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Class Position and Economic Behavior in a Tunisian Village: Selective Separability in a multi-factor household model[†]

by

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Abstract

The purposes of this paper are twofold. First, we examine, using a unique dataset collected in the Tunisian village of El Oulja, what might be termed "all or nothing" separability (Benjamin, 1992) by testing, while controling for plot characteristics (Udry, 1996), the proposition that farm input use is independent of household characteristics. Second, we test for separability in the context of a model of class structure based on the seminal work of Eswaran and Kotwal (1986). In order to do so, we construct a model of class structure which offers an appealing representation of the typology of household types in the village when they are classified in terms of (i) their hiring in of wage labor, and (ii) their hiring out of family labor. We use a two-stage estimation technique in which we first estimate the probability of class membership as a function of household characteristics using discrete choice methods. In the second stage we estimate labor intensity per hectare using a Lee-Heckman procedure in which the inverse-Mill ratio from the first stage is included as an additional explanatory variable. As with the case of the test for "all or nothing" separability, the test for selective separability involves exclusion restrictions on household characteristics, although these are now conditional on class membership.

Our empirical results strongly support the selective separability hypothesis as well as our theoretical model: most of the "action" in terms of non-separability stems, as one would expect from the model, from the class of "self-cultivators" who neither hire in wage labor nor hire out family labor. Our paper extends the work of DeJanvry, Sadoulet and Benjamin (1996) on Mexican ejidatarios to plot- as opposed to household-level estimation. Moreover, our paper provides an elaboration on and an empirical bridge to theoretical models, such as Roemer (1982), Eswaran and Kotwal (1986), and Carter and Zimmerman (1995) which examine how credit constraints and imperfections on factor markets shape the class structure of the agrarian economy. The implications and scope for government intervention in the context of market imperfections are also examined.

1. INTRODUCTION

A common practice in the empirical investigation of agricultural production is to assume that consumption and production decisions are separable.[1] This is because separability is equivalent to assuming that peasant household production behavior is determined by profit- as opposed to utility-maximizing behavior. The theoretical underpinning for this practice is that input markets are complete and perfectly competitive. Although substantial evidence has been presented to support this theory,[2] there also are arguments favoring incomplete or imperfectly competitive markets.[3] If input markets were indeed incomplete or imperfect, then household characteristics would be important determinants of farm input use and consequently the consumption and production decisions of peasant households would not be separable.

The first purpose of this paper is to examine what might be termed "all or nothing" separability by testing the proposition that farm input use is independent of household characteristics. The second purpose of this paper, building on the work of Bedi and Tunali (1995) and DeJanvry, Sadoulet and Benjamin (1996), is to extend the discussion of separability to situations in which households transact on more than one market simultaneously (the previous literature has explicitly or implicitly held all other factor of production as exogenously fixed while testing for separability on one factor demand equation at a time. In this respect, our paper provides an elaboration on and an empirical bridge to theoretical models, such as Roemer (1982), Eswaran and Kotwal (1986), and Carter and Zimmerman (1995) which examine how credit constraints and imperfections on factor markets shape the class structure of the agrarian economy.

Previous work on testing (directly or indirectly) the "all or nothing" separation hypothesis includes Pitt and Rosenzweig (1986), Arayama (1986), Lopez (1986), Jacoby (1993), and Benjamin (1992). All these studies focus exclusively on the labor market. They test the "all or nothing" separation hypothesis by examining either the returns to on- and off-farm employment or the effects of household composition on farm labor allocation. With respect to testing the "all or nothing" separation hypothesis, our paper differs from these previous studies in four respects.

First, failure of separation is likely to affect all inputs as well as farm output, while the usual procedure has been to focus on the labor market. We have data on the use of several

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[1] See the collection of papers collected in Singh, Squire, and Strauss (1986).

[2] The most notable recent example is Benjamin (1992), who also gives representative references from the literature.

[3] See, for example, Udry (1996) and the references cited therein.

inputs, as well as on farm output, so we can implement a more powerful test for separation through estimating multiple equations and testing the separation hypothesis in each of these equations. Second, since plots may be cultivated under tenancy contracts, the term of the contracts and the monitoring activities of the landlord may have effects on input use and on farm output. If these effects were not controlled for, the test for separation would be biased. Given that we have detailed data on the terms of the contracts as well as on the landlord's monitoring and agricultural management activities, we can control for these effects by explicitly including these variables in regression equations estimated at the plot level (the only other paper we are aware of which test for separability using plot-level, as opposed to household-level, data is Udry (1996)). Moreover these additional, plot-specific, characteristics may provide important information which will mitigate omitted variable bias which has been a source of concern in recent work.[4] Third, farm households may opt not to use certain inputs. When this happens, the use of these inputs are recorded as zero. This will be particularly common when working with data at high levels of disaggregation and at the plot level, as we do. Econometrically, this means that these inputs are subject to a left censoring problem. If this problem is not dealt with properly, the test for separation is biased. We use tobit regression techniques to control for censoring bias. Fourth, while household composition is an important determinant of input use under nonseparation, other household characteristics (e.g. land ownership or the human capital of household members) may also be important. The test for separation would be more powerful if these other characteristics were included in the regressions. We include these other characteristics in the input use and output equations. Consideration of these additional factors which may lie behind the potential rejection of "all or nothing" separability also allows us to paint a more detailed picture of the nature and operation of various markets in the Tunisian village we will be considering.

An simple empirical model that incorporates these extensions is developed and estimated on a rich plot-level dataset from the Tunisian village of El Oulja. We first pool data on plots producing heterogeneous crops for two years (1986 and 1993), and test for "all or nothing" separation. We find that household characteristics are insignificant in the output and total labor input equations, but that they are significant in other input equations as well as in disaggregated male labor and female labor input equations. These results clearly reject the "all or nothing" separation hypothesis. However, these results may be biased because of pooling of (i) heterogeneous crops, and (ii) data from different agricultural years. To test the robustness of our results, we also estimate the model separately for the 1986 and 1993 agricultural years. Still, we find in favor of "all or nothing" nonseparation. We then estimate the model for a subsample of plots producing wheat across the two sample years, as well as for the 1986 and

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[4] For example, Benjamin (1994) notes that ommitted land characteristics may be an important source of bias leading to the well-known inverse relationship between land size and input use.

1993 years separately. We now find that the impact of household characteristics is more pronounced in both the output and total labor input equations. They are also significant in other input equations. This leads us to conclude that the consumption and production decisions are "all nothing" nonseparable, at least in El Oulja. To summarize, "all or nothing" separation is inherently linked to market completeness and perfection and its difference from nonseparation can be characterized by a set of exclusion restrictions. These exclusion restrictions allow us to test the "all or nothing" separation hypothesis.

The second purpose of our paper, namely to test for separability in the context of a model of class structure, extends the work of DeJanvry, Sadoulet and Benjamin (1996) on Mexican ejidatarios to plot- as opposed to household-level estimation. As with "all or nothing" separability, this allows us to control for plot characteristics which would be a potential source of ommitted variable bias in houeshold-level estimation. We construct a simple model of class structure, in the spirit of Eswaran and Kotwal (1986), which would appear to offer a reasonable approximation of the typology of household types when they are classified in terms of (i) their hiring in of wage labor, and (ii) their hiring out of family labor. We use a two-stage estimation technique in which we first estimate the probability of class membership as a function of household characteristics using a multinomial probit procedure. In the second stage we estimate labor intensity per hectare using a Lee-Heckman procedure in which the inverse-Mill ratio from the first stage is included as an additional explanatory variable. As with the case of the test for "all or nothing" separability, the test for selective separability involves exclusion restrictions on household characteristics, although these are now conditional on class membership. Our empirical results strongly support the selective separability hypothesis as well as our theoretical model: most of the "action" in terms of non-separability stems, as one would expect from the model, from the class of "self-cultivators" who neither hire in wage labor nor hire out family labor. It is not surprising to find that the marginal productivity of labor for these self-cultivators is a function of their endowments of land and labor.

The paper is organized as follows. Section 2 presents a simple theoretical framework for demonstrating the "all or nothing" separability result. Section 3 specifies the econometric model for testing for "all or nothing" separability; we then discuss the resulting empirical results. Section 4 provides a simple theoretical model which is consistent with the observed class structure of El Oulja, at least with respect to participation in the family and hired labor markets; we then implement this model empirically and present our results. Section 5 concludes the paper.

2. ALL OR NOTHING SEPARABILITY

In this section, we will use a simple model to demonstrate the basic separability result. Let $U(c;a)$ denote the household utility function, where c is consumption and the vector a parameterizes the utility function and summarizes household characteristics. We assume that a is exogenous. Let $F(A,X;T,b)$ denote the production function, where $A=L+H$ is the sum of family (L) and hired (H) labor, X is a vector of other inputs such as fertilizer, seeds, plowing, and transportation, while land, denoted by T, is assumed fixed and exogenous. The vector b parameterizes the production function and summarizes land characteristics; b is also assumed to be exogenous. As will become clear below, the assumption that hired and family labor are perfect substitutes is an extremely strong assumption which, though commonly made, is not innocuous.

Suppose that the prices of hired labor H and off-farm labor L_O are equal to w and that the prices of purchasing other inputs X are equal to p. The household has an endowment of family labor equal to L^e and exogenous income y. Let the price of output be the numéraire. The farmer allocates his endowment of labor between work on the farm and work off the farm.[5] He can also hire labor to produce output that he sells in a competitive market. Since agricultural production takes time, we assume that production takes place during the period and consumption takes place at the end of the period. The household's budget constraint is given by

$$c = F(A,X;T,b) - wH - pX + wL_O + y, \tag{1}$$

while its labor endowment allocation constraints are given by

$$L_O + L = L^e \text{ and } A = L + H \tag{2}$$

Since production takes place before consumption, the household only has income y available to purchase inputs and hire labor if credit markets do not exist; in this case, the household is subject to the liquidity constraint $wH + pX \le y$. Credit can easily be introduced into the discussion by assuming that the right-hand-side of the constraint is a function of the availability of credit which is itself a function of wealth or land ownership, an issue we shall delve into in some detail in section 5. If off-farm employment opportunities are limited, the household may also be subject to the constraint $L_O \le \tilde{L}$, where $\tilde{L}$ denotes the maximum number of hours the farmer can work off-farm. To summarize, when input markets are incomplete or imperfect,

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[5] One can easily extend the model to incorporate labor-leisure choice, in effect endogenizing L^e, but we will refrain from doing so here in order to illustrate the separability result as transparently as possible.

there are other constraints in addition to (1) and (2) that households will be subject to. In what follows, we will not spell out the details of the imperfections that give rise to these conditions. Instead, we will summarize potential constraints associated with household-specific characteristics in the form of the inequality:

(3) $$h(L, H, L_O, X, w, p) \leq 0 .$$

The farmer's problem is to maximize household utility $U(c;a)$ subject to constraints (1), (2) and (3). Let l denote the Lagrange multiplier associated with (3). The first order conditions (FOCs) to the farmer's problem are

(4) $$\frac{\P U(c;a)}{\P c}\frac{\P c}{\P q} = l\,\frac{\P h(.)}{\P q} ,$$

where $q = L,\ H,\ L_O,\ X$. The coefficient l is nonzero when (3) is binding. Solving (4) gives

(5) $$q = f\left(a, b, A, w, p, l\right).$$

Note that the multiplier l can be interpreted as the increase in household utility resulting from increasing the right hand side of (3) from 0 to 1; l is generally a function of $a, b, A,\ w, p,$ and y if it is nonzero. This implies that input use is a function of $a, b, A, w, p,$ and y. If l is zero, one can show from (4) that L and X are determined by the FOCs

(6) $$\frac{\P F(A, X; T, b)}{\P A} = w \ \text{ and } \ \frac{\P F(A, X; T, b)}{\P X} = p .$$

The solution for A and X from (6) are then independent of a and y. Thus, a and y are excluded from the input use equations when separation holds and they are not excluded when separation does not hold. These exclusion restrictions form the basis of our test for separation.

