Pluriactivity Decisions by Farm Households in Italy

Cristina Salvioni, Dario Sciulli, Giuliana Parodi

Cristina Salvioni, University D'Annunzio, DMQTE, Pescara, Italy, salvioni@dmqte.unich.it
Dario Sciulli, University "Tor Vergata", DEI, Rome, Italy, dario.sciulli@uniroma2.it
Giuliana Parodi, University D'Annunzio, DMQTE, Pescara, Italy, parodi@dmqte.unich.it

Paper prepared for presentation at the XIth International Congress of the EAAE

(European Association of Agricultural Economists),

'The Future of Rural Europe in the Global Agri-Food System*, Copenhagen, Denmark, date as in: August 24-27, 2005*

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Abstract

In this article we test whether in Italy the off-farm participation decisions of household members in working age are taken jointly and what are the variables that affect them. We find that the decisions of the operator, the spouse and the eldest child are not joint. Conversely, the participation decision of the operator and the spouse, that is of the two household's members belonging to the same generation, are found to be joint. The results suggest that policy actions for the purpose of encouraging off-farm participation rely on measures geared at improving the level of education and providing childcare services.

Keywords

Off-farm work participation, multivariate probit, household models.

JEL

C35, J43, Q12.

Introduction

Pluriactivity concerns a progressively greater share of farm households in all industrialized countries, and in fact off-farm incomes play an increasingly important role in the determination of farm households' global income (OCSE, 2001; Eurostat, 2002; Huffman and El Hosta, 1997).

In the last decades participation has been enforced by the increasing participation of women in the labour market. More generally, the diffusion of capital intensive technological innovations has usually reduced the amount of labour required both in the farm and in the domestic production processes, therefore making labour time available for more productive off-farm activities. The decreasing need for on farm and domestic labour operated in conjunction with "demand pull factors". The increase in the educational level of the agricultural population[1], and especially of females, eased the outflow of this excess labour force out of the agricultural sector and its absorption in off-farm sectors.

Farm households often use multiple job-holding by their members as a strategy to reach a better position in terms of both income and lifestyle benefits. Also, off-farm employment is often a temporary strategy for diversifying the households' financial position, generating additional income used to overcome temporary crisis in farm income. Recent evidences also suggest that pluriactivity can be a permanent strategy used by households to spread on different activities the income risk stemming from farm income variability. In addition, farm households' pluriactivity can be also explained in terms of objectives such as career development, lifestyle or personal fulfilment (Mishra *et al*., 2002).

Despite the importance of gaining a good understanding of the determinants of off-farm labour decisions, both for the design and the valuation of rural and agricultural policies, quantitative analysis in the EU are scarce (Benjamin *et al,* 1996*;* Bjørnsen, 2004; Weiss, 1997; Woldehanna, Lansink and Peerlings, 2000); this is mainly due to the lack of data needed to estimate household models.

The focus of this paper is to investigate the determinants of off-farm participation decisions[2] in Italian farm households by using a reduced-form multivariate probit model. In the following sections we present a review of the theoretical background and of the empirical methods used to investigate the determinants of off-farm participation; we then present the data used in the application and the results obtained.

Theoretical background and estimation strategy.

Theoretical background

During the last two decades there has been an increasing volume of empirical research on the issue of off-farm participation. This problem may be modelled by following a game theoretic[3] or with an econometric approach. In the latter, the most frequently followed, the choice behaviour is usually specified as a probabilistic process[4].

Initially research was limited to estimate off-farm participation and labor supply equations of a single individual, typically the farm operator (Sumner, 1982). More recently, research has focussed on jointness in the decisions of the farm couple (operator and spouse, or husband and wife) and, recently, of the couple and of other adult household members, namely the oldest child in the household (Kimhi, 2004).

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[1] The low educational level and qualification of agricultural labour force have in the past limited the exit of workers out of the agricultural sector towards more productive sectors.

[2] Note that throughout the paper we assume that there are no demand constraints in off-farm work, so that the decision to participate off-farm coincides with being employed off-farm; this definition obviously differs from the usual definition of participation rate, where both the employed and those looking for employment in a particular labour market are considered as participants.

[3] For example Caiumi and Perali (1997) present a cooperative game situation in which operator and spouse are both assumed to have at least partly concurrent interests, and to agree on maximising the household's utility.

[4] This allows us to account for the individual's uncertainty by introducing randomness in the decision rule or in the utility function.

