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Abstract

During the last decade considerable research has been carried out on the non-farm labor supply of farm households. New insights and hypotheses on the economic behavior of households, known as "new home economics," and progress in applying more sophisticated estimation techniques have stimulated these research activities. The focus of this paper is the standard neoclassical model of labor supply and a corresponding empirical research strategy. The empirical model refers to household-level data from West Germany. As the results reveal, farm households decide on the allocation of their resources in a very rational manner. This shows their high capability and flexibility to adjust to varying economic circumstances.

NON-FARM LABOR SUPPLY: THEORY AND ESTIMATION

1. The Historical Background of Labor Supply Studies

In the past, studies on labor supply were dominated by macroeconomic considerations; they dealt with the transfer of labor and capital from the agricultural to the growing non-agricultural sector in the course of economic development (see Hayami and Ruttan, 1985, pp. 11-72; Ghatak and Ingersent, 1984). Less research activity has been dedicated to the microeconomic dimensions and implications of the decisions on income earning and spending by individual farm households. There is, however, an early exception: Chayanov's theory of peasant economy (see Tschajanow, 1923; and Thorner, et al., 1986). According to the tradition and terminology of the marginal utility school, Chayanov already pointed out the criteria for the optimal allocation of time. Later on, Robbins (1930) introduced the labor-leisure model based on ordinary utility theory. Even today this model represents the focal point of the microeconomic theory of labor supply. The main dilemma of the theoretical model is its failure to predict changes in the supply of labor according to wage rate changes. An upward or downward sloping labor supply curve, resulting from a change in the wage rate, depends on the dominance of either the income or the substitution effect. Empirical models trying to capture and to explain these changes therefore gain importance.

Empirical approaches do not allow for any straight-forward solutions; they have to be carefully designed and require the use of adequate estimation techniques. That's one reason why the empirical research on these issues first started out during the 1960s and 1970s. At that time

the main focus was on the analysis the female labor supply and the consequences of positive and negative income transfers on the supply of labor. During the 1970s a number of studies were published which analyzed the resource allocation decisions of farm households (see, e.g., Lau, et al., 1978). One of the central focuses of the empirical work is the analysis of non-farm labor supply. The current paper contributes to this tradition and reports on an empirical investigation using household-level data from farm households in West Germany.

2. Microeconomic Models of Labor Supply and a Corresponding Research Strategy

2.1 The static labor supply model

The traditional Robbins model was first applied to labor supply decisions made by farm households by Lee (1965) and Nakajima (1970, 1986). Both authors took into account the fact that farm households usually have an employment alternative: working outside and/or working onside the farm holding.

Assuming the traditional utility maximization behavior, the preference system of the farm household implied by the standard model need not be changed: Utility, according to the traditional neoclassic framework, is derived both from income (or the bundle of consumer goods, X_i) and leisure L. X_i and L represent the arguments of the utility function U; utility maximization is subject to a budget and a time constraint.

$$(1)\quad \max_{L,X}[U(L,X_i)\,|\,N+w(T-L-H_L)+qQ(H_L,\ V_j)-\sum_j^k r_jV_j = \sum_i^n p_iX_i]$$

The farm household is supposed to chose the optimal combination of leisure and income; income results from on-farm (H_L) and/or off-farm work (H_a), and from any other sources N (unearned income like interest, pensions, dividends). T in equation (1) represents the total time endowment, Q (H_L, V_j) is a production function for the farm enterprise with H_L and V_j as inputs; q, p, r are prices for consumer goods, farm products and variable inputs, respectively; w indicates the non-farm wage rate.

An interior solution for the optimal allocation of time between leisure, on- and/or non-farm work is determined by solving the set of first order conditions. The equilibrium is characterized by the identity of the marginal utility between leisure and income, the non-farm market wage rate (w) and the value marginal product of on-farm labor. Labor to non-farm activities will be provided only if the non-farm wage rate exceeds the shadow value of the labor supplied to on-farm activities. This leads to the following participation "rule" (y^* represents a binary variable):