The simple model above can be extended in several respects, but the exclusion restrictions which characterize the separable case remain unchanged. First, markets for some inputs may not exist.[6] When this happens, the corresponding components of p are shadow prices and these shadow prices will be functions of household characteristics a and y. Second, the returns to on- and off-farm employment may differ. Benjamin (1992) showed that the exclusion restrictions still hold in this case. Third, households may farm several plots and

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[6] An example in the Tunisian village we are considering is animal manure. In the Asian context, bullocks are often cited as the prototypical example of an unmarketed input. Unmarketed inputs, such as management and supervision also play a prominent role in certain models of tenancy, such as Eswaran and Kotwal (1985).

some of these plots may be cultivated under tenancy contracts. One can show that the above exclusion restrictions hold true for each plot, provided that the terms of the contracts are controlled for.[7]

3. ECONOMETRIC IMPLEMENTATION: A FIRST PASS

We implement the test for separation by parameterizing (5) and then testing the exclusion restrictions. We specify (5) as

$$(7) \qquad \ln\left(\frac{A}{T}\right) = Z'b + u\,,$$

$$(8) \qquad \ln\left(\frac{X}{T} + 1\right) = Z'a + v\,.$$

Note that we specify the non-labor input equation (equation (8)) differently from the total labor input equation (equation (7)). The reason for this is entirely empirical. In our data set, the ratio A/T is always positive, but X/T frequently takes the value of zero. Adding the constant 1 ensures that $\ln\left((X/A)+1\right)$ is well defined. Further, $\ln\left((X/A)+1\right) > 0$ if and only if $X/A > 0$ and $\ln\left((X/A)+1\right) = 0$ if and only if $X/A = 0$.[8]

In addition to (7) and (8), we will also estimate

$$(9) \qquad \ln\left(\frac{Y}{A}\right) = Z'g + e\,,$$

$$(10) \qquad \ln\left(\frac{L_M}{A}\right) = Z'd + m\,,$$

$$(11) \qquad \ln\left(\frac{L_F}{A} + 1\right) = Z'g + e\,,$$

where L_M and L_F denote the total male and female labor inputs respectively and Y denotes output. The vector Z contains the following four classes of variables:

— (i) land characteristics (type of soil: clay, red earth, sandy, or barren; and whether the plot is irrigated);

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[7] The only other paper dealing with plot-level (in contrast to household-level) estimation is that by Udry (1996), although his data pertain solely to owner-operators.

[8] An alternative approach is to use a linear instead of a log-linear specification. In the interest of brevity we do not present the linear results as they did not differ appreciably from the log-linear results we do present.

— (ii) household characteristics (household size, the proportion of household members constituted by prime-age males, the same percentage for females, the age of the household head, the age of the household head squared, the educational level of the household head, the average level of education in the household, the maximum level of schooling among household members excluding the household head, and the amount of land owned by the household, which is a proxy for wealth);

— (iii) the terms of the contract on each plot of land cultivated by the household under a sharecropping contract; the terms of the contract are constituted by the ratio of the cost share borne by the tenant to his output share for (a) family labor, (b) hired labor, (c) irrigation, (d) plowing, (e) manure, insecticides, pesticides, herbicides, and sulfur, (f) transportation, (g) chemical fertilizer (regular phosphates, super phosphates and amonitre), (h) harvesting, and (i) seeds); contract terms also include the frequency of visits by the landlord to the peasant on plots under tenancy arrangements, whether the tenant and landlord had a contractual relationship during the previous season, as well as dummy variables which indicate whether it was the peasant or the landlord who took a series of key agricultural management decisions;

— (iv) the logarithm of the plot area and a time dummy for the 1986 or the 1993 crop seasons.

The first two classes of variables are similar to those used by Benjamin (1992) except that some of them are defined slightly differently and additional characteristics are included. Household size is the total number of people who live in the same household. Prime-age male fraction is the ratio of the number of males aged between 14 and 64 divided by household size. Prime age female fraction is defined analogously. The separability hypothesis is equivalent to testing whether the coefficients on the second class of variables equal zero in all equations.

The third class of variables were used by Ai, Arcand, and Ethier (1996) in testing for the presence of moral hazard in tenancy contracts. These variables are intended to control for the possible effects of tenancy contracts and landlord intervention on input use. The logarithm of plot size is included to control for the inverse relationship between plot size and productivity familiar from a number of studies.[9] The time dummy is used to represent the effects of w and p on which the data are not available to us. Fortunately, in El Oulja, w and p do not vary across plots and households, but they may vary over time. The time dummy also captures other time varying variables such as technical progress. Note that the contractual variables we include are the ratios of the cost share borne by the peasant to the output share accruing to him, for each input over which there is potentially cost-sharing. This is because the peasant, if

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[9] See Bardhan (1973), Berry and Cline (1979), Deolalikar (1981), as well as Rao and Chotigeat (1981). See Benjamin (1995) and Udry (1996) for recent explanations of this phenomenon based on omitted land characteristics.

he is maximizing profits, takes the effective real price of inputs to be their price multiplied by his cost share and divided by his output share.

The dependent variables are farm output, total (family and hired) labor use, total (family and hired) male labor use, total (family and hired) female labor use, seeds, chemical fertilizers, irrigation and transportation. Output, seeds, chemical fertilizer, irrigation, and transportation are expressed in Tunisian dinars per hectare, while labor inputs are expressed in person-days per hectare.

Results

We estimate (7), (9) and (10) by ordinary least squares regression and (8) and (11) by tobit maximum likelihood estimation with data pooled from several crops and from the 1986 and 1993 agricultural years. The dataset used in this study comes from a survey conducted by the authors in 1993 and by Laffont and Matoussi in 1986 in the Tunisian village of El Oulja. Detailed information on household and plot characteristics, landlord activities on plots under tenancy arrangements, and contract terms were collected. There are total of 297 households in the village. These households cultivated 983 plots of land. Each plot is counted as one observation. After eliminating observations with missing data as well as plots lying fallow, only 749 plots are used in the estimation. Summary statistics of the data used in estimation are reported in Table 1. Table 2 reports censoring frequencies for the relevant inputs.

Estimation results for the full sample are presented in Table 3. The null hypothesis that total labor input per hectare is independent of household characteristics is not rejected by the data, as shown by the $c^{2}(10)$ test statistic. The same is true of output per hectare and total male labor input per hectare. On the other hand, the null hypothesis that total female labor input per hectare is independent of household characteristics is rejected at the 1% level. Among the nonlabor input equations, household characteristics were found to be significant in plowing, manure, and seeds at the 5%, 1%, and 5% levels respectively.

Male labor input per hectare is a decreasing function of the proportion of prime-age females, while the opposite relationship holds for female labor input per hectare. Thus, households with a higher proportion of prime-age females tend to use male labor less intensively and female labor more so. They also tend to use chemical fertilizer more intensively, as is indicated by the statistically significant (t=2.50) positive coefficient on the prime-age female fraction in the chemical fertilizer per hectare equation. There is also a statistically significant relationship between female labor input per hectare and family size:

larger families tend to use less female labor; household size, on the other hand, has no impact on male labor intensity. It appears, therefore, that families particularly well endowed with prime-age female labor use it in agricultural production in substitution for male labor. Concomitantly, larger families tend to reduce female labor use in agricultural production, perhaps by redirecting female family labor towards household production activities. Finally, note that the human capital variables have very little explanatory power: it is only in the equation for irrigation input per hectare that the maximum level of schooling and the average level of schooling in the household are significant at the usual levels of confidence.

These results highlight the importance of testing for separability at a level of aggregation which does not obscure potential departures from profit-maximizing behavior. Had we relied solely on the total labor or output per hectare equations, we would not have rejected the null hypothesis that input use or output is independent of household characteristics. Indeed, in so far as the labor demand equations are concerned, the distinction between male and female labor appears to be crucial. In the context of a relatively traditional Islamic society such as rural Tunisia's, this should not come as a surprise. Moreover, Indian evidence (Rosenzweig (1980), Bardhan (1984)) indicates that labor supply elasticities differ substantially by sex and that gender-specific activities render aggregation over both sexes problematic.

Robustness

Because different crops may use different technologies and because farmers may use different technologies in different years, the results above may be biased due to pooling. To check our results for robustness, we re-estimated the model for the following subsamples: (a) all crops for the year 86; (b) all crops for the year 1993; (c) a subsample of plots producing wheat for both years; (d) the wheat subsample for the year 1986; and (e) wheat subsample for the year 93. The results are reported in Table 4 to 8. Note that different sets of regressors were used in the estimations. This is because, when restricting to a subsample, some regressors are either zero or perfectly correlated with other regressors, and hence must be dropped. If the regressors that are dropped are perfectly correlated with included family characteristics, then the coefficients on family characteristics would be biased and our test of separation would be inappropriate. Fortunately, for those input equations reported in Tables 4 to 8, the set of included regressors with which the dropped regressors are perfectly correlated does not include any of the family characteristics. Thus, the coefficients on these family characteristics are consistently estimated and our test for separation is the appropriate one.

For the case of subsamples (a) and (b), the rejection of separation is now stronger that in the case of the full sample. In addition to some non-labor inputs, household characteristics are also significant in total labor and total male labor input per hectare and in the output equation for subsample (a). These results indicate that there might be biases due to pooling observations from two different crop years, but that these biases are not driving our rejection of the null hypothesis of separation. For the case of subsamples (c), (d), and (e), the results show that there are biases resulting from pooling different crops as well as pooling time series. However, the separation hypothesis is still rejected.

The result for the wheat subsample are presented in Table 6. First, note that male labor input per hectare is a decreasing function of the prime-age female fraction (as in the full sample results), as well as of the prime age male fraction. This would appear to indicate that families endowed with above average levels of prime-age individuals hire out a higher proportion of their labor resources. This intuition receives support from the output intensity equation. Output per hectare is a decreasing function of prime age male and prime age female fractions. Since households with higher prime-age fractions use less male labor per hectare (the same is true in the total labor per hectare equation), it follows that a greater proportion of household income may stem from hired out labor: it would appear that households trade less output per hectare on plots that they cultivate for greater labor income when they are relatively well endowed in highly marketable prime-age males. This also indicates that the marginal product of male labor on farmed plots is not equated to the corresponding wage rate.[10] Note also that, for the wheat subsample, land ownership (which here represents effects stemming from differences in wealth) has a positive and statistically significant impact on output per hectare. This impact appears to stem from a greater use of chemical fertilizer, as indicated by the positive and statistically significant coefficient on land ownership in the chemical fertilizer per hectare equation. In the context of El Oulja, where credit markets are far from perfect, it would appear quite reasonable to infer that a binding working capital constraint is driving these results.[11]

Female labor input per hectare constitutes the most interesting labor input equation: it is a decreasing function of household size (as in the full sample). In contrast to male labor, female labor input per hectare is independent of the prime-age male fraction, while it is an increasing function of the prime-age female fraction (as in the full-sample results). Its relationship to the age of the household head plots out an inverted-U, with the coefficients on age and age squared both being statistically significant. Female labor input per hectare is also

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[10] This hypothesis is tested explicitly by Jacoby (1993).

an increasing function of the schooling of the household head, while it is a decreasing function of the average schooling of household members. Note also that female labor input per hectare is unique among the labor input equations in that it does not display the strong inverse relationship with land size displayed by male and total labor input per hectare.

4. CLASS STRUCTURE AND SELECTIVE SEPARABILITY

While the results we have just presented suggest that the average behavior in our sample is consistent with non-separability, it would seem obvious to pose the following question: are all the households in our sample subject to non-separability or are there household-specific characteristics which divide households into different categories with display differing responses with respect to the separability issue? We are not the first to pose this question, which constitutes the crux of so-called models of "class structure", although we are among the first to offer a structural econometric implementation which bridges the divide between theoretical (Roemer (1982), Eswaran and Kotwal (1986), Carter and Zimmerman (1995)) and empirical work. Perhaps the paper closest in spirit to our own is that by DeJanvry, Sadoulet, and Benjamin (1996) who construct an Eswaran and Kotwal (1986) type model in which households with differential endowments of labor skills and which are heterogeneous in the transactions costs they incur in accessing labor markets self select into one of three classes: labor importers, labor exporters and non-participants.[12]

Table 9 presents the agrarian production organization of the Tunisian village of El Oulja as it appeared in the 1986 and 1993 surveys. Recall that L^e represents the household's endowment of labor, L represents family labor used on plots of land cultivated (either as the owner or as the tenant) by the household, $L^e - L$ represents family labor hired out, H represents outside labor hired in by the household, T^e is the household's endowment of land, while T is the amount of land that it cultivated. The unit of observation here is the household. The typology we adopt, classifying households into laborer, self cultivator, laborer-cultivator

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[11] If one refers to section 2, we mean a constraint of the form $wL_H + pX \leq y$, where X is chemical fertilizer and y is an increasing function of land ownership).