Modelling joint decisions of two economic agents requires assumptions about a dependence between their behaviour. The off-farm employment decisions of the household can be modelled in different ways according to how decisions are assumed to be taken. Here we briefly describe to two possible scenarios, with respect to operators and spouses.

A first possibility is to assume that there is only one decision maker (the operator or, alternatively, the spouse) that makes the decision for the entire household. In this case the modelling problem equals a multinomial case, with only one agent choosing between four alternative work regimes.

A second possibility is to assume interdependence among potential decision makers in the farm household; in particular, employment and participation decisions of each one can be assumed to be taken conditionally upon the other one's choice. The results obtained modelling this assumption within a multivariate probit approach are not univocal. Within this framework some studies have not found any evidence of jointness in the decision (Lass and Gempesaw, 1992; Bharadwaj and Findeis, 2003; Oluwole and Findeis, 2001; Bjørnsen, 2004), some others have found that couples jointly make off-farm work participation decisions (Tokle and Huffman, 1991; Lim-Applegate et al., 2002) and more recent studies have found evidence of jointness in the decision of the farm operator, the spouse and their eldest adult child (Kimhi, 2004).

The farm household model originally formalized by Singh, Squire, and Strauss (1986) is the basis of the theoretical framework used to tackle the labour supply and the participation decisions problem. The labour supply and participation decisions of farm households are originally derived by Huffman (1991) and Huffman and El-Osta (1997); in what follows we briefly illustrate the model which is at the basis of our exercise, derived from the model developed by Huffman and El Osta, and elaborated by Bjørnsen (2004) and by Oluwole and Findeis (2001).

In our model the decisions considered are those of the two members of the couple, named hereafter operator and spouse. The family utility function is defined over family consumption, leisure of the operator and of the spouse; the assumed behaviour is the utility maximizing one, subject to several constraints, i.e. time constraints, the production function constraint, and the budget constraint.

Operator and the spouse hours are heterogeneous, and for each of them exhaustively allocated to leisure, off-farm work and farm work; it is assumed that leisure and farm work are positive, while off-farm work can be zero or positive, so that a non negativity constraint is imposed on this variable. According to the production function constraint, the amount of good produced by the farm depends on the time the operator and the spouse work on the farm, and on the inputs of hired factors of production. According to the budget constraint the value of the family consumption entirely exhausts the family income, made up of capital income, income acquired by the operator and the spouse working off-farm, and household earnings from the farm business, defined as the difference between revenue from the good produced and sold (there are no stocks), and cost of hired factors of production.

Particularly important in the model are the explanatory variables, which in the literature are often grouped as follows: indicators of the level of education of operator and spouse, which affect both the utility function and the production function; household characteristics (i.e. composition of the family) and labour market characteristics which affect the utility function.

The model is therefore:

$$Max\, U = U\left(C, L^g, H^g, Z_H, Z_M\right) \quad g = o, s \tag{1}$$

$$S.t.:$$

$$T^g = F^g + M^g + L^g, \tag{2}$$

$$F^g, L^g > 0, \tag{3}$$

$$M^g \geq 0, \tag{4}$$

$$Q = f\left(F^g, X, H^g, Z_F\right), \tag{5}$$

$$PQ + W^g M^g + V = C + RX \tag{6}$$

where:

C: family consumption (the price of which is 1 by assumption)
L: leisure
g = o, s, i.e. refers to the two members of the couple, operator and spouse
H: vector of personal variables, i.e. age and education
Z_H: vector of characteristics of the household, i.e. number of children
Z_M: vector of characteristics of the off-farm market
T: total available time
F, M respectively time spent working on the farm and off the farm
Q: quantity of the good produced by the farm
X: vector of hired inputs
Z_F: vector of characteristics of the farm
P: price of the good produced by the farm
W: off-farm market wage
V: value of capital income
R: vector of prices of hired inputs

The Kuhn - Tucker conditions for a maximum allow for the solutions of the choice variables, which are the level of family consumption, hours of leisure, off-farm work, and therefore of farm work for both the operator and the spouse, level of hired factors of production and of quantity of good produced.