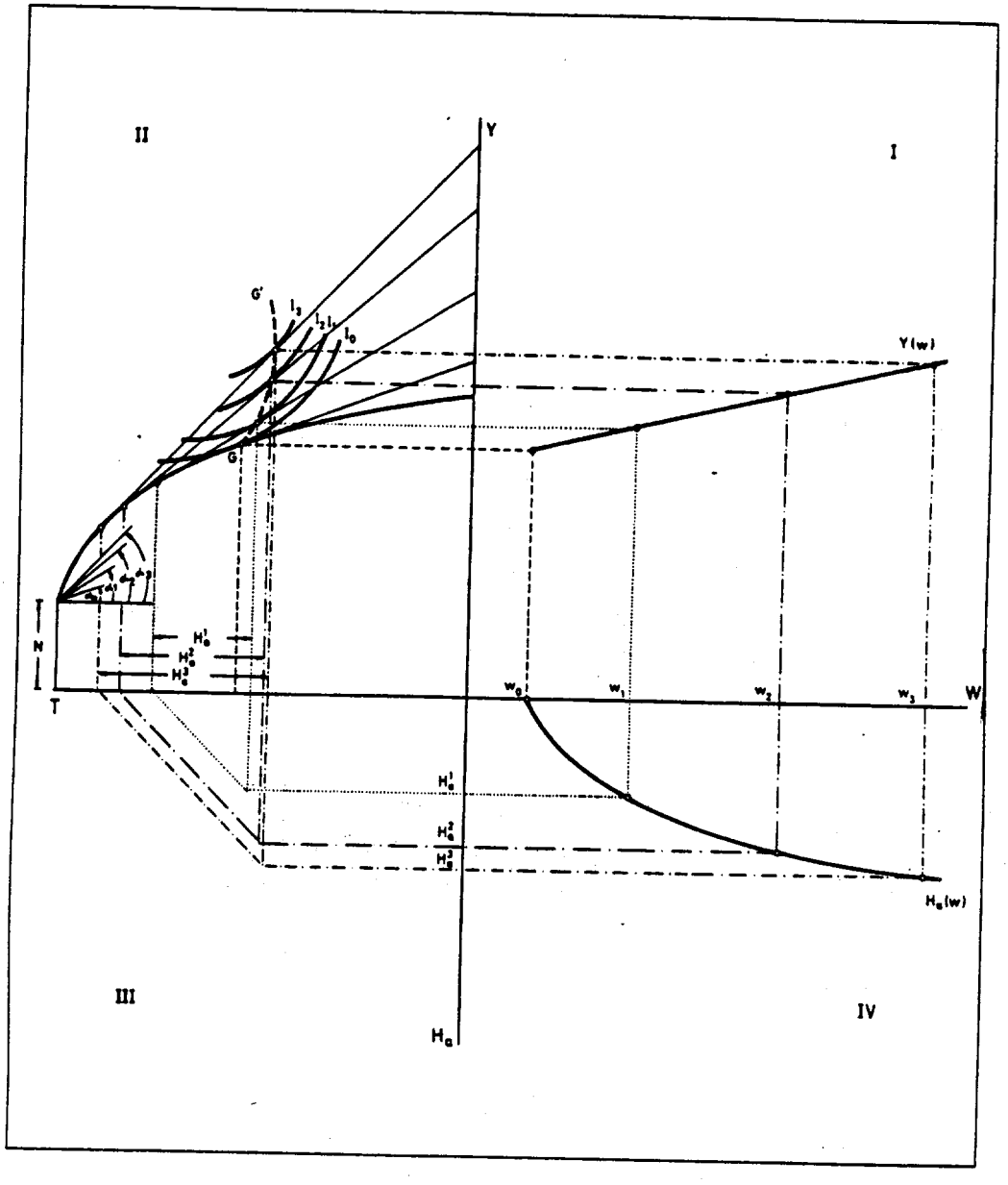
$$(2) \quad y^* \begin{cases} 1 & \text{if } w^* > 0 \\ 0 & \text{if } w^* \leq 0 \end{cases}$$

where $$w^* = q - q \frac{\partial Q(H_L; V_j)}{\partial H_L} \Big| H_a = 0$$

Figure 1 tries to capture the non-farm labor supply decision of farm households utilizing a four-quadrant presentation. The classical model, modified by Lee and Nakajima, is shown in the second quadrant. Various indifference curves indicate the leisure-income preferences of the farm household; budget lines characterize various income earning possibilities according to the type and the amount of labor supplied to various activities. The line GG' indicates a path of optimal income-leisure

combinations reflecting changes in the level of the non-farm wage rate. The abscissa of the income quadrant shows the allocation of the total time T. The time spent on a non-farm job will be transferred (via quadrant 3) to the abscissa of the fourth quadrant. The non-farm wage rates are transferred via the wage-income diagram (quadrant 1); the fourth quadrant finally shows the non-farm labor supply curve.