[12] Also see Carter (1990), Carter and Wiebe (1993), and Frisvold (1994) for attempts to implement the Eswaran-Kotwal typology empirically.

1, laborer-cultivator 2 and small capitalist classes is drawn in part from Eswaran and Kotwal (1986). Table 10 presents the characteristics of households, according to class membership.

Given that our goal is to derive a theoretical model which is estimable, it is worth enumerating the minimum requirements that such a model must satisfy for it to provide a useful description of the class structure in El Oulja. First, we shall confine our attention to households which engage in agricultural production: we therefore exclude absentee landlords and households composed exclusively of wage laborers *a priori*. Second, we shall assume that family labor use is always strictly positive, so as to be in conformity with our data (from which fallow plots have been purged). Third, hired labor must be an optional input, again in conformity with our data. Fourth, the model must accomodate households which both hire in wage labor and hire out family labor —the laborer-cultivator 1 class in Table 9; the Eswaran and Kotwal (1986) model does not allow for this class. Finally, the model must allow for non-participation in the labor market, i.e., no hiring out of family labor, no hiring in of wage labor.

A simple model

Consider a standard household production model in which land and family labor are "essential" inputs in that no agricultural production can take place without them, whereas the use of hired labor is optional. In contrast to many treatments of household production, we will assume that hired and family labor are not perfect substitutes in the production process. This additional assumption leads by necessity to one extra constraint in the household's maximization program, namely, that "exports" of family labor be non-negative. In addition to the usual constraints, we shall be assuming that the household must pay for all of its inputs "up front", so that it is subject to a cash-in-advance constraint. In the simplest version of the model, we will be assuming that there is no credit market.

In order to simplify our presentation, we will assume that the household is risk neutral and maximizes its (linear) utility subject to the above-mentioned constraints. Its optimization program is therefore given by:

$$
\begin{aligned}
&\max_{\{L,H,T\}} L^{a}\,(1+H)^{b}\,T^{d} + w\left(L^{e}-L\right)+r\left(T^{e}-T\right)-wH-F \\
&s.t.\;\; w\left(L^{e}-L\right)+r\left(T^{e}-T\right)-wH-F \geq 0 \;\;(l) \qquad (12)\\
&\quad L^{e}-L \geq 0 \;\;(m)\\
&\quad H \geq 0 \;\;(h)
\end{aligned}
$$

where l, m and h are the associated Lagrange multipliers. In order to be able to obtain closed form solutions for illustrative purposes, we shall assume that the production function exhibits decreasing returns to scale ($a+b+d<1$), rather than assuming supervision costs associated with hired labor as in Eswaran and Kotwal (1986). Note that this specification can be thought of as the reduced form of a linearly homogeneous production function where the inputs are family labor, land, and "effective" hired labor, where effective hired labor, $\tilde{H}$, is given by $\tilde{H}=q(H,L,T)$, with $q_H>0, q_L>0, q_T<0$. In order to rule out the division of the farm into infinitessimally small plots, we shall assume that there are fixed costs, denoted by F, associated with producing on each plot. Forming the Lagrangian, the Kuhn-Tucker conditions for profit-maximization are given by:

$$
\begin{aligned}
&a\,L^{a-1}(1+H)^{b}\,T^{d} - w(1+l)-m=0\\
&b\,L^{a}\,(1+H)^{b-1}T^{d} - w(1+l)+h=0\\
&d\,L^{a}\,(1+H)^{b}\,T^{d-1}-r(1+l)=0 \qquad (13)\\
&\left(w\left(L^{e}-L\right)+r\left(T^{e}-T\right)-wH-F\right)l=0\\
&\left(L^{e}-L\right)m=0\\
&Hh=0
\end{aligned}
$$

We can then summarize the mapping from endowment space to class structure with the following proposition (the proof, which is rather tedious, follows from considering the 8 possibilities which arise when one has 3 Lagrange multipliers which can be either zero or strictly positive):

PROPOSITION 1. The problem posed in (13) admits 8 solutions which may be parametrized in (L^{e},T^{e}) space and are defined as follows:

— A) Cash in advance constraint binding

(i) constrained self-cultivator (no hiring out of family labor, no hiring in of wage labor):

For $T^e > \frac{F}{r};\ T^e > \frac{F}{r} + \left(\frac{w}{a}\right)\left(\frac{r}{d}\right)^{-1} L^e;\left(\frac{w}{b}\right)\left(\frac{r}{d}\right)^{-1} + \frac{F}{r} > T^e$

we have $T = T^e - \frac{F}{r},\ L = L^e,\ H = 0$

(ii) constrained small capitalist (no hiring out of family labor, wage labor hired in):

For $T^e > \frac{F-w}{r}, T^e > \left(\frac{b+d}{d}\right)\left(\frac{w}{a}\right)\left(\frac{r}{d}\right)^{-1} L^e + \frac{F-w}{r}, T^e > \left(\frac{w}{b}\right)\left(\frac{r}{d}\right)^{-1} + \frac{F}{r}$

we have

$$T = \left(\frac{r}{d}\right)^{-1}\left(\frac{rT^e - F + w}{b+d}\right),\ L = L^e,\ H = \left(\frac{rT^e - F + w}{b+d}\right)\left(\frac{w}{b}\right)^{-1} - 1$$

(iii) constrained laborer-cultivator 2 (hiring out of family labor, no hiring in of wage labor):

For

$$T^e > -\frac{w}{r}L^e + \frac{F}{r},\ \left(\frac{a+d}{d}\right)\left(\frac{r}{d}\right)^{-1}\left(\frac{w}{b}\right) - \frac{w}{r}L^e + \frac{F}{r} > T^e,$$

$$T^e < \left(\frac{r}{d}\right)^{-1}\left(\frac{w}{a}\right)L^e + \frac{F}{r}$$

we have

$$T = \left(\frac{r}{d}\right)^{-1}\left(\frac{wL^e + rT^e - F}{a+d}\right),\ L = \left(\frac{w}{a}\right)^{-1}\left(\frac{wL^e + rT^e - F}{a+d}\right),\ H = 0$$

(iv) constrained laborer-cultivator 1 (hiring out of family labor, wage labor hired in):

For $T^e > -\frac{w}{r}L^e + \frac{F}{r} - \frac{w}{r},\ T^e < \left(\frac{b+d}{d}\right)\left(\frac{r}{d}\right)^{-1}\left(\frac{w}{a}\right)L^e + \frac{F}{r} - \frac{w}{r},$

$$T^e > -\frac{w}{r}L^e + \left(\frac{a+d}{d}\right)\left(\frac{r}{d}\right)^{-1}\left(\frac{w}{b}\right) + \frac{F}{r},$$

we have

$$T = \left(\frac{r}{d}\right)^{-1}\left(\frac{wL^e + rT^e + w - F}{a+b+d}\right),\ L = \left(\frac{w}{a}\right)^{-1}\left(\frac{wL^e + rT^e + w - F}{a+b+d}\right),$$

$$H = \left(\frac{w}{b}\right)^{-1}\left(\frac{wL^e + rT^e + w - F}{a+b+d}\right) - 1$$

— B) Cash in advance constraint not binding

(v) unconstrained self-cultivator (no hiring out of family labor, no hiring in of wage labor):

For $\left(\left(\frac{w}{b}\right)^{1-d}\left(\frac{r}{d}\right)^{d}\right)^{\frac{1}{a}} > L^e > \left(\left(\frac{w}{a}\right)^{1-d}\left(\frac{r}{d}\right)^{d}\right)^{\frac{1}{a+d-1}}, T^e - \left(L^e\right)^{\frac{a}{1-d}}\left(\frac{r}{d}\right)^{-\frac{1}{1-d}} - \frac{F}{r} > 0$ we have

$$T = \left(L^e\right)^{\frac{a}{1-d}}\left(\frac{r}{d}\right)^{-\frac{1}{1-d}},\ L = L^e,\ H = 0$$

(vi) unconstrained small capitalist (no hiring out of family labor, wage labor hired in):

For $L^e > \left(\left(\frac{w}{a} \right)^{1-b-d} \left(\frac{w}{b} \right)^{b} \left(\frac{r}{d} \right)^{d} \right)^{\frac{1}{a+b+d-1}}$, $L^e > \left(\left(\frac{w}{b} \right)^{1-d} \left(\frac{r}{d} \right)^{d} \right)^{\frac{1}{a}}$,

$$T^e > \left(L^e\right)^{\frac{a}{1-b-d}} \left(\frac{b+d}{d} \right) \left(\frac{w}{b} \right)^{\frac{-b}{1-b-d}} \left(\frac{r}{d} \right)^{\frac{b-1}{1-b-d}} + \frac{F}{r} - \frac{w}{r}$$

we have

$$T = \left(L^e\right)^{\frac{a}{1-b-d}} \left(\frac{w}{b} \right)^{\frac{-b}{1-b-d}} \left(\frac{r}{d} \right)^{\frac{b-1}{1-b-d}},\ L = L^e,\ H = \left(L^e\right)^{\frac{a}{1-b-d}} \left(\frac{w}{b} \right)^{\frac{d-1}{1-b-d}} \left(\frac{r}{d} \right)^{\frac{-d}{1-b-d}} - 1$$

(vii) unconstrained laborer-cultivator 2 (hiring out of family labor, no hiring in of wage labor):

For $\frac{w}{b} > \left(\frac{w}{a} \right)^{\frac{a}{a+d-1}} \left(\frac{r}{d} \right)^{\frac{d}{a+d-1}}$, $T^e > -\frac{w}{r} L^e + \left(\frac{a+d}{d} \right) \left(\left(\frac{w}{a} \right)^{a} \left(\frac{r}{d} \right)^{1-a} \right)^{\frac{1}{a+d-1}} + \frac{F}{r}$ we have

$$T = \left(\frac{w}{a} \right)^{\frac{a}{a+d-1}} \left(\frac{r}{d} \right)^{\frac{1-a}{a+d-1}},\ L = \left(\frac{w}{a} \right)^{\frac{1-d}{a+d-1}} \left(\frac{r}{d} \right)^{\frac{d}{a+d-1}},\ H = 0$$

(viii) unconstrained laborer-cultivator 1 (hiring out of family labor, wage labor hired in):

For $\left(\left(\frac{w}{a} \right)^{a} \left(\frac{w}{b} \right)^{1-a-d} \left(\frac{r}{d} \right)^{d} \right)^{\frac{1}{a+b+d-1}} > 1$, $\left(\left(\frac{w}{a} \right)^{1-b-d} \left(\frac{w}{b} \right)^{b} \left(\frac{r}{d} \right)^{d} \right)^{\frac{1}{a+b+d-1}} < L^e$,

$$T^e > -\frac{w}{r} L^e + \left(\frac{a+b+d}{d} \right) \left(\left(\frac{w}{a} \right)^{a} \left(\frac{w}{b} \right)^{b} \left(\frac{r}{d} \right)^{1-a-b} \right)^{\frac{1}{a+b+d-1}} + \frac{F}{r} - \frac{w}{r}$$

we have

$$T = \left(\left(\frac{w}{a} \right)^{a} \left(\frac{w}{b} \right)^{b} \left(\frac{r}{d} \right)^{1-a-b} \right)^{\frac{1}{a+b+d-1}},\ L = \left(\left(\frac{w}{a} \right)^{1-b-d} \left(\frac{w}{b} \right)^{b} \left(\frac{r}{d} \right)^{d} \right)^{\frac{1}{a+b+d-1}},$$

$$H = \left(\left(\frac{w}{a} \right)^{a} \left(\frac{w}{b} \right)^{1-a-d} \left(\frac{r}{d} \right)^{d} \right)^{\frac{1}{a+b+d-1}} - 1$$

We summarize the model in factor endowment space in Figure 1. The incorporation of credit into the preceding model is extremely simple given our assumption of the presence of fixed costs. If we denote the working capital available to the household by B, then the budget constraint faced by the household becomes: $w\left(L^e - L\right) + r\left(T^e - T\right) - wH - F + B \geq 0$; PROPOSITION 1 is then readily modified by substituting F by $F - B$. Note also that while PROPOSITION 1 yields exclusion restrictions which allow one to identify whether a household belonging to a given class is credit-constrained or not, it also yields predictions regarding the sign of the partial derivative of total labor input per hectare with respect to the labor and the land endowment. We will look at these comparative statics later when we discuss the empirical results.