In this paper we are concerned with off-farm participation, therefore of the whole model we only consider the utility maximizing condition that identifies participation in off-farm work. As it is well known, there is an interior solution, i.e. hours worked off-farm are positive, if for the operator and/or the spouse the off-farm market wage is higher than his/her reservation wage, i.e. $(W_M > W_R)_g$; this is also the condition of participation in off-farm work:

$$M_g > 0 \text{ if } (W_M > W_R)_g; \text{ or } M_g > 0 \text{ if } (W_M - W_R)_g > 0 \tag{7}$$
$$M_g = 0 \text{ otherwise}$$

where W_M is off-farm market wage and W_R is reservation wage.

Analytically, the reservation wage equals the value of the marginal product of the farm work, evaluated at zero off-farm work.

Estimation Strategy

With respect to working off-farm, we can envisage the following alternative situations:

I. Both operator and spouse participate in off-farm work: $M_o > 0, M_s > 0$
II. Operator participates in off-farm work, spouse does not: $M_o > 0, M_s = 0$
III. Operator does not participate, spouse does participate in off-farm work: $M_o = 0, M_s > 0$
IV. Neither operator nor spouse participate in wage work: $M_o = 0, M_s = 0$.

Therefore each spouse can work off-farm, conditionally on the probability that the spouse does or does not work off-farm. The theoretical model outlined above implies that for each spouse the decision to work off-farm depends on the relationship between off-farm wage, and personal reservation wage. As a result, the probability that each member of the couple works off-farm conditionally on the off-farm working situation of the other member of the couple depends ultimately on equation (1) above.

Given that the reservation wage is not observable, neither is observable the difference $(W_M - W_R)_g$, which is therefore a latent variable, Y_g^*.

In order to give operational meaning to the above condition of participation, it is assumed that the latent variable is a stochastic function of individual and market characteristics.

$$Y_g^* = X_g \beta_g + \varepsilon_g \quad g = o, s \tag{8}$$

where ε_g are the error terms distributed as multivariate normal, each with a mean of zero, and variance – covariance matrix Γ, where Γ has values 1 on the leading diagonal and correlations $\rho_{jk} = \rho_{kj}$ as off – diagonal elements.

The condition of participation ($Y_g = 1$) therefore becomes:

$$Y_g = 1 \quad \text{if } Y_g^* > 0 \tag{9}$$

In a multivariate probit model each off – farm probability of participation equation is modelled as a probit equation, assuming normally distributed additive stochastic terms.

The probability of participation is explained by exogenous variables that affect household utility and available time for all household members.

Assuming a general correlation structure between the equations requires joint estimation in order to exploit all available information and provide efficient estimators. This correlation structure could result, for example, from unobserved household level variables that are common to all equations.

In the trivariate case, the three subjects whose off-farm participation decisions we are investigating are operator (*o*), spouse (*s*), and descendent (*d*).

With respect to working off-farm, we can envisage the following work regimes:

I. Operator, spouse and descendent participate in wage work: $M_o > 0\ M_s > 0\ M_d > 0$
II. Both Operator and spouse, but not the descendent, participate in wage work: $M_o > 0\ M_s > 0\ M_d = 0$
III. Both spouse and the descendent, but not the operator, participate in wage work: $M_o = 0\ M_s > 0\ M_d > 0$
IV. Operator and the descendent, not the spouse participate in wage work: $M_o > 0\ M_s = 0\ M_d > 0$
V. only operator participates in wage work: $M_o > 0\ M_s = 0\ M_d = 0$
VI. only spouse participates in wage work: $M_o = 0\ M_s > 0\ M_d = 0$
VII. only descendant participates in wage work: $M_o = 0\ M_s = 0\ M_d > 0$
VIII. none of them participates in wage work: $M_o = 0\ M_s = 0\ M_d = 0$

For each of the three subjects the probability of participating off-farm is therefore conditional on the probability that each of the other two subjects do or do not participate in off-farm work; for each of the three subjects conditions (1) and therefore (2) above stand, where now *g* can take up one of three values, i.e. *g= o, s, d.*

The application

The data

The data used for this study have been taken from a survey on the socio-economic characteristics of Italian agriculture conducted in 1996 by the Italian Institute for the Studies of Agricultural Markets (Ismea) in Italy.

The aim of the survey is to collect statistical information on the behaviour of each member of the agricultural household and on the sharing rule of public and private resources within the household, in order to eventually perform empirical analyses of the household decision process. The survey has been designed on the basis of a reference theoretical model at the micro level, which considers the general equilibrium of the farm household as a micro economy; this allows to establish links between the micro and macro levels of economic and policy analysis. According to this model each household can be seen as a household-enterprise producing domestic public goods by transforming factors which are in part non-market goods, and therefore not easily measurable. Unlike an urban family, the members of a rural household can allocate their working time with certainty between household and agricultural production activities.