Figure 1. Non-Farm Labor Supply - A Diagrammatical Presentation



2.2 A Corresponding Research Strategy

Less elaborate empirical models focusing on the time allocation issue, usually claim the validity of the standard neoclassical assumptions. This implies that they do not take into account, e.g., limited possibilities of substituting between family and non-family farm labor or, another example, different preferences for working on or off the farm holding. The advantages of this strategy in terms of the empirical work are obvious: it allows for analyzing the production and consumption decisions separately and within a single equation framework, "even though they may be made simultaneously" (Singh, et al., 1986, p. 89). These types of models are called recursive (for a detailed discussion see, Singh, et al, 1986, pp. 48-91; Lopez, 1986; and Huffman, 1988).

The very early empirical research work, the so-called "first generation studies" (Killingsworth, 1983, p. 67), started out using least-square techniques for modeling the labor supply decisions. Least square models, however, yielded biased parameter estimates (see Judge, et al., 1980, p. 516; Dhrymes, 1986, p. 157), for a discussion of the difficulties of the LSQ models dealing with censored sample and binary choice problems); the application of alternative estimation techniques then became necessary.

Motivation and construction of the so-called "second generation models" follow the basic implications of the theoretical model outlined in the previous section (see also Killingsworth, 1983, pp. 135-150). According to the criteria set up in equation (2) for the optimal allocation of time and the participation rule, members of the farm household are taking over non-farm jobs only if their non-farm wage rate (including "transaction costs") exceeds their value marginal product of on-farm labor.

The wage rate at which an individual considers to take over a non-farm job is called "reservation wage" (W_R). The reservation wage is determined by individual preferences and also by the level of income obtained from farming and from other sources (pensions, interest, etc.: unearned income). The market wage rate on the other hand, depends primarily on current labor market settings, individual qualification, job experience and age.

According to this understanding, labor supply decisions may be considered to be a combination of qualitative and quantitative choices and can be divided into two separate, but strongly related steps:

- First, the individual makes a "take-it-or-leave-it" decision and
- Second, in case the job offer is accepted (that implies: $w > w_R$), the individual makes a decision on the working hours (time-sovereignty assumed).

The econometric model capturing both dimensions of labor supply decisions, takes the following form:

$$(3)\quad H_{ai} = y_i \begin{cases} x_i'\beta + \epsilon_i & \text{if } w_i > w_{Ri} \\ 0 & \text{if } w_i \leq w_{Ri} \end{cases}$$

Consequently: y_i is greater (equal) zero if:

$$x_i'\beta + \epsilon_i > 0 (x_i'\beta + \epsilon_i \leq 0) \quad \text{or} \quad \epsilon_i > -x_i'\beta (\epsilon_i \leq -x_i'\beta).$$

The estimation techniques matching this model are discussed in the following sections.

2.2.1 Participation Decision: Logit- and Probit-Models

The "take-it-or-leave-it" decision is characterized by a binary random variable with 0,1 outcomes, respectively. If ϵ [in equation (3)] is independent and identically distributed within a group of persons, then the decision-alternative could be described using a probability P:

$$(4) \quad P(y^* = 1) = P\ (w_i > w_R) = P\ (\epsilon_i > -x_i'\beta) = F\ (x_i'\beta)$$

where $F(x_i'\beta)$ represents the distribution function of ϵ_i evaluated at $x_i'\beta$.

Examination techniques analyzing the decision behavior of individuals which are confronted with one or several alternatives, are called "binary or quantal choice models". These models do not reproduce the outcome of the random variable. They refer to the conditional probability, in this special case, of working outside the farm. The label of the response-model is related to the underlying distribution function F; if F represents a logistic distribution, the model is called "logit-model"; if F is based on a standard normal distribution, it is labelled "probit-model".

