in the African Semi-Arid Tropics", unpublished dissertation, University of California, Berkeley.

[21] Francisco, E. and J. Anderson "Chance and Choice West of the Darling", Australian Journal of Agricultural Economics, 3(1978), 99-109.

[22] Gregory, G. C. "Tests Of Equality Between Sets Of Coefficients In Two Linear Regressions", Econometrica, 28(July 1960), 591-605.

[23] Halter, A. N. and Robert Mason "Utility Measurement for Those Who Need to Know", Western Journal of Agricultural Economics, 3(1978), 99-109.

[24] Ham, John C. "Estimation of a Labour Supply Model with Constraints due to Unemployment and Underemployment", Review of Economic Studies., XLIX(1982), 335-354.

[25] Ham, John C. "Three Empirical Essays on Constraints in the Labour Market", unpublished dissertation, Princeton University.

[26] Heckman, James "Sample Selection Bias as a Specification Error", Econometrica, 47(1979), 153-162.

[27] Hinkley, D. V. "Jackknifing in Unbalanced Situations", Technometrics, 19(1977), 285-292.

[28] Horn, S. D., R. A. Horn and D. B. Duncan "Estimating Heteroscedastic Variances in Linear Models", Journal of the American Statistical Association., 70(1975), 380-385.

[29] Horowitz, Ira "Decision Making and the Theory of the Firm", Holt, Rinehart and Winston Inc., 1970.

[30] Huffman, Wallace E. "Farm and Off-Farm Work Decisions: The Role of Human Capital, Review of Economics and Statistics, 62(1980), 14-23.

[31] Judge, G. et. al. "The Theory And Practice Of Econometrics", Wiley, 1985.

[32] Judge, G. et. al. "Introduction To The Theory And Practice Of Econometrics", Wiley, 1988.

[33] Kataoka, S. "A Stochastic Programming Model", Econometrica , 31(1963), 181-196.

[34] Krishna, Raj "A Note on the Elasticity of the Marketable Surplus of a Subsistence Crop", Indian Journal of Agricultural Economics, July-Sept. 1962.

[35] Krishna, Raj "Agricultural Price Policy and Economic Development" in H. M. Southworth and B. F. Johnston (eds.) "Agricultural Development and Economic Growth", 1967.

[36] Lin, William, G. W. Dean and C. V. Moore "An Empirical Test of Utility vs. Profit Maximisation in Agricultural Production", American Journal of Agricultural Economics, Aug. 1974, 497-508.

[37] McCarthy, W and J. Anderson "Applied Aspects of Farmer Decision Making", *Conference Proceedings on the Committee on Economics of Range Use and Development*, West. Agr. Econ. Res. Council Rep. No. 8, 1966, 141-155.

[38] McDonald, J., and R. Moffitt "The Uses of Tobit Analysis", Review of Economics and Statistics, 62(1980), 318-321.

[39] McKinnon, J. G. and H. White "Some Heteroskedasticity Consistent Covariance Estimators with Improved Finite Sample Properties", Journal of Econometrics, 29(Sept. 1985), 305-325.

[40] Menezes, C., G. Geiss and J. Tressler "Increasing Downside Risk", American Economic Review, 70(1980), 921-932.

[41] Moscardi, E. and A. de Janvry, "Attitudes Towards Risk among Peasants: An Econometric Approach", American Journal Of Agricultural Economics, Nov. 1977, 710-716.

[42] Nelson, F. "Efficiency of the Two-Step Estimator for Models with Endogenous Sample Selection", Journal of Econometrics, 24(1984), 181-196.

[43] Newbery, D. and J. Stiglitz "The Theory of Commodity Price Stabilization: A Study In The Economics of Risk", 1981.

[44] Officer, R. R. and A. N. Halter "Utility Analysis in a Practical Setting", American Journal of Agricultural Economics, 50(May 1968), 491-506.

[45] Olsen, R. "A Note on the Uniqueness of the Maximum Likelihood Estimator for the Tobit Model", Econometrica, 46(1978), 1211-1215.

[46] Parliament, Claudia "Agricultural Production Cooperatives: Factors Affecting Performance", unpublished Ph.D dissertation, University of California, Berkeley.

[47] Pratt, J. W. "Risk Aversion in the Small and in the Large", Econometrica , 32(1964), 122-136.

[48] Quizon, Jaime B. et. al. "Attitudes toward Risk: Further Remarks", The Economic Journal, March 1984, pp. 144-148.

[49] Rao, C. R. "Estimation of Heteroscedastic Variances in Linear Models, Journal of the American Statistical Association, 65(1970), 161-172.

[50] Robison, L. J. "An Appraisal of Expected Utility Hypothesis Tests Constructed from Responses to Hypothetical Questions and Experimental Choices", American Journal of Agricultural Economics, 1982, 367-375.

[51] Roe, Terry and Theodore Graham-Tomasi "Yield Risk in a Dynamic Model of the Agricultural Household", in Singh, Inderjit et. al (eds.) "Agricultural Household Models: Extensions, Applications, and Policy", 1986, 255-276.

[52] Rosenzweig, Mark "Neoclassical Theory and the Optimizing Peasant: An Econometric Analysis of Market Family Labour Supply in Developing Countries", Quarterly Journal of Economics, 94(1979), 31-56.

[53] Singh, R. P. et. al. "Manual Of Instructions For Economic Investigators In ICRISAT's Village Level Studies (Revised)", International Crops Research Institute for the Semi-Arid Tropics, 1985.

[54] Sumner, Daniel A. "The Off-Farm Labour Supply of Farmers", American Journal of Agricultural Economics, Aug. 1980, 499-509.

[55] Taylor, W. E. "Small Sample Properties of a Class of Two-Step Aitken Estimators", Econometrica, 45(1977), 497-508.

[561 Taylor, W. E. "The Heteroscedastic Linear Model: Exact Finite Sample Results", Econometrica, 46(1978), 663-675.

[57] Tobin, James "Estimation Of Relationships For Limited Dependent Variables", Econometrica, 1958, 24-36.

[58] Wales, T. and A. Woodland "Estimation of Household Utility Functions and Labour Supply Response", International Economic Review, 17(1976), 397-410.

[59] Wales, T. and A. Woodland "Estimation of the Allocation of Time for Work, Leisure and Housework", Econometrics, 45(1977), 115-132.

[60] Walker, Thomas S. and James G. Ryan "Village and Household Economies in India's Semi-Arid Tropics", Johns Hopkins Press, Baltimore, 1990.

[61] Walker, T. S. and K. V. Subba Rao "Yield and Net Return Distributions in Common Village Cropping Systems in the Semi-Arid Tropics of India", Economics Programme, Progress Report 41, ICRISAT.

[62] Webster, J. and J. Kennedy "Measuring Farmers' Tradeoffs between Expected Income and Focus Loss Income", American Journal of Agricultural Economics, 57(1975), 97-105.

[63] White, H. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", Econometrica, 48(1980), 817-838.

[64] Young, Douglas L. "Risk Preferences of Agricultural Producers: Their Use in Estimation and Policy", American Journal of Agricultural Economics, 61(1979), 1063-1084.