Empirical implementation

We now implement the simple model of class structure outlined in the previous section. For the moment, we shall only be considering separability issues in the markets for wage labor that is hired in and family labor that is hired out. Let $j = 1, 2, 3, 4$ denote the class to which a household, indexed by h, belongs to; plots will be indexed by i. Class 1 will correspond to self cultivators, class 2 will correspond to laborer cultivators of the first type, class 3 will correspond to laborer cultivators of the second type, while class 4 will correspond to small capitalists. The labor demand per hectare equation for plot i worked by household h belonging to class j is given by

$$\frac{L_{ih}}{A_{ih}} = Z'_{ih} b_j + u_{ihj}, \tag{14}$$

where u_{ihj} is the class-specific disturbance term. Note that PROPOSITION 1 and the four-fold partition of household endowment space represented in Figure 1 (cases 1 and 5, cases 2 and 6, cases 3 and 7, cases 4 and 8) implies a switching regression specification with four régimes and two indicator functions (this last point arises because each class is defined by two inequalities). Despite this theoretical specification, we cannot identify the parameters of each indicator function separately because there are no *a priori* reasonable exclusion restrictions which would allow one to have non-overlapping exogenous variables in the two indicator functions. It follows that the first-stage in the two-stage Lee-Heckman estimation procedure we implement yields reduced form coefficients for the indicator functions which cannot unambiguously be disentangled so as to yield the partition of endowment space. We implement the first stage of our procedure by first estimating the probability of a household belonging to a given class using a multinomial probit procedure. The dependent variable is the 4-by-1 vector of indicator variables, while the explanatory variables is the usual matrix of household characteristics. Though computationally cumbersome (it involves the computation of triple integrals over the trivariate normal distribution), this procedure yields consistent estimates of the probability of class membership, which can then be sustituted in inverse-Mills ratio form so as as to yield estimates of the slope coefficients $b = (b_1, b_2, b_3, b_4)$ in the factor intensity equations as well as their associated standard errors in standard OLS regressions. Inference can then be performed on the slope coefficients associated with household characteristics in order to test the selective separability hypothesis. Apart from the usual multicollinearity problems, all coefficients in this second stage are properly identified because of the lack of perfect overlap in the explanatory variables in the first and second stage estimations.

Results

In interpreting the empirical results in what follows, two lines of though should be kept in mind. The first is that testing for selective separability is simply a more precise form of testing for separability which conditions on the observed class membership of households. In this framework, one should interpret the results as tests of the exclusion restrictions implied by separability, and allow the class structure which has been superimposed on the separability issue to guide us in identifying those specific households which are responsible for the failure of "all or nothing" separability to hold. The second line of thought is more structural in nature and involves using the estimation results to provide one with a test of the validity of the class structure approach which is being proposed. Though it is unreasonable to expect that such a simple model will provide an explanation for all aspects of labor use, it may help to guide us toward those specific imperfections which are driving non-separability within the confines of the class structure framework.

With respect to the exclusion restrictions associated with separability (and associated with the endowments of labor and land), the results presented in Table 12 indicate that all of the "action" regarding non-separability stems from the self-cultivator and laborer cultivator 1 classes. Indeed, the null hypothesis of separability is not rejected for the laborer cultivator 2 and small capitalist classes. In terms of household composition variables, it is the laborer cultivator 1 class which is the most interesting. For this class,which is engaged on both the hired-in wage labor and hired-out family labor markets, the prime age percentages (both male and female) are highly significant and negative. This is consistent with what one would expect: households which participate on both sides of the labor market and which are particularly well-endowed with prime-age individuals will tend to reduce the use of these individuals on the plots that they farm and will prefer to offer their services on the labor market. It would seem likely that, for laborer cultivators of the first type, the marginal productivity of family labor is smaller than their corresponding wage rate. These households will thus tend to substitute hired-in wage labor for the family labor that they hire out. For the self cultivator households, which participate in neither market, the failure of separability is not surprising: self cultivators are households where, by definition, the marginal productivity of both types of labor is not equated to the market wage rate.

The hypotheses which are associated with PROPOSITION 1 offer a test of the structural validity of our model of class structure. It is immediate, by examining the results presented in PROPOSITION 1, that a credit constrained self cultivator's labor use per hectare will be a decreasing function of his land endowment. This is indeed the case, implying that one potential source of non-separability for this class is constituted by a binding credit constraint. If this is the case, one should also have a positive and statistically significant coefficient on the household's labor endowment. This is not the case, the relevant coefficient being statistically insignificant. While this might cast doubt on the theoretical validity of the model of class structure which underlies our estimation, the statistical significance of the household's average level of schooling suggests that the relevant measure of labor endowment might be the human capital augmented labor endowment, i.e., the value of the labor endowment, adjusted for labor quality. For the small capitalist class, a non-binding credit constraint implies that the total labor input per hectare will be independent of the household's endowment of land. That this is so is readily apparent from the results presented in Table 12. On the other hand, unconstrained small capitalists' total labor input per hectare should also be an increasing function of the household's labor endowment, and this is not the case.

The two laborer cultivator classes provide the most appealing support for our model of class structure. In neither case is total labor input per hectare significantly related to either the land or the labor endowment: this implies that these classes are not subject to a binding credit constraint and is perfectly coherent with the theoretical model. On the other hand, and as was noted above, laborer cultivators of type 1 do not have a separable labor input per hectare equation. This implies that the source of non-separability does not lie in a binding credit constraint, but rather, as was noted above, in a discrepancy between the marginal productivity of labor on and off the farm, stemming probably from labor market imperfections.

5. CONCLUDING REMARKS

In contrast to the work on separability undertaken in the Indonesian context by Benjamin (1992), our results for Tunisia yield a strong rejection of the null hypothesis of "all or nothing" separability between consumption and production decisions. This is true for the entire sample, in which we pool data across crops and across sample years, as well as for subsamples in which the various sources of heterogeneity bias are eliminated. Our tests for selective separability in the context of a model of class structure allowed us to identify two classes —self cultivators and laborer cultivators of the first type— as the source of non-separation. Restriction on parameter estimates implied by our theoretical model also allowed us to rule out that non-separation in the laborer cultivator of type one class stemmed from a binding credit constraint.

The results of our paper highlight three important points regarding household models and the question of separability. First, in the context of "all or nothing" separability, it is important to consider input use at a level of disaggregation which does not obscure potential departures from separability. Second, estimation at the plot (as opposed to the household) level is essential if one is to be able to control for plot-specific characteristics, such as soil type and contractual status, which may have important effects on input use. Third, departures from separability may stem from multiple sources, and identifying these is a complex process which leads to empirical methods which are by necessity much more "structural" than what has been implemented so far. If the results in this paper have shown that it is possible to disentangle various sources of non-separability, then they have also shown that further investigation of the sources of market failure in the context of LDCs is not pointless, and may indeed be useful.

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Table 1
Description of the variables and Summary Statistics

VARIABLES		MEAN	STD. ERROR	MIN.	MAX.
Output	expressed in Tunisian dinars per hectare	4589.84	10334.10	4.00	110000
Factor inputs					
Male family labor	expressed in person-days per hectare	94.17	113.45	1.00	1134.00
Female family labor	expressed in person-days per hectare	27.22	56.94	0.00	480.00
Male hired labor	expressed in person-days per hectare	117.39	260.55	0.00	2310.00
Female hired labor	expressed in person-days per hectare	132.33	362.93	0.00	4180.00
Cost of irrigation	expressed in Tunisian dinars per hectare	277.97	629.77	0.00	9000.00
Cost of ploughing	expressed in Tunisian dinars per hectare	179.13	335.19	0.00	2880.00
Cost of manure and herbicides etc.	expressed in Tunisian dinars per hectare	177.38	423.25	0.00	4500.00
Cost of transportation	expressed in Tunisian dinars per hectare	173.36	413.18	0.00	5400.00
Cost of chemical fertilizer	expressed in Tunisian dinars per hectare	2.76	5.32	0.00	54.24
Cost of harvesting	expressed in Tunisian dinars per hectare	0.08	0.52	0.00	8.50
Cost of seeds	expressed in Tunisian dinars per hectare	0.25	0.49	0.00	6.00
Landlord management inputs					
Landlord chooses crop	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord choses the crop, equals 0 otherwise	0.13	0.33	0.00	1.00
Landlord chooses timing and type of plowing	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord choses the quantity, timing and type of plowing, equals 0 otherwise	0.15	0.35	0.00	1.00
Landlord chooses type and quantity of seeds, and the timing of sowing	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses type and quantity of seeds, and the timing of sowing, equals 0 otherwise	0.09	0.28	0.00	1.00
Landlord chooses type, timing and quantity of transportation	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses type, timing and quantity of transportation, equals 0 otherwise	0.07	0.26	0.00	1.00
Landlord chooses type, timing and quantity of fertilizer	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses type, timing and quantity of fertilizer, equals 0 otherwise	0.09	0.28	0.00	1.00

VARIABLES		MEAN	STD. ERROR	MIN.	MAX.
Landlord chooses type, timing and quantity of manure	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses type, timing and quantity of manure, equals 0 otherwise	0.08	0.27	0.00	1.00
Landlord chooses type, timing and quantity of family labor	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses type, timing and quantity of family labor, equals 0 otherwise	0.03	0.17	0.00	1.00
Landlord chooses type, timing and quantity of hired labor	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses type, timing and quantity of hired labor, equals 0 otherwise	0.03	0.17	0.00	1.00
Landlord chooses type, timing and quantity of irrigation	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses type, timing and quantity of irrigation, equals 0 otherwise	0.05	0.22	0.00	1.00
Landlord chooses use made of livestock	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses use made of livestock, equals 0 otherwise	0.05	0.22	0.00	1.00
Landlord chooses timing of harvesting	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses timing of harvesting, equals 0 otherwise	0.08	0.27	0.00	1.00
Landlord chooses timing and use of combine harvester	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses timing and use of combine harvester, equals 0 otherwise	0.06	0.23	0.00	1.00
Landlord chooses the proportion of total output to be sold	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord chooses the proportion of total output to be sold, equals 0 otherwise	0.09	0.29	0.00	1.00
Landlord has final say regarding decisionmaking on the plot	equals 1 when the plot is cultivated under a fixed rental or sharecropping tenancy contract and the landlord has final say regarding decisionmaking on the plot, equals 0 otherwise	0.09	0.29	0.00	1.00
Supervision and repeated interaction					
Contract with same landlord in previous season	equals 1 when the plot is under a fixed rental or sharecropping tenancy contract and the tenant had the same contractual relationship with the same landlord in the previous growing season, equals 0 otherwise	0.22	0.41	0.00	1.00

Supervision by the landlord	for plots under sharecropping or fixed rental contracts: 1 = every day, 2 = twice a week, 3 = once a week, 4 = once or twice a month, 5 = once or twice a season, 6 = not at all; equals 0 otherwise	1.42	2.25	0.00	6.00

VARIABLES		MEAN	STD. ERROR	MIN.	MAX.
Terms of the contract					
Percentage of pre-harvesting costs paid by peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	90.48	23.52	0.00	100.00
Percentage of harvesting costs paid for by peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	93.01	20.36	0.00	100.00
Percentage of manure, herbicide and insectide cost paid by peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	88.69	21.17	0.00	100.00
Percentage of irrigation cost paid by peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	85.29	28.43	0.00	100.00
Percentage of family labor cost paid by the peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	96.60	12.59	25.00	100.00
Percentage of hired labor cost paid by the peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	96.39	14.01	0.00	100.00
Percentage of ploughing cost paid by peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	82.41	34.90	0.00	100.00
Percentage of seed cost paid by peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	89.13	20.88	0.00	100.00
Percentage of transportation cost paid by peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators	88.96	21.78	0.00	100.00
Percentage of principal crop accruing to the peasant	for plots under sharecropping or fixed rental contracts only; equals 100 for owner-operators and tenants under fixed rental contracts	87.95	21.17	25.00	100.00
Characteristics of land					
Clay soil	equals 1 when soil is clay, zero otherwise	0.27	0.44	0.00	1.00
Red earth	equals 1 when soil is “red earth”, zero otherwise	0.13	0.34	0.00	1.00
Sandy soil	equals 1 when soil is sandy, zero otherwise	0.49	0.50	0.00	1.00
“Barren” soil	equals 1 when soil is “barren”, zero otherwise	0.10	0.29	0.00	1.00
Irrigated plot	equals 1 when the plot is irrigated, zero otherwise	0.92	0.27	0.00	1.00
Plot area	surface of the plot in hectares	14.80	32.75	0.20	500.00