2.2.2 The decision on hours: Tobit-model

The estimation technique discussed so far only handles the reconstruction of the participation decision. Logit- and probit-models do not cover the second dimension of labor supply decisions, namely, the decision on the hours supplied. One approach to deal with this problem is to realize that within a group of persons (farm households) a certain number of persons (farm households) do not hold any off-farm job while the rest of the group offers any positive number of working hours.

The endogenous variable obviously shows a "truncated" distribution; an adequate estimation technique, therefore, has to handle both the participation decision of the sample altogether and the actual labor supply of working persons. The expected mean value of y_i, therefore, is:

(5) $E(H_a) = E(y_i|y_i > 0) \cdot P(y^* = 1) = E(x_i'\beta + \epsilon_i|\epsilon_i > -x_i'\beta) \cdot F(x_i'\beta)$

This task accomplishes a technique first invented by Tobin (see Amemiya, 1984).

2.2.3 Remarks on the implementation and efficiency of the proposed techniques

The estimation techniques discussed above are relatively simple approaches for analyzing both dimensions of individual/household labor supply based on single equation models. The specification of the models presented here is basically similar; it is intended to relate the labor supply behavior of members of farm households to a few and theoretically based explanatory factors. The following equation represents the basic or standard empirical model:

(6) $H_{ai} = y_i = \beta_0 + \beta_1 \ln(\hat{w}_i) + \beta'_2 Y_i + \beta'_3 Z_i + \epsilon_i$

In equation (6) H_{ai} (y_i) represents the non-farm labor supply (the endogenous variable). $\ln(\hat{w})$ indicates the opportunity costs (= non-farm earning capacity). The calculation of the opportunity costs is based on information on age, job experience and formal education (see below, "imputed wages"). Y represents a vector of income variables, Z captures individual and household specific information (age, sex, marital status, education, number of adult persons, etc.), and ϵ represents the error term; $\beta_0 \ldots \beta_3$ are the parameter values of the estimated model.

The empirical models yield efficient and consistent parameter values only if exogenous and endogenous variables are recorded for all individuals/households. Most data sets, however, do not meet these requirements; problems caused by lacking or unobserved data are summarized by the term "sample selectivity bias" (see Heckman, 1980, for a detailed discussion).

The sample selectivity problems within empirical labor supply problems take two forms. "The first concerns studies that analyze cross sections of hours while ignoring the participation decision, and the second concerns the lack of observation on the wage offers received by individuals who do not participate in the labor force" (Deaton and Muellbauer, 1980, p. 227). At the very beginning of the empirical research work these problems were partly ignored or data analyses were restricted to the subpopulation of individuals in the labor force. Later on, techniques were developed to deal with these defects. The dimension of the sample selectivity problem mentioned first will be captured by the "uno actu" approach of the Tobit-model (for a detailed discussion of the properties of the Tobit model see Mroz, 1987). The Tobit approach, however, still remains arbitrary since no data are available for the whole sample on certain factors influencing the labor supply decisions. This refers to the second dimension of the sample selectivity problem; the missing data on the (hypothetical) market wage rates for all persons without actual labor supply to non-farm activities. In the literature quite a number of procedures are discussed to correct these deficiencies. The most popular method is based on Heckman's proposal (see Heckman, 1980).

To deal with the missing information on market wage rates in this

study, "imputed wages" were calculated. Human capital theory forms the basis of this approach. Individual income earning capacities are assumed to depend on the amount and type of investment in education (see Willis, 1986). Hypothetical market wage rates for all persons without non-farm labor supply are obtained using the parameter values of a previously estimated market wage function and plugging in individual data for age, education, type of vocational training, etc. For details, see Gebauer, 1988, pp. 95-97.

2.2.4 Data

Household-level data have been collected within a "Socio-economic Farm Census" conducted by the Landwirtschaftskammer Westfalen-Lippe in 1982. This survey covers all farm households with an associated farm holding larger than five hectares. A standardized questionnaire was used to gather information on the factor endowment and production of the farm, on socio-economic characteristics of the household, and on single members of the household (age, sex, education, employment). For more details including descriptive statistics of the sample data see Gebauer, 1988, pp. 93-94 and 196-199.