The Ismea survey is a probability weighted, stratified survey (by European Size Unit[5] and Farm Typology[6]) that collected information from 1881 farms, 1777 of whom are household farms. The sampling has been based on the Agricultural Census conducted in 1991 by the Italian National Statistical Institute, and it is censored at the cut-off point of farms with an economic dimension greater than 4 ESU. This criterion has been adopted with the aim of excluding those enterprises where the agricultural activity is either marginal or dismissed. The sample is statistically representative at macro-regional level (North, Centre and South).

The survey data is merged with official statistics at the provincial level of the unemployment rate used as a proxy for the local labour market conditions.

For the following analysis we make use of a sub-sample of 4035 individuals in 1060 households of couples with both members in working age (16-60) and another with 542 households of couples with both members in working age and a child of working age.

The variables used and expected signs

Following previous researches we use four categories of variables to specify the model for off-farm participation decision: individual, household, farm and local market characteristics. The empirical definitions of the variables, the summary statistics and the expected estimated signs are reported in tables 1, 2 and 3.

Individual attributes include age, age squared and years of education. Off-farm participation is likely to follow a curvilinear life-cycle pattern, with a positive age effect with a negative age-squared coefficient. It is also expected that more human capital will result in higher off-farm participation rates; the higher the educational level is the wider the range of possible work positions that can be considered.

Household attributes include the number of pre-school children (Nchild05), the number of children of school age (Nchild614), the number of descendants – sons and daughters of working age- (Nchild15), presence of household members more then 60 years old contributing to domestic activities (Substitutes). Farm household attributes are expected to affect operators' allocation of time to farming, as the work of other family members (spouses, descendants and substitutes) is a substitute for the

[5] The European Size Unit (ESU) is the indicator used by FADN to measure the economic dimension of a farm. It is based on the standard gross margins attributed to the farm, that is on the potential gross margins producible in a farm with given structural characteristics. In 1995: 1ESU = 1200 ecu = 920.95 euro.

[6] This is the classification farms typology in use in the EU; it is based on the financial potential of the various agricultural activities of the farm and the combination of these activities.

operator's own farm work. The presence of young children in the household likely contributes to a greater need for household activity (and less off-farm work) by the farm spouse and potentially by the farm operator. The spouse's participation and hours of off-farm work is expected to be influenced (positively) by the spouse's educational attainment.

The presence of pre-school children is anticipated to decrease the probability of off-farm work, for not operators and spouses, particularly for women, due to the high amount of time required by child care, i.e. domestic work. Conversely, it is anticipated that children of school age (Nchild614) will increase the likelihood of off-farm participation of the operator in order to raise the money needed for the required higher expenses; less certain is the prediction of the effect of this variable on spouses' participation. The presence of children in working age (Nchild15) potentially increases family income, hence this can involve a reduction in off – farm participation. The expected sign is negative for both operators and spouses. The presence of Substitutes is expected to positively influence the likelihood of off-farm participation.

The location of the family in Northern regions is likely to positively affect off-farm participation given a strong demand pull effect in these areas. Conversely, the location in the South is expected to negatively influence off-farm participation given the slack demand for labour.

Farm attributes include variables indicating the farm specialisation in labour intensive productions, namely dairy (Dairy) and vegetable, fruit, and nursery crops (Vegfruit), farm type (Farmtype), farm location (Mountain), value of land (Land). Farm sales and farm size variables were excluded from the off-farm participation equations due to potential simultaneity with operator off-farm work decisions.

It is anticipated that the specialisation in dairy and vegetable, fruit, and nursery crops reduces the likelihood to work off-farm, given the higher labour requirements of these productions. The farm typology used (Castagnini, *et al.,* 2003) divides the sample in 6 types of farm households: small limited resources, small retirement, small-medium residential, small medium and large commercial. The sign of these dummies is anticipated to be positive only in the case of farm type 3 (residential farm household), that is for those farm households which are characterized by a large share of off-farm work. Mountain farms are typically characterized by low returns; accordingly, the variable Mountain is expected to positively affect participation for operators and children of working age, trying to increase household revenue with off-farm work; the expected sign for spouse is negative, given the likely great travelling distances between the farm and the off-farm workplace. Larger land values are expected to have a negative effect on off-farm participation, because of the wealth effect (Findeis, 2003)[7]. Finally, ambiguous is the sign of the provincial unemployment rate (Urate), i.e. the variable capturing the characteristics of local labour markets; in fact the model of the discouraged and of the additional worker predict respectively a negative and a positive sign for unemployment as an explanatory variable of participation[8].