Table 2
Percentage of censored dependent variables, by factor input

Factor input	Percentage of censored dependent variables
Female family labor	56.8
Female hired labor	54.1
Male hired labor	32.8
Manure, herbicides and insecticides	29.3
Chemical fertilizers	5.9
Irrigation	14.1
Plowing	2.8
Transportation	12.7
Harvesting	82.8
Seeds	8.5

TABLE 3: FULL SAMPLE (749 OBSERVATIONS)

	M.lab	Tot. lab	Fem.lab	Output	Irrigation	Plowing	Manure	Chem. fert	Seeds
Repeated interaction	-0.69	-0.73	-0.87	-0.49	-0.01	-0.02	-0.02	-0.03	0.00
	(2.65)	(2.62)	(1.79)	(2.43)	(0.53)	(2.14)	(0.89)	(0.40)	(0.12)
Choice of crop	-1.04	-1.62	-3.36	0.11	-0.26	-0.04	-0.14	-0.46	-0.33
	(0.56)	(0.81)	(1.00)	(0.01)	(1.47)	(0.60)	(0.92)	(0.92)	(1.85)
Choice of plowing	0.68	0.65	0.97	0.64	0.07	0.02	0.06	0.02	0.05
	(1.04)	(0.94)	(0.84)	(1.28)	(1.09)	(0.91)	(1.05)	(0.11)	(0.86)
Choice of transportation	-1.20	-1.10	-0.42	1.22	0.02	-0.02	0.03	-0.46	-0.04
	(0.75)	(0.65)	(0.15)	(0.26)	(0.15)	(0.31)	(0.21)	(1.07)	(0.25)
Final decisionmaking on plot	0.90	1.21	2.49	0.51	0.09	0.01	0.01	0.16	0.14
	(1.06)	(1.32)	(1.62)	(0.78)	(1.17)	(0.43)	(0.18)	(0.68)	(1.73)
Landlord visits	0.13	0.15	0.16	0.14	0.01	0.00	0.00	0.02	0.01
	(3.24)	(3.39)	(2.17)	(4.72)	(3.01)	(1.32)	(0.42)	(2.23)	(1.36)
% of pre-harvesting costs	-0.37	-0.35	-0.33	-0.14	0.00	-0.01	-0.02	-0.01	-0.01
	(2.52)	(2.29)	(1.30)	(1.30)	(0.01)	(1.30)	(1.82)	(0.37)	(0.37)
% of fert., herb. and ins. costs	1.33	1.77	4.73	0.62	0.27	-0.01	0.04	0.41	0.21
	(0.89)	(1.12)	(1.50)	(0.54)	(1.91)	(0.17)	(0.30)	(1.04)	(1.47)
% of irrigation costs	-0.10	-0.13	-0.27	0.09	-0.05	-0.01	-0.02	-0.07	-0.05
	(0.53)	(0.62)	(0.68)	(0.60)	(2.47)	(1.25)	(1.22)	(1.40)	(2.77)
% of plowing costs	-0.10	-0.14	-0.12	-0.05	0.01	0.00	0.00	-0.03	0.00
	(0.61)	(0.83)	(0.42)	(0.38)	(0.45)	(0.74)	(0.01)	(0.69)	(0.11)
% of family labor costs	-0.13	-0.14	0.33	0.16	0.01	-0.01	-0.05	-0.04	0.04
	(0.23)	(0.23)	(0.29)	(0.39)	(0.17)	(0.37)	(1.04)	(0.30)	(0.85)
% of hired labor costs	-0.38	-0.41	-0.79	0.17	-0.01	0.00	0.01	-0.13	0.06
	(0.85)	(0.86)	(1.00)	(0.50)	(0.19)	(0.04)	(0.22)	(1.05)	(1.34)
% of seed costs	-0.83	-1.09	-3.93	-0.51	-0.17	-0.01	-0.03	-0.35	-0.21
	(0.59)	(0.73)	(1.28)	(0.47)	(1.28)	(0.13)	(0.23)	(0.92)	(1.59)
% of transportation costs	-0.40	-0.45	-0.84	-0.05	-0.03	0.00	0.00	-0.12	0.00
	(1.10)	(1.16)	(1.32)	(0.16)	(0.94)	(0.41)	(0.16)	(1.18)	(0.01)
% of harvesting costs	0.32	0.28	0.34	0.11	0.00	0.00	-0.01	0.11	-0.11
	(0.82)	(0.67)	(0.49)	(0.36)	(0.07)	(0.33)	(0.25)	(1.02)	(3.03)
Joint signif. of contract vars	28.65	32.75	49.21	24.31	28.18	12.67	9.22	16.36	55.00
Prime-age males	0.12	-0.37	-1.88	-0.25	-0.05	0.00	0.08	0.07	0.04
	(0.27)	(0.81)	(2.35)	(0.75)	(1.20)	(0.04)	(2.15)	(0.61)	(0.94)
Prime-age females	-0.97	-0.47	2.99	-0.20	0.03	0.01	-0.01	0.32	0.05
	(2.00)	(0.90)	(3.39)	(0.54)	(0.62)	(0.45)	(0.13)	(2.50)	(1.13)
Household size	-0.01	-0.09	-0.59	0.07	0.01	0.00	-0.01	0.03	0.02
	(0.10)	(0.58)	(2.11)	(0.65)	(0.91)	(0.84)	(0.78)	(0.78)	(1.40)
Age of head	2.22	2.34	-6.27	-2.99	-0.69	0.40	0.46	-0.17	-0.80
	(0.58)	(0.57)	(0.85)	(1.02)	(1.86)	(3.14)	(1.39)	(0.16)	(2.16)
Age of head squared	-2.37	-2.41	5.82	2.37	0.59	-0.34	-0.37	-0.01	0.67
	(0.70)	(0.67)	(0.89)	(0.91)	(1.78)	(3.06)	(1.27)	(0.01)	(2.04)
Schooling of head	-0.03	-0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00
	(1.22)	(0.62)	(0.80)	(0.01)	(0.94)	(0.78)	(1.17)	(0.56)	(0.56)
Max. school. excl. head	0.04	0.04	0.04	-0.01	-0.01	0.00	0.00	0.01	0.00
	(1.09)	(0.95)	(0.59)	(0.29)	(2.04)	(0.96)	(0.89)	(0.60)	(0.51)
Ave. schooling in hh.	0.01	0.01	-0.06	0.03	0.02	0.00	0.01	-0.02	0.00
	(0.08)	(0.11)	(0.47)	(0.58)	(2.26)	(0.52)	(1.13)	(0.99)	(0.65)
Marital status of head	0.15	0.19	0.24	0.19	-0.02	-0.01	0.07	0.01	-0.01
	(0.80)	(0.95)	(0.70)	(1.35)	(1.27)	(1.51)	(4.33)	(0.12)	(0.45)
Land ownership	-0.08	-0.09	-0.13	0.05	0.01	0.00	0.00	0.02	0.01
	(1.31)	(1.43)	(1.01)	(1.11)	(1.53)	(0.37)	(0.34)	(1.23)	(1.55)
Joint signif of hhold chars	**12.79**	**7.45**	**6.24**	**31.00**	**15.70**	**18.53**	**40.40**	**13.86**	**19.61**
Clay soil	0.15	0.29	1.66	-1.49	-0.05	0.00	0.03	-0.06	0.02
	(0.26)	(0.45)	(1.09)	(3.28)	(0.84)	(0.08)	(0.70)	(0.36)	(0.36)
Red earth	0.39	0.55	1.46	-0.96	-0.01	-0.01	0.06	-0.01	0.05
	(0.65)	(0.87)	(0.95)	(2.10)	(0.13)	(0.52)	(1.22)	(0.09)	(0.90)
Sandy soil	-0.18	0.01	1.30	-1.44	-0.05	-0.01	0.04	-0.03	0.01
	(0.30)	(0.02)	(0.85)	(3.19)	(0.76)	(0.53)	(0.79)	(0.22)	(0.12)
“Barren” soil	0.18	0.38	2.05	-1.26	-0.04	0.00	0.13	0.08	0.03
	(0.30)	(0.59)	(1.32)	(2.73)	(0.57)	(0.12)	(2.72)	(0.47)	(0.54)
Irrigated plot	2.39	2.74	4.24	1.80	0.25	0.01	0.09	0.19	0.04
	(10.83)	(11.65)	(6.58)	(10.69)	(7.98)	(1.73)	(4.45)	(3.26)	(1.76)
Area of plot	-0.56	-0.56	-0.37	-0.21	-0.04	0.00	0.01	-0.04	-0.03
	(8.06)	(7.60)	(2.80)	(4.04)	(6.08)	(0.73)	(1.94)	(2.28)	(4.62)
Year	0.75	0.87	0.85	2.24	0.10	0.08	0.15	0.61	0.06
	(3.57)	(3.84)	(2.12)	(13.76)	(4.64)	(11.99)	(8.27)	(10.63)	(3.13)
Intercept	-0.09	-0.28	-2.80	-1.85	0.11	-0.10	-0.47	-0.09	0.17
	(0.08)	(0.21)	(1.08)	(1.98)	(0.89)	(2.61)	(4.50)	(0.28)	(1.44)
s^2			5.27		0.02	0.00	0.01	0.13	0.02
			(10.86)		(14.31)	(15.57)	(13.10)	(15.20)	(14.88)

TABLE 4. 1993 SAMPLE (415 OBSERVATIONS)