3. Results

The results documented in this section represent an attempt to integrate ubiquitous information and hypotheses about off-farm work into simple labor supply models. The main focus is on the evaluation of factors determining off-farm labor supply decisions. Two groups of persons are considered in this section: the members of the farm household altogether

and the farm operator. Prior to the presentation of the results, some information on the interpretation of the parameters is given.

3.1 Interpretation of Parameter Values.

Parameter estimates obtained from Logit-, Probit-, and Tobit-models require a specific interpretation (see Judge, et al., 1985, pp. 766-767). Opposed to the OLS-technique, the parameters of Logit- and Probit-models do not reflect the increase of the probability (P_i) of (not) working outside the farm according to a one-unit change of an exogenous variable; the parameter value rather reflects on the change of an independent variable via F (P_i) (Probit-model), resp. $\ln(P_i/1 - P_i)$ for the Logit-model.

Also the parameter values obtained for the hours-, i.e., Tobit-model require a modified interpretation due to the fact that only the parameter values weighted with the probability of participation refer to a one-unit change of an exogenous variable (see also Judge, et al., 1985, pp. 783-784).

3.2 Non-farm Labor Supply Decisions of the Farm Households.

The following section focuses on the labor supply decision of the members of a farm household altogether; the emphasis is on the question if any member(s) of the farm household is (are) engaged in non-farm work at all and how many hours they spend on non-farm employment per year. Those decisions are analyzed taking into account:

(1) the income earning capacity of the farm holding as measured by the standardized farm income or "standard gross margin" (LNBYLSF);

(2) the income earning capacity in non-farm employment (opportunity costs; SUMOPPX);

(3) the number of people of working age (HPERWB); the number of persons with unearned income (SUMNEX); the type of farm operation (dairy or other; BTYP), and the age of the farm operator (HV-ALTER)--a proxy variable indicating the stage of the family life cycle.

Table 1 represents the results of the participation and hours supply models. At first glance the regression coefficients reveal that the decision on non-farm labor supply is mostly influenced by the "size" of the farm holding, measured in terms of the income capacity. The next most important factors are the number of people of working age, their opportunity costs and the age of the farm operators. It turns out that the availability of unearned income sources and the type of farming seem to be less important for these decisions.

In interpreting the results, quality and availability of the data should be kept in mind, i.e., neither information on the total amount of household income is recorded nor are certain (un-) earned income sources recorded. Nevertheless, the results obtained provide a good representation of the current data. The signs of the parameter estimates corresponding to the predictions and implications of the theoretical model. Null-hypotheses, for single parameters or for all of them, can be rejected at a highly significant level. Two pseudo-R-Square statistics (ρ^2; Θ) are employed to evaluate the overall-fit. They show that a good deal of the observed non-farm labor supply behavior could be explained by referring to so-called "objective" and measurable factors. Subjective factors

influencing labor supply actions may account for a smaller part than usually claimed.

3.3 Non-Farm Labor Supply Decisions of Farm Operators

In two-thirds of all farm households with non-farm labor supply, the farm operator is employed outside the farm. The labor supply decisions of this group are, consequently, highly important for the intensity and dynamic of structural adjustments within the agricultural sector.

The models as presented in Table 2 reveal again the large impact of the farm-size variable on the non-farm labor supply decision. All other variables considered in the model confirm well-known and anticipated effects--that the non-farm labor supply of farm operators is more likely for male persons, for persons with non-farm vocational training, and higher opportunity costs.

Table 1. Non-Farm Labor Supply Decisions: Farm Households.