Table 2 and 3 respectively present means and standard deviations of all the variables for the whole selected sample and the various working regime. In the sample the average participation in the off-farm labour market is 8.1%. According to the Farm Structure Survey by Eurostat in the same year the percentage of holders with another main activity was 23.5%. The large difference between these two data is partly due to the fact that the sample in use in this paper does not contain farms with less than 4ESU.

[7] In the econometric analysis land values are expressed in logarithms.

[8] This variable suggests the possibility of unemployment among those looking for off-farm work, contrary to what is generally assumed in the literature.

Table 2. Descriptive statistics by working regime – averages, (standard deviations in brackets).

Characteristics	Working regime*											
	All			110			101			011		
	o	*s*	*d*	*o*	*s*	*d*	*o*	*s*	*d*	*o*	*s*	*d*
Age	46,03	42,87	23,15	46,23	43,31	23,75	49,67	46,17	21,33	49,11	47	24,33
	(9,06)	(9,08)	(5,25)	(7,75)	(7,48)	(6,04)	(6,02)	(5,23)	(4,63)	(5,56)	(5,66)	(4,90)
Schooling	7,44	7,51	10,27	12	12,38	13,2	7	7	10	7,89	7,89	10,78
	(3,59)	(3,51)	(3,51)	(4,14)	(4,17)	(4,26)	(4,29)	(4,29)	(3,46)	(2,32)	(4,65)	(2,64)
Nchild05		0,18			0			0			0	
		(0,47)										
Nchild614		0,40			0,23			0			0	
		(0,71)			(0,44)							
Nchild15		0,84			1,08			1,5			1,67	
		(0,99)			(0,95)			(0,55)			(1,00)	
North		0,37			0,08			0,5			0,33	
		(0,48)			(0,28)			(0,55)			(0,50)	
South		0,42			0,85			0,33			0,44	
		(0,49)			(0,38)			(0,52)			(0,53)	
Land (000 lire)		9404,18			9016,03			4298,64			22551,38	
		(17131,78)			(18451,31)			(2937,77)			(41606,44)	
Farm1		0,07			0			0			0	
		(0,26)										
Farmtype3		0,04			0,85			0,33			0,11	
		(0,19)			(0,38)			(0,52)			(0,33)	
Farm4		0,14			0,08			0			0,21	
		(0,34)			(0,28)						(0,43)	
Farm5		0,48			0			0,67			0,44	
		(0,50)						(0,52)			(0,53)	
Farm6		0,28			0,08			0			0,22	
		(0,45)			(0,28)						(0,44)	
Mountain		0,07			0			0,17			0,11	
		(0,25)						(0,41)			(0,33)	
Vegfruit		0,21			0,25			0,04			0,34	
		(0,37)			(0,38)			(0,09)			(0,49)	
Dairy		0,07			0,11			0,17			0,22	
		(0,26)			(0,33)			(0,41)			(0,44)	
Substitute		0,07			0,08			0,17			0,22	
		(0,27)			(0,28)			(0,41)			(0,67)	
Urate		0,129			0,161			0,134			0,128	
		(0,072)			(0,046)			(0,079)			(0,066)	

* The 111 combination has zero observation. With reference to the eight working regimes identified in the text, here 1 and 0 indicate respectively off-farm participation and not participation of the individual concerned. Individuals are listed in the order operator (*o*), spouse (*s*) and eldest descendent (*d*).

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Table 2. Descriprive statistics by working regime *(continued)*.