	M.lab	Tot. lab	Output	Plowing	Manure	Chem.fert.	Seeds
Repeated interaction	-0.49	-0.58	-0.50	-0.04	0.02	0.10	-0.04
	(1.13)	(1.23)	(1.60)	(2.03)	(0.48)	(0.67)	(0.76)
Choice of plowing	9.48	9.29	6.21	0.12	0.65	2.09	0.57
	(0.93)	(0.84)	(0.84)	(0.27)	(0.63)	(0.58)	(0.45)
Choice of transportation	-1.14	-1.10	0.44	0.00	0.02	-0.41	-0.04
	(0.64)	(0.57)	(0.34)	(0.04)	(0.12)	(0.66)	(0.18)
Final decisionmaking on plot	5.44	5.33	4.20	0.08	0.44	1.77	0.72
	(0.58)	(0.53)	(0.62)	(0.20)	(0.48)	(0.54)	(0.63)
Landlord visits	0.10	0.13	0.15	0.00	0.00	0.04	0.01
	(1.46)	(1.90)	(3.12)	(1.33)	(0.26)	(1.56)	(1.77)
% of pre-harvesting costs	4.13	5.44	0.75	0.06	0.04	0.88	0.52
	(2.02)	(2.46)	(0.51)	(0.73)	(0.22)	(1.22)	(2.06)
% of fertilizer, herb. and insect. costs	-8.60	-8.48	-3.77	-0.04	0.23	-0.19	-0.11
	(1.34)	(1.23)	(0.82)	(0.13)	(0.37)	(0.09)	(0.14)
% of irrigation costs	0.08	-0.30	0.20	-0.02	-0.02	-0.04	-0.19
	(0.13)	(0.47)	(0.48)	(0.85)	(0.30)	(0.19)	(2.57)
% of plowing costs	1.31	1.44	0.79	0.03	0.10	0.32	0.16
	(0.65)	(0.66)	(0.54)	(0.37)	(0.50)	(0.45)	(0.65)
% of family labor costs	-2.92	-3.31	-0.47	-0.03	-0.14	-0.56	-0.08
	(1.99)	(2.09)	(0.44)	(0.55)	(0.94)	(1.08)	(0.42)
% of hired labor costs	-1.25	-1.34	-0.61	-0.02	-0.10	-0.36	-0.04
	(0.67)	(0.66)	(0.44)	(0.19)	(0.52)	(0.54)	(0.17)
% of seed costs	8.88	9.33	3.65	0.03	-0.23	0.22	0.27
	(1.39)	(1.35)	(0.79)	(0.10)	(0.36)	(0.10)	(0.35)
% of transportation costs	-1.73	-1.84	-0.97	-0.01	-0.14	-0.45	-0.12
	(0.75)	(0.73)	(0.58)	(0.15)	(0.61)	(0.55)	(0.42)
% of harvesting costs	0.30	0.35	0.13	-0.01	0.00	0.11	-0.10
	(0.64)	(0.70)	(0.39)	(0.33)	(0.02)	(0.68)	(1.72)
Joint signif of contract vars	20.02	24.82	21.85	8.72	6.45	15.72	44.94
Prime-age males	-0.48	-1.08	-0.17	0.00	0.06	-0.03	0.04
	(0.79)	(1.62)	(0.39)	(0.14)	(1.04)	(0.15)	(0.57)
Prime-age females	-0.53	-0.07	0.62	0.02	0.07	0.61	0.00
	(0.73)	(0.09)	(1.18)	(0.69)	(0.94)	(2.37)	(0.02)
Household size	0.09	-0.03	-0.02	0.01	0.00	0.04	-0.01
	(0.39)	(0.10)	(0.10)	(0.69)	(0.20)	(0.52)	(0.38)
Age of head	16.05	15.94	-1.73	0.72	0.53	0.37	-1.28
	(2.64)	(2.43)	(0.39)	(2.75)	(0.86)	(0.17)	(1.69)
Age of head squared	-14.80	-15.09	1.98	-0.64	-0.44	-0.52	1.09
	(2.62)	(2.47)	(0.48)	(2.61)	(0.77)	(0.26)	(1.55)
Schooling of head	0.01	0.03	0.01	0.00	0.00	0.00	0.00
	(0.38)	(0.80)	(0.46)	(0.91)	(0.85)	(0.02)	(0.82)
Max. school. excl. head	0.05	0.02	0.00	0.00	-0.01	0.01	0.00
	(0.90)	(0.33)	(0.02)	(0.88)	(1.02)	(0.42)	(0.58)
Ave. schooling in hh.	0.04	0.10	0.01	0.00	0.01	-0.02	0.00
	(0.37)	(0.90)	(0.15)	(0.53)	(1.11)	(0.54)	(0.19)
Marital status of head	0.18	0.31	0.07	-0.02	0.08	0.02	-0.05
	(0.66)	(1.05)	(0.38)	(1.67)	(2.94)	(0.21)	(1.47)
Land ownership	-0.82	-0.53	0.37	0.01	0.04	0.01	0.16
	(1.32)	(0.79)	(0.82)	(0.29)	(0.69)	(0.04)	(2.09)
Joint signif of hhold chars	**22.88**	**21.51**	**3.51**	**18.42**	**21.07**	**9.50**	**25.61**
Clay soil	0.15	0.27	-1.08	0.01	0.00	-0.28	-0.05
	(0.23)	(0.37)	(2.23)	(0.31)	(0.05)	(1.19)	(0.56)
Red earth	0.47	0.61	-0.67	-0.01	0.03	-0.19	0.03
	(0.70)	(0.84)	(1.39)	(0.37)	(0.43)	(0.81)	(0.37)
Sandy soil	-0.03	0.03	-0.94	-0.01	-0.01	-0.21	-0.07
	(0.04)	(0.05)	(1.98)	(0.51)	(0.08)	(0.93)	(0.79)
“Barren” soil	0.53	0.78	-0.76	0.01	0.20	0.11	-0.01
	(0.75)	(1.03)	(1.51)	(0.29)	(2.89)	(0.43)	(0.14)
Irrigated plot	1.47	1.84	1.13	0.02	0.08	0.30	0.08
	(4.32)	(5.00)	(4.68)	(1.24)	(2.28)	(2.48)	(1.79)
Area of plot	-0.74	-0.77	-0.15	0.00	0.00	-0.08	-0.07
	(6.75)	(6.54)	(1.85)	(0.33)	(0.19)	(2.11)	(4.83)
Intercept	-2.57	-2.56	0.05	-0.10	-0.35	0.30	0.48
	(1.54)	(1.42)	(0.04)	(1.44)	(2.09)	(0.51)	(2.27)
s^{2}				0.00	0.02	0.26	0.03
				(10.74)	(9.60)	(10.35)	(10.05)

TABLE 5. 1986 SAMPLE

	Male labor	Total labor	Output	Female labor	Irrigation	Plowing	Manure	Transp.	Chemical fertilizer
Repeated interaction	-0.45	-0.45	-0.46	-0.44	0.00	0.00	-0.01	0.00	-0.02
	(1.50)	(1.40)	(1.75)	(1.08)	(0.61)	(1.02)	(2.25)	(0.69)	(1.31)
Landlord visits	0.15	0.15	0.18	0.09	0.00	0.00	0.00	0.00	0.01
	(2.93)	(2.83)	(4.15)	(1.35)	(0.13)	(1.90)	(1.65)	(0.17)	(3.14)
% of pre-harvesting costs	-0.17	-0.20	-0.06	-0.26	0.00	0.00	0.00	0.00	-0.01
	(1.14)	(1.19)	(0.42)	(1.23)	(0.80)	(1.14)	(0.07)	(0.46)	(0.94)
% of fertilizer, herb. and insect. costs	1.86	2.10	1.36	1.84	-0.02	0.00	0.01	0.01	0.08
	(1.14)	(1.20)	(0.95)	(0.84)	(1.35)	(0.43)	(0.88)	(0.52)	(0.92)
% of irrigation costs	0.08	0.13	0.09	0.38	0.00	0.00	0.00	0.00	0.00
	(0.51)	(0.74)	(0.62)	(1.42)	(0.02)	(0.08)	(1.06)	(0.31)	(0.10)
% of plowing costs	-0.19	-0.25	-0.19	-0.52	0.00	0.00	0.00	0.00	-0.01
	(1.28)	(1.62)	(1.47)	(2.13)	(0.66)	(0.50)	(0.04)	(0.12)	(1.42)
% of family labor costs	-0.82	-0.83	-0.58	1.09	0.01	0.00	0.00	-0.01	-0.08
	(0.81)	(0.76)	(0.65)	(0.81)	(0.59)	(0.92)	(0.59)	(0.66)	(1.43)
% of seed costs	-1.65	-1.66	-0.96	-2.34	-0.01	-0.01	-0.01	-0.02	-0.09
	(1.30)	(1.22)	(0.86)	(1.06)	(0.76)	(1.60)	(1.18)	(1.54)	(1.41)
% of transportation costs	0.22	0.88	-0.63	1.73	0.02	0.00	0.00	-0.01	-0.09
	(0.20)	(0.73)	(0.64)	(0.88)	(1.93)	(0.93)	(0.37)	(1.06)	(1.46)
% of harvesting costs	0.41	0.02	0.72	-3.13	-0.02	0.00	0.01	0.02	0.09
	(0.32)	(0.02)	(0.63)	(1.69)	(1.91)	(0.93)	(0.55)	(1.17)	(1.28)
Joint significance of contractual variables	14.76	15.83	28.95	13.24	13.47	17.82	9.66	11.90	25.28
Prime-age males	0.49	0.08	-0.43	-2.14	0.00	0.00	0.01	0.00	0.01
	(0.72)	(0.11)	(0.72)	(2.29)	(0.28)	(0.30)	(1.10)	(0.37)	(0.33)
Prime-age females	-0.86	-0.17	-0.47	1.35	0.00	0.00	0.00	0.00	0.00
	(1.23)	(0.22)	(0.76)	(1.45)	(0.73)	(0.97)	(0.21)	(0.06)	(0.09)
Household size	0.05	-0.14	0.26	-0.82	0.00	0.00	0.00	0.00	0.02
	(0.22)	(0.61)	(1.38)	(2.64)	(0.73)	(1.00)	(1.48)	(1.44)	(1.89)
Age of head	-16.02	-13.73	-8.57	-10.79	-0.03	-0.05	0.01	-0.07	-0.75
	(3.25)	(2.60)	(1.99)	(1.63)	(0.66)	(2.97)	(0.21)	(1.43)	(2.88)
Age of head squared	12.52	10.86	6.09	9.06	0.01	0.03	-0.01	0.06	0.51
	(3.00)	(2.42)	(1.67)	(1.60)	(0.39)	(2.50)	(0.37)	(1.35)	(2.29)
Schooling of head	-0.09	-0.08	-0.03	-0.08	0.00	0.00	0.00	0.00	0.00
	(2.51)	(2.16)	(1.05)	(1.61)	(1.39)	(3.98)	(1.22)	(1.19)	(2.49)
Max. school. excl. head	-0.05	-0.01	-0.08	0.16	0.00	0.00	0.00	0.00	0.00
	(0.93)	(0.13)	(1.49)	(2.01)	(0.20)	(2.86)	(0.89)	(1.93)	(1.25)
Ave. schooling in hh.	0.06	-0.03	0.08	-0.21	0.00	0.00	0.00	0.00	0.00
	(0.55)	(0.29)	(0.93)	(1.50)	(0.01)	(3.40)	(1.23)	(0.75)	(0.42)
Marital status of head	0.32	0.20	0.47	-0.15	0.01	0.00	0.01	0.00	0.02
	(1.24)	(0.73)	(2.06)	(0.42)	(3.11)	(1.33)	(2.60)	(0.33)	(1.48)
Land ownership	-0.03	-0.07	0.14	-0.22	0.00	0.00	0.00	0.00	0.00
	(0.54)	(1.10)	(2.66)	(2.52)	(0.38)	(1.55)	(1.54)	(0.05)	(1.36)
Joint significance of household characteristics	**32.40**	**21.21**	**21.92**	**38.78**	**23.07**	**26.14**	**21.50**	**13.48**	**33.57**
Red earth	0.46	0.40	0.67	-0.86	0.00	0.00	0.00	0.01	0.02
	(1.50)	(1.22)	(2.52)	(1.93)	(0.23)	(0.13)	(0.75)	(1.77)	(1.43)
Sandy soil	-0.27	-0.15	0.04	0.16	0.00	0.00	0.00	0.00	0.01
	(1.56)	(0.80)	(0.23)	(0.65)	(1.90)	(1.75)	(1.37)	(1.75)	(0.90)
"Barren" soil	-0.08	-0.14	0.31	-0.11	0.00	0.00	0.00	0.00	0.01
	(0.28)	(0.47)	(1.28)	(0.29)	(0.19)	(1.13)	(0.26)	(0.73)	(0.43)
Irrigated plot	3.54	3.80	2.81	3.10	0.02	0.00	0.01	0.01	0.05
	(12.53)	(12.55)	(11.37)	(4.56)	(5.93)	(1.15)	(4.32)	(2.80)	(3.65)
Area of plot	-0.33	-0.33	-0.30	-0.07	0.00	0.00	0.00	0.00	0.00
	(3.88)	(3.60)	(4.00)	(0.58)	(2.76)	(1.82)	(4.22)	(0.17)	(0.43)
Intercept	3.74	3.52	-2.60	2.97	-0.01	0.02	-0.02	0.02	0.22
	(2.63)	(2.31)	(2.09)	(1.47)	(0.60)	(4.00)	(1.89)	(1.10)	(2.95)
s^2				1.79	0.00	0.00	0.00	0.00	0.00
				(7.74)	(10.67)	(11.27)	(8.46)	(10.53)	(11.11)
Number of observations	334	334	334	334	334	334	334	334	334