Dimension:	PARTICIPATION			HOURS OF WORK	
Estimation technique:	LOGIT	LOGIT	PROBIT	TOBIT	TOBIT
Model:	HH.M-L01	HH.ML02	HH.M-P01	HH.M-T01	HH.M-T01
Variable	Parameter estimates*				
Standardized Farm Income (DM; log.) LNBYLSF	-2.70239 (21.571)	-2.6594 (20.949)	-1.3722 (24.701)	-1433.90 (32.513)	-1429.4 (32.514)
Opportunity Costs (DM; log.) SUMOPPX	1.8877 (7.2751)	1.8246 (6.9503)	0.4234 (5.4568)	678.37 (6.8283)	658.86 (6.6879)
Household Labor Force (Persons) HPERWB	1.1653 (9.3562)	1.2285 (9.6771)	0.8481 (14.165)	1203.6 (22.373)	1213.0 (22.541)
Age, Head of Household (Years) ALTER-HV	-0.0554 (8.081)	-0.05931 (8.4223)	-0.028169 (7.777)	-34.796 (9.8010)	-34.678 (9.7993)
Persons with Unearned Income (Persons) SUMNEX		-0.3443 (3.989)		-271.57 (5.3443)	-267.97 (5.2941)
Type of Farm Operation (0,1-Dummy) BTYP		0.47325 (3.4633)			230.56 (3.0612)
Constant	6.6182 (2.5664)	6.8155 (2.6114)	8.629 (9.3601)	6346.0 (5.8219)	6363.9 (5.8574)
Test Statistics					
LIKELIHOOD RATIO TEST	1481.43	1510.94	1423.90	1978.98	1988.35
ρ^2 (Logit,Probit); Θ (Tobit)	0.5092	0.5193	0.4894	0.6254	0.6264
Standard Error of Estimate				1540.3	1535.7
E(y)				1197.4	1197.6
E(y*)				1641.0	1638.8
Observations (N)	2135	2135	2135	2135	2135
Participation rate (Actual)	0.5766	0.5766	0.5766	0.5766	0.5766
Participation rate (Estimated)	0.7184	0.7162	0.6904	0.7297	0.7308

*Data in parentheses: asymptotic t values.
Source: Socioeconomic Farm Census (5 percent random sample).

Table 2. Non-Farm Labor Supply Decisions: Farm Operators.

Dimension:	PARTICIPATION			HOURS OF WORK	
Estimation technique:	LOGIT	LOGIT	PROBIT	TOBIT	TOBIT
Model:	HH.M-L01	HH.ML02	HH.M-P01	HH.M-T01	HH.M-T01
Variable	Parameter estimates*				
Sex (0,1 Dummy) GSL-HV	2.7371 (6.5799)	2.7978 (6.7267)	1.3677 (6.6766)	1849.0 (7.1510)	1875.6 (7.2817)
Vocational Training (non-farm) (0,1 Dummy) AUSB-HV	1.3660 (6.7253)	1.3656 (6.8624)	0.7853 (7.3412)	828.66 (7.8329)	816.04 (7.8138)
Age (Head of Household) (Years) ALTER-HV	-0.04648 (7.2296)	-0.04707 (7.2843)	-0.02562 (7.2409)	-27.680 (6.9968)	-27.461 (6.9887)
Opportunity Costs (Head of Household)(DM; log.) DM-HV	0.8988 (3.1969)	0.81085 (3.2545)	0.43564 (3.4432)	406.62 (4.2068)	384.37 (4.2584)
Standardized Farm Income (DM; log) LNBYLSF	-2.1956 (20.786)	-2.1908 (20.823)	-1.1488 (23.168)	-1290.4 (26.398)	-1282.3 (26.465)
Type of Farm Operation (0,1-Dummy) BTYP		0.41042 (3.0901)	0.24794 (3.3955)		323.87 (3.9671)
Constant	11.128 (3.9682)	11.733 (4.6462)	6.1083 (4.7706)	7598.6 (7.1068)	7545.0 (7.4301)
Test Statistics					
LIKELIHOOD RATIO TEST	1208.72	1218.33	1187.37	1184.39	1200.16
ρ^2 (Logit,Probit); Θ (Tobit)	0.4456	0.4491	0.4377	0.3894	0.3974
Standard Error of Estimation				1442.7	1431.8
E(y)				300.8	299.9
E(y*)				938.3	931.9
Observations N	2135	2135	2135	2135	2135
Participation Rate (Actual)	0.3316	0.3316	0.3316	0.3316	0.3316
Participation Rate (Estimated)	0.2265	0.2277	0.2568	0.3206	0.3218

*Data in parentheses: asymptotic t values.
Source: Socioeconomic Farm Census (5 percent random sample).

4. Final Remarks

The models presented in this paper accomplish a sound description and reconstruction of non-farm labor supply decisions of farm households. Although only a few variables were employed, all models succeed in describing the empirical findings very well. The results might provide an indication on the "rationality" of resource allocation decisions made by the farm households; these decisions seemed to be widely determined by objective factors rather than subjective motivations. Farm households prove to be very flexible in their adjustments to changing economic conditions.

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