	Working regime											
	100			010			001			000		
	o	*s*	*d*	*o*	*s*	*d*	*o*	*s*	*d*	*o*	*s*	*d*
Age	45,67	41,90	20,56	39,87	36,29	18,82	52,81	49,15	25,65	46,48	43,03	23,09
	(7,75)	(8,31)	(4,20)	(8,02)	(8,17)	(3,62)	(5,55)	(5,67)	(4,23)	(9,12)	(9,09)	(5,33)
Schooling	8,34	8,07	9,26	9,94	10,57	8,92	6,10	6,14	11,86	7,14	7,17	10,16
	(3,92)	(3,58)	(3,27)	(3,41)	(3,46)	(3,22)	(2,98)	(3,21)	(2,95)	(3,45)	(3,26)	(3,53)
Nchild05		0,25			0,31			0,06			0,18	
		(0,47)			(0,58)			(0,29)			(0,48)	
Nchild614		0,74			0,43			0,19			0,39	
		(0,93)			(0,67)			(0,55)			(0,71)	
Nchild15		0,64			0,33			2,18			0,78	
		(0,88)			(0,62)			(1,07)			(0,94)	
North		0,23			0,65			0,47			0,34	
		(0,42)			(0,48)			(0,50)			(0,48)	
South		0,48			0,21			0,36			0,43	
		(0,50)			(0,41)			(0,48)			(0,50)	
Land		5064,42			9450,21			6685,05			9865,61	
		(6385,88)			(17744,25)			(5487,14)			(17822,68)	
Farm1		0,08			0,03			0			0,08	
		(0,27)			(0,18)						(0,28)	
Farmtype3		0,31			0,04			0,01			0	
		(0,47)			(0,21)			(0,12)				
Farm4		0,26			0,25			0,17			0,11	
		(0,44)			(0,43)			(0,38)			(0,32)	
Farm5		0,28			0,45			0,50			0,50	
		(0,45)			(0,50)			(0,50)			(0,50)	
Farm6		0,07			0,22			0,32			0,30	
		(0,25)			(0,42)			(0,47)			(0,46)	
Mountain		0,05			0,02			0,15			0,07	
		(0,22)			(0,15)			(0,36)			(0,25)	
Vegfruit		0,21			0,23			0,12			0,21	
		(0,37)			(0,67)			(0,30)			(0,37)	
Dairy		0,03			0,03			0,08			0,08	
		(0,18)			(0,18)			(0,28)			(0,27)	
Substitute		0,03			0,02			0,11			0,07	
		(0,18)			(0,15)			(0,43)			(0,26)	
Urate		0,137			0,107			0,127			0,130	
		(0,059)			(0,049)			(0,085)			(0,074)	

Table 3. Expected signs.

Variables	Expected sign	
	Operator	Spouse
Age	+	+
Age square	-	-
Schooling	+	+
Nchild05	-	-
Nchild614	+	+
Nchild15	-	+
Substitute	+	+
North	+	+
South	-	-
Mountain	+	-
Farmtype3	+	+
Vegfruit	-	-
Dairy	-	-
Land	-	-
Urate	-/+	-/+

In the first place, in ¾ of families no individuals (out of all those examined) offer off – farm work, while in only 2.7% families two or more persons offer it. If we concentrate on the individual off-farm participation rate, we can see that 7.5% of operators offer off-farm work (higher values are observed in Southern regions and in presence of children). 10.5% of spouses offer off-farm work, and they are mostly resident in Northern regions. Finally, off-farm participation of the eldest descendent is 15.9% (high values are present in Northern regions and in mountain farms).

On average, schooling is higher for eldest children (10.3 years) rather that for operators and spouses (about 7.5 years). The presence of children in working age is much higher (0.84) with respect to the presence of children in not working age; particularly low is the presence of pre-school children (0.18), while the presence of substitutes is rather low (0.07). The families are distributed in the follow way: 37% live in Northern regions, 21% live in the Centre of Italy and 42% live in Southern regions. Only 7% of sampled families live in mountain zone.

With respect to working regimes, families with two or more individuals that offer off-farm work are characterized by low presence of children in not working age and by a number of substitutes relatively higher. Instead, on average schooling and age are slightly higher in families with no or one individual offering off-farm work. Finally, families where only operator and spouse offer off-farm work jointly are characterized by a very high schooling (12 and 12.38 years respectively) and by a very low presence of children in not working age. 85% of these households live in Southern regions.

Results

The first hypothesis tested is if that off-farm participation decisions of the operator, spouse and the eldest child are joint. Even if theory suggests to include all the personal characteristics of the operator in the spouse participation equation, and vice versa, we estimate a specification without cross age and education effects in order to avoid multicollinearity problems stemming from the high correlation we observed across these variable.

We start estimating a trivariate probit model for the eight different and mutually exclusive household's off-farm work regimes. The results of this model are presented in table 4.