TABLE 6. WHEAT SUBSAMPLE

	Male labor	Total labor	Output	Female labor	Plowing	Transport.	Chemical fertilizer	Seeds
Repeated interaction	-1.30	-1.40	0.25	-3.54	-0.03	-0.06	-0.14	0.11
	(1.34)	(1.41)	(0.30)	(0.00)	(0.99)	(1.13)	(1.19)	(6.50)
Landlord visits	0.20	0.20	0.01	-1.27	0.00	0.00	0.01	-0.01
	(1.22)	(1.15)	(0.08)	(0.00)	(0.25)	(0.37)	(0.58)	(5.11)
% of irrigation costs	-1.36	-1.34	-0.25	-2.40	-0.01	0.04	0.03	0.02
	(1.68)	(1.61)	(0.37)	(0.00)	(0.18)	(0.85)	(0.32)	(1.28)
% of plowing costs	-1.37	-1.40	-0.82	-5.69	0.00	0.03	-0.02	-0.01
	(1.98)	(1.97)	(1.39)	(0.00)	(0.01)	(0.68)	(0.19)	(0.58)
% of family labor costs	0.61	0.52	0.29	3.39	0.02	-0.10	0.04	-0.01
	(0.46)	(0.38)	(0.25)	(0.00)	(0.35)	(1.00)	(0.23)	(0.48)
% of hired labor costs	0.94	1.39	0.80	9.08	-0.01	0.13	-0.01	-0.04
	(0.60)	(0.86)	(0.59)	(0.00)	(0.25)	(1.22)	(0.06)	(1.39)
% of seed costs	10.69	10.18	5.81	21.52	0.03	-0.23	-0.16	0.06
	(2.46)	(2.28)	(1.56)	(0.00)	(0.21)	(0.96)	(0.31)	(0.73)
% of harvesting costs	-8.00	-8.09	-4.13	-23.72	0.02	0.23	0.28	-0.01
	(2.00)	(1.97)	(1.20)	(0.00)	(0.16)	(0.99)	(0.59)	(0.19)
Joint significance of contractual variables	14.93	15.20	12.32	6.25	5.73	7.88	6.50	55.89
Prime-age males	-2.63	-2.62	-2.00	0.91	-0.02	0.10	0.01	-0.03
	(3.36)	(3.26)	(3.03)	(0.36)	(0.63)	(2.50)	(0.12)	(2.27)
Prime-age females	-3.30	-2.99	-1.76	3.68	0.00	0.10	0.00	-0.02
	(3.73)	(3.28)	(2.38)	(1.90)	(0.06)	(2.22)	(0.03)	(1.57)
Household size	0.12	-0.02	0.35	-2.17	0.01	-0.02	0.02	0.00
	(0.46)	(0.07)	(1.60)	(2.96)	(0.60)	(1.49)	(0.77)	(1.04)
Age of head	9.70	13.13	3.63	73.59	0.51	0.53	-0.61	-0.21
	(1.87)	(2.46)	(0.82)	(2.52)	(2.76)	(1.99)	(0.97)	(2.25)
Age of head squared	-10.02	-12.66	-3.20	-61.04	-0.43	-0.36	0.35	0.14
	(2.20)	(2.70)	(0.82)	(2.44)	(2.66)	(1.54)	(0.63)	(1.76)
Schooling of head	-0.04	-0.01	0.05	0.42	0.00	0.01	0.00	0.00
	(1.03)	(0.28)	(1.58)	(3.33)	(1.09)	(3.38)	(1.06)	(0.68)
Max. school. excl. head	0.07	0.11	-0.04	0.39	0.00	0.00	-0.02	0.00
	(1.19)	(1.76)	(0.74)	(1.82)	(1.91)	(1.30)	(2.75)	(0.31)
Ave. schooling in hh.	0.09	0.01	0.15	-1.18	-0.01	-0.01	0.02	0.00
	(0.82)	(0.12)	(1.53)	(2.44)	(1.77)	(2.47)	(1.71)	(0.17)
Marital status of head	0.31	0.27	0.43	-1.13	-0.01	0.03	0.02	0.00
	(1.25)	(1.05)	(2.02)	(1.18)	(0.67)	(2.26)	(0.53)	(0.21)
Land ownership	-0.01	-0.07	0.19	-1.00	0.00	0.00	0.02	0.00
	(0.21)	(0.91)	(3.27)	(1.44)	(0.04)	(0.53)	(2.06)	(0.70)
Joint significance of household characteristics	**31.20**	**31.05**	**42.34**	**19.48**	**15.29**	**26.54**	**15.16**	**27.74**
Clay soil	-0.16	-0.12	-1.61	7.62	0.00	0.03	-0.37	-0.02
	(0.28)	(0.21)	(3.35)	(0.00)	(0.16)	(0.93)	(5.57)	(1.84)
Red earth	-0.15	-0.03	-1.29	11.14	-0.01	0.06	-0.21	-0.02
	(0.26)	(0.05)	(2.65)	(0.00)	(0.61)	(2.11)	(3.11)	(1.61)
Sandy soil	-0.95	-0.74	-1.80	9.75	-0.01	0.04	-0.27	-0.01
	(1.72)	(1.30)	(3.80)	(0.00)	(0.27)	(1.60)	(4.12)	(1.42)
“Barren” soil	-1.47	-1.44	-1.77	1.69	0.01	0.04	-0.26	-0.02
	(2.34)	(2.22)	(3.34)	(0.00)	(0.38)	(1.41)	(3.55)	(2.08)
Irrigated plot	0.86	0.88	0.94	-0.05	0.00	-0.01	-0.07	0.00
	(3.95)	(3.94)	(5.06)	(0.07)	(0.12)	(1.32)	(2.74)	(0.79)
Area of plot	-0.83	-0.81	-0.62	0.18	0.00	0.00	-0.01	0.00
	(8.06)	(7.68)	(7.08)	(0.60)	(1.34)	(0.45)	(1.04)	(1.61)
Year	-0.11	-0.13	2.36	-0.19	0.08	0.08	0.31	0.03
	(0.36)	(0.42)	(8.83)	(0.17)	(6.82)	(5.02)	(8.18)	(5.14)
Intercept	0.35	-0.53	-2.96	-26.43	-0.13	-0.31	0.62	0.11
	(0.21)	(0.30)	(2.03)	(0.00)	(2.08)	(3.47)	(3.00)	(3.61)
s^2				1.48	0.00	0.00	0.01	0.00
				(2.86)	(8.30)	(7.71)	(8.07)	(7.96)
Number of observations	145	145	145	145	145	145	145	145

TABLE 7. WHEAT SUBSAMPLE: 1993

	Male labor	Total labor	Output	Plowing	Manure	Transport.	Chemical fertilizer	Seeds	Havesting
Repeated interaction	-0.06	-0.04	0.30	-0.06	-0.08	-0.07	-0.01	0.11	-0.03
	(0.05)	(0.04)	(0.40)	(1.09)	(1.40)	(1.01)	(0.09)	(4.13)	(0.76)
Landlord visits	-0.06	-0.08	-0.11	0.00	0.00	-0.01	-0.02	-0.01	0.01
	(0.29)	(0.39)	(0.86)	(0.24)	(0.47)	(0.69)	(0.72)	(2.63)	(0.87)
% of plowing costs	-2.62	-2.62	0.80	0.05	-0.03	0.03	0.23	0.02	0.12
	(1.26)	(1.25)	(0.59)	(0.51)	(0.35)	(0.25)	(0.85)	(0.46)	(1.85)
% of hired labor costs	1.51	1.52	-1.40	0.00	0.08	0.05	-0.30	-0.07	-0.02
	(0.66)	(0.67)	(0.94)	(0.04)	(0.77)	(0.38)	(1.04)	(1.42)	(0.26)
% of seed costs	0.74	0.30	-2.25	0.06	-0.83	-0.67	-2.13	0.12	-0.10
	(0.11)	(0.04)	(0.51)	(0.17)	(2.76)	(1.83)	(2.41)	(0.79)	(0.48)
Joint significance of contractual variables	2.97	3.27	2.44	3.16	23.59	13.31	11.42	23.78	7.23
Prime-age males	-2.26	-2.01	0.51	0.02	0.28	0.23	0.40	-0.04	-0.03
	(1.47)	(1.30)	(0.51)	(0.26)	(4.16)	(2.80)	(2.05)	(1.25)	(0.59)
Prime-age females	-1.80	-1.58	1.27	0.02	0.12	0.28	0.16	-0.08	-0.16
	(1.04)	(0.91)	(1.14)	(0.21)	(1.54)	(3.06)	(0.73)	(2.00)	(2.77)
Household size	-0.35	-0.41	0.12	0.02	0.01	0.00	0.13	0.01	-0.02
	(0.71)	(0.84)	(0.36)	(0.69)	(0.52)	(0.10)	(1.99)	(0.46)	(1.49)
Age of head	21.85	23.23	-1.78	1.19	0.90	0.89	-1.42	-0.27	-0.11
	(2.50)	(2.66)	(0.32)	(2.70)	(2.13)	(1.91)	(1.24)	(1.35)	(0.40)
Age of head squared	-22.92	-24.14	1.27	-1.01	-0.61	-0.59	1.06	0.16	0.08
	(2.80)	(2.94)	(0.24)	(2.46)	(1.56)	(1.36)	(1.00)	(0.88)	(0.31)
Schooling of head	-0.02	-0.01	0.05	0.00	0.01	0.02	0.00	0.00	0.00
	(0.30)	(0.11)	(1.04)	(0.81)	(4.47)	(4.41)	(0.19)	(1.20)	(0.31)
Max. school. excl. head	0.03	0.03	-0.06	0.01	0.00	0.00	-0.04	0.00	0.00
	(0.31)	(0.28)	(0.87)	(2.01)	(0.04)	(0.39)	(3.04)	(0.31)	(0.86)
Ave. schooling in hh.	0.06	0.04	0.03	-0.02	-0.02	-0.03	0.00	0.00	0.00
	(0.31)	(0.18)	(0.25)	(2.29)	(1.66)	(2.45)	(0.17)	(0.62)	(0.56)
Marital status of head	0.66	0.69	0.86	-0.01	0.08	0.07	0.14	0.00	-0.03
	(1.54)	(1.61)	(3.08)	(0.37)	(4.24)	(3.17)	(2.47)	(0.17)	(1.85)
Land ownership	-2.49	-2.57	-1.53	0.03	-0.18	-0.16	-0.45	0.02	-0.03
	(2.09)	(2.16)	(2.05)	(0.56)	(3.37)	(2.64)	(3.03)	(0.86)	(0.76)
Joint significance of hh. charact.	**19.92**	**20.84**	**15.08**	**18.24**	**79.62**	**45.65**	**37.40**	**26.77**	**29.00**
Clay soil	-0.19	-0.23	-1.28	-0.01	0.02	-0.03	-0.52	-0.04	-0.01
	(0.24)	(0.30)	(2.49)	(0.15)	(0.49)	(0.60)	(4.97)	(1.98)	(0.48)
Red earth	0.09	0.14	-1.13	-0.01	0.04	0.05	-0.33	-0.03	0.04
	(0.12)	(0.19)	(2.40)	(0.31)	(1.07)	(1.15)	(3.50)	(1.75)	(1.67)
Sandy soil	-0.36	-0.22	-0.67	0.02	0.09	0.10	-0.18	-0.02	-0.03
	(0.46)	(0.28)	(1.31)	(0.40)	(2.65)	(2.45)	(1.74)	(1.12)	(1.13)
"Barren" soil	0.55	0.63	-0.32	0.01	0.08	0.09	-0.15	-0.05	0.00
	(0.57)	(0.66)	(0.56)	(0.16)	(2.05)	(1.89)	(1.31)	(2.54)	(0.11)
Irrigated plot	-0.53	-0.55	0.05	0.02	-0.05	-0.03	-0.22	0.00	0.04
	(1.22)	(1.28)	(0.17)	(0.78)	(2.85)	(1.56)	(4.12)	(0.43)	(3.15)
Area of plot	-0.49	-0.47	0.06	0.00	0.04	0.02	0.07	0.00	0.01
	(1.98)	(1.87)	(0.36)	(0.34)	(3.09)	(1.46)	(2.17)	(0.62)	(0.95)
Intercept	-1.65	-2.00	-0.98	-0.28	-0.58	-0.51	0.83	0.20	0.19
	(0.66)	(0.79)	(0.59)	(2.17)	(4.78)	(3.77)	(2.51)	(3.20)	(2.31)
s^2				0.00	0.00	0.00	0.00	0.00	0.00
				(4.87)	(4.49)	(5.04)	(4.98)	(4.77)	(4.52)
Number of observations	53	53	53	53	53	53	53	53	53

TABLE 8. WHEAT SUBSAMPLE: 1986

	Male labor	Total labor	Output	Plowing	Chemical fertilizer	Seeds
Repeated interaction	-10.12	-9.87	-5.06	-0.01	0.13	0.01
	(1.85)	(1.69)	(0.98)	(0.32)	(0.59)	(0.28)
Landlord visits	1.67	1.59	0.94	0.00	-0.03	0.00
	(1.80)	(1.60)	(1.06)	(0.35)	(0.80)	(0.24)
% of plowing costs	1.54	1.45	0.64	0.00	-0.05	0.00
	(1.46)	(1.29)	(0.64)	(0.08)	(1.30)	(1.01)
% of family labor costs	0.71	0.82	-0.21	0.00	0.09	0.00
	(0.49)	(0.53)	(0.15)	(0.15)	(1.47)	(0.51)
% of seed costs	-9.87	-9.40	-3.46	0.00	0.35	0.02
	(1.15)	(1.03)	(0.43)	(0.14)	(1.02)	(0.59)
% of harvesting costs	10.60	10.31	5.36	0.01	-0.22	-0.01
	(1.47)	(1.33)	(0.78)	(0.23)	(0.76)	(0.33)
Joint significance of contractual variables	7.13	6.29	7.80	1.77	15.20	19.16
Prime-age males	-2.57	-3.03	-3.17	0.00	-0.04	-0.01
	(2.61)	(2.87)	(3.39)	(0.09)	(0.95)	(1.46)
Prime-age females	-3.07	-2.89	-3.23	0.00	-0.02	0.00
	(3.13)	(2.74)	(3.46)	(0.21)	(0.43)	(0.51)
Household size	0.54	0.29	0.55	0.00	0.00	0.00
	(1.79)	(0.91)	(1.93)	(0.77)	(0.09)	(1.29)
Age of head	-4.31	3.92	8.77	-0.01	0.53	-0.01
	(0.67)	(0.57)	(1.43)	(0.25)	(2.00)	(0.53)
Age of head squared	1.43	-4.84	-7.57	0.01	-0.47	0.01
	(0.27)	(0.84)	(1.48)	(0.37)	(2.12)	(0.46)
Schooling of head	-0.08	-0.03	0.06	0.00	0.00	0.00
	(1.72)	(0.57)	(1.42)	(0.46)	(0.50)	(0.35)
Max. school. excl. head	0.02	0.12	0.01	0.00	0.00	0.00
	(0.29)	(1.55)	(0.11)	(1.89)	(0.87)	(2.16)
Ave. schooling in hh.	0.21	0.04	0.08	0.00	0.01	0.00
	(1.58)	(0.26)	(0.65)	(1.98)	(1.25)	(2.54)
Marital status of head	0.73	0.57	0.37	0.00	0.00	0.00
	(2.40)	(1.73)	(1.29)	(0.55)	(0.19)	(0.39)
Land ownership	0.04	-0.04	0.22	0.00	0.01	0.00
	(0.57)	(0.67)	(3.69)	(2.77)	(3.09)	(2.95)
Joint significance of household characteristics	**28.35**	**23.66**	**54.29**	**14.22**	**25.52**	**20.11**
Red earth	-0.84	-0.98	-0.36	0.00	0.00	0.00
	(1.71)	(1.86)	(0.76)	(0.89)	(0.08)	(0.96)
Sandy soil	-1.18	-1.10	-0.70	0.00	0.00	0.00
	(4.68)	(4.08)	(2.91)	(0.22)	(0.35)	(0.48)
“Barren” soil	-1.52	-1.65	-0.62	0.00	0.02	0.00
	(3.23)	(3.28)	(1.39)	(0.49)	(0.87)	(0.49)
Irrigated plot	1.80	1.76	1.25	0.00	-0.01	0.00
	(6.74)	(6.16)	(4.93)	(1.98)	(0.68)	(1.10)
Area of plot	-0.84	-0.85	-0.87	0.00	-0.01	0.00
	(7.46)	(6.98)	(8.10)	(3.02)	(2.56)	(3.53)
Intercept	2.10	0.44	-4.84	0.01	-0.05	0.01
	(1.20)	(0.23)	(2.92)	(1.30)	(0.73)	(1.42)
s^2				0.00	0.00	0.00
				(6.74)	(6.32)	(6.30)
Number of observations	92	92	92	92	92	92

Table 9. Agrarian structure in El Oulja, 1993 survey

Type of household: Eswaran-Kotwal (1986) typology	definition	Number of households	Percentage of households	Number of plots	Percentage of plots
Self cultivator	$L^e - L = 0$, $L > 0$, $H = 0$	26	8.7	56	7.0
Laborer-cultivator-1	$L^e - L > 0$, $L > 0$, $H > 0$	150	50.5	405	50.9
Laborer-cultivator-2	$L^e - L > 0$, $L > 0$, $H = 0$	38	12.8	80	10.1
Small capitalist	$L^e - L = 0$, $L > 0$, $H > 0$	83	28.0	254	31.9

Table 10. Characteristics of households by class

Household level variables	Self cultivator	Laborer-cultivator 1	Laborer-cultivator 2	Small capitalist
Definition	$L^e - L = 0$, $L > 0$, $H = 0$	$L^e - L > 0$, $L > 0$, $H > 0$	$L^e - L > 0$, $L > 0$, $H = 0$	$L^e - L = 0$, $L > 0$, $H > 0$
Family size	6,52	9,00	6,78	6,70
Prime age males (%)	0,30	0,35	0,36	0,31
Prime age females (%)	0,30	0,32	0,33	0,24
Head age	0,55	0,48	0,54	0,49
Head school	1,96	3,51	1,90	4,78
Ave. school	3,79	3,84	3,25	3,48
Max. school	6,93	8,20	6,28	6,94
Land ownership (hectares)	0,43	9,17	1,90	7,15
Marital status of head	1,00	0,87	0,71	0,94
Wealth (Tunisian dinars)	5751	29875	4233	29907

Figure 1. Partition of factor endowment space implied by Proposition 1

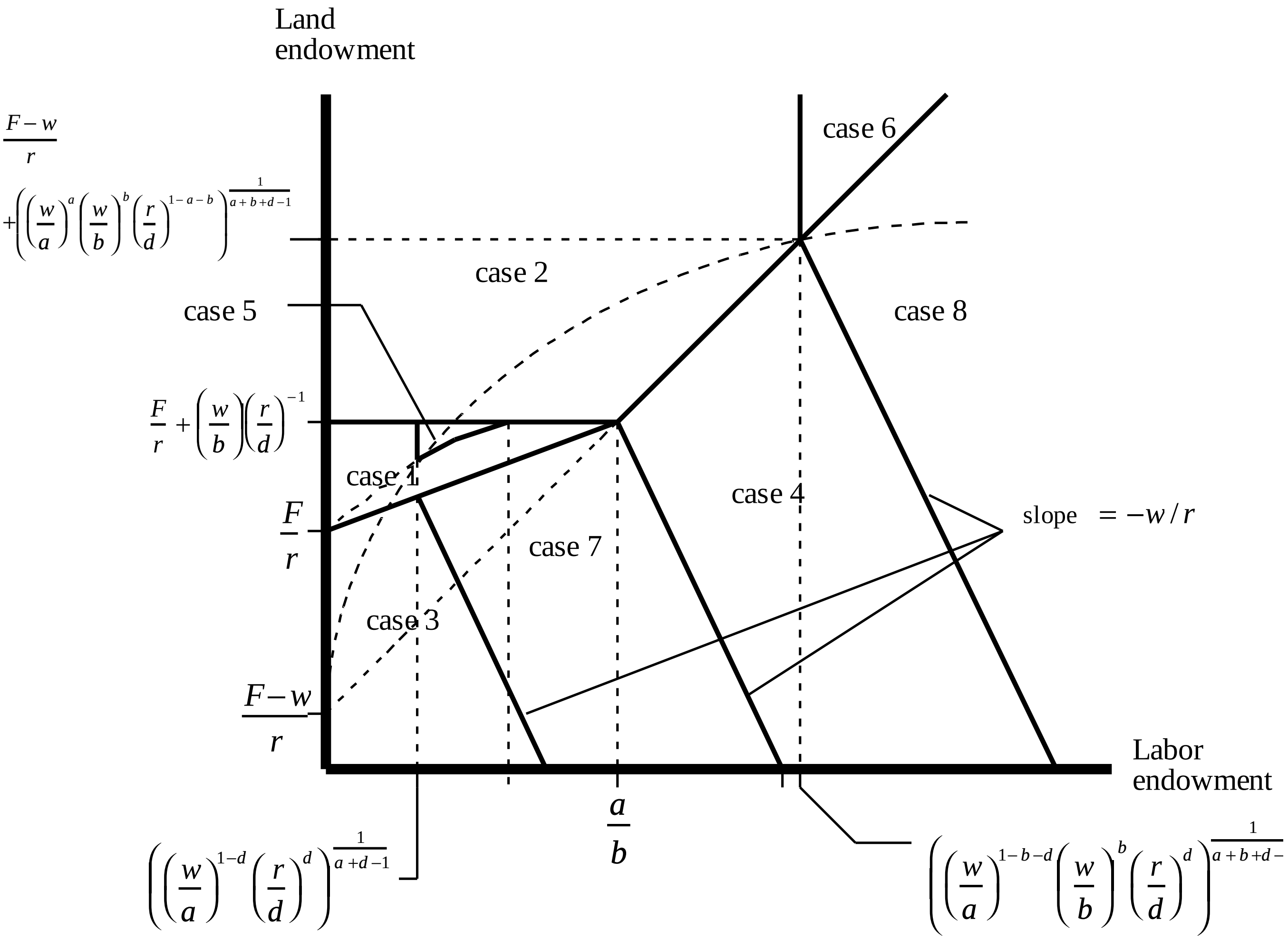

TABLE 11. FIRST STAGE MULTINOMIAL PROBIT (P-VALUES IN PARENTHESES)

Class	**Self cultivator**	**Laborer cultivator 1**	**Laborer cultivator 2**	**Small capitalist**
Intercept	2.3285	-0.1812	1.5037	1.2847
	(0.0743)	(0.0804)	(0.1183)	(0.0639)
Household size	0.1039	-0.1356	0.0603	0.0857
	(0.1862)	(0.0002)	(0.2563)	(0.0335)
Age of head	-0.0284	0.0270	-0.0105	-0.0148
	(0.1414)	(0.0123)	(0.4696)	(0.1795)
Schooling of head	0.1001	0.0675	0.0801	-0.1399
	(0.2674)	(0.0894)	(0.2433)	(0.0009)
Ave. schooling in hh.	-0.0363	-0.0805	0.0576	0.0701
	(0.7217)	(0.1718)	(0.4936)	(0.2634)
Land ownership	0.0886	-0.00303	0.00404	0.000848
	(0.0132)	(0.0401)	(0.2219)	(0.5616)
Percentage concordant	79.5	68.1	66.3	65.4
Number of observations	297	297	297	297

TABLE 12. TEST FOR SELECTIVE SEPARABILITY: TOTAL LABOR INPUT

Class	**Self cultivator**	**Laborer cultivator 1**	**Laborer cultivator 2**	**Small capitalist**
Repeated interaction	-0.360630		0.178048	
	(-2.453)		(3.263)	
Landlord visits	0.025797		-0.021676	
	(1.437)		(-1.555)	
% of pre-harvesting costs		-0.039507		-0.078245
		(-2.074)		(-2.051)
% of irrigation costs		-0.049571		
		-2.107		
% of plowing costs			-0.123314	
			(-4.964)	
% of hired labor costs			0.023189	
			(0.511)	
% of transportation costs				-0.051486
				(-0.641)
Household characteristics				
Prime-age males		**-0.214065**		
		(-3.532)		
Prime-age females	**-0.786037**	**-0.249267**	-0.002024	0.158896
	(-4.838)	**(-3.794)**	(-0.038)	(1.214)
Household size	-0.014602	0.018563	0.001182	-0.002074
	(-1.577)	(1.015)	(0.311)	(-0.359)
Age of head		0.503211		
		(1.236)		
Age of head squared	**0.719649**	-0.684326		-0.122125
	(2.099)	(-1.662)		(-1.044)
Schooling of head		**-0.009228**		
		(-3.323)		
Max. school. excl. head			-0.001625	0.004398
			(-0.548)	(1.299)
Ave. schooling in hh.	**0.061361**	**0.024603**		
	(3.202)	**(3.794)**		
Marital status of head		**-0.087740**	0.006959	
		(-3.463)	(0.318)	
Land ownership	**-2.921466**	0.016387	0.072260	-0.025501
	(-3.174)	(0.475)	(1.617)	(-1.410)
Plot characteristics				
Clay soil		0.043412	-0.019454	
		(2.529)	(-0.640)	
Red earth				0.086976
				(2.091)
“Barren” soil				0.141120
				(3.101)
Irrigated plot		0.041786	0.091727	0.131639
		(1.575)	(3.009)	(2.459)
Area of plot	-0.024320	-0.000211	-0.010295	-0.001689
	(-2.954)	(-1.005)	(-3.647)	(-1.705)
Intercept	-1.804946	-0.259282	0.432005	-0.059634
	(-1.921)	(-0.456)	(1.332)	(-0.345)
Inverse Mills ratio	2.373610	0.314220	-0.487567	0.235323
	(2.284)	(0.755)	(-1.416)	(1.230)

Adjusted R-Squared	0.40	0.11	0.41	0.16
Number of observations	54	398	78	219