Given that the estimated correlation coefficients of the disturbances (ρ) is not significantly different from zero, we conclude that the three household members' (operator, spouse, eldest children) decisions are not joint. This result appeals to intuition: joint decisions on time allocation seem intuitively acceptable between people of the same generation, i.e. spouses, who share similar kind of responsibilities, and who may jointly decide on the basis of complementarity/substitutability of each

others' leisure; intergenerational joint decisions, i.e. among parents/children, appear intuitively less acceptable.

The second step is to estimate a bivariate probit model in which the two equations respectively refer to the participation decision of the operator and the spouse that is of the two household's members belonging to the same generation. The results of this model are presented in table 5. The estimated correlation of the error terms (ρ) is significantly different from zero, based on the likelihood ratio test. This result confirms the hypothesis that operators and spouses make joint decisions. An additional confirm of this hypothesis is provided by the comparison of the sum of the log likelihoods obtained fitting two probit and the log likelihood of the full bivariate model. The latter is greater than the first, as a consequence we can conclude that the bivariate probit model fits the data better than the two separate binary models "nested" in the bivariate. Finally, the negative sign of ρ suggests that the random disturbances in the couples' off-farm work participation decisions are influenced in opposite direction by unmeasured effects (or random shocks).

Table 4. Trivariate Probit Estimation Results.

	Operator		Spouse		Descendent	
	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics
Age	0.884	2.350 **	0.068	0.330	0.298	2.300 **
Age square	-0.009	-2.320 **	-0.001	-0.430	-0.005	-1.950 *
Schooling	0.084	2.650***	0.119	4.580***	-0.006	-0.240
Nchild05	0.602	1.400	0.391	1.210	0.451	1.340
Nchild614	0.144	0.750	-0.307	-1.500	0.018	0.110
Nchild15	-0.082	-0.540	-0.209	-1.420	0.313	3.630***
Substitute	0.132	0.330	0.378	1.260	0.438	1.980 **
North	-0.127	-0.410	0.205	0.690	0.474	2.240 **
South	-0.609	-1.520	0.229	0.660	-0.140	-0.460
Mountain	-0.199	-0.390	-0.462	-0.770	0.357	1.390
Farmtype3	2.969	6.660***	1.027	3.020***	0.510	1.420
Vegfruit	-0.652	-1.710 *	0.157	0.630	-0.265	-1.190
Dairy	-0.212	-0.440	0.290	0.830	-0.009	-0.030
Land	-0.251	-3.120***	-0.019	-0.230	-0.157	-2.460 **
Urate	4.619	1.750 *	1.265	0.550	1.772	0.970
constant	-22.442	-2.410 **	-3.435	-0.720	-4.763	-2.860***
Correlation	Coefficient	Std. Err.	Coefficient	Std. Err.		
with spouse	0.181	0.127				
with descendent	0.111	0.114	0.201	0.115		

*** Significant at 1%
** Significant at 5%
* Significant at 10%

Table 5. Bivariate Probit Estimation Results

	Coefficient	t-statistics		Coefficient	t-statistics		Marginal Effects	
	Operator			Spouse			Operator	Spouse
Age	0.172	1.775	*	0.012	0.189		3.33E-04	2.17E-05
Age square	-0.002	-1.569		0.000	-0.558		-3.19E-06	-7.79E-07
Schooling	0.056	2.716	***	0.125	7.103	***	1.09E-04	2.30E-04
Nchild05	0.106	0.641		-0.085	-0.703		4.73E-05	
Nchild614	0.176	1.864	*	-0.197	-2.154	**	-2.10E-05	
Nchild15	-0.073	-0.870		-0.086	-1.063		-3.00E-04	
Substitute	-0.003	-0.012		-0.005	-0.021		-1.49E-05	
North	-0.305	-1.536		0.455	2.651	***	2.30E-04	
South	-0.095	-0.373		-0.082	-0.345		-3.25E-04	
Mountain	0.074	0.242		-0.703	-2.139	**	-6.64E-04	
Farmtype3	2.653	9.714	***	1.037	4.387	***	2.15E-01	
Vegfruit	-0.221	-1.095		-0.078	-0.488		-5.70E-04	
Dairy	-0.010	-0.033		0.032	0.124		3.99E-05	
Land	-0.203	-3.557	***	-0.069	-1.382		-5.19E-04	
Urate	0.412	0.235		0.426	0.264		1.58E-03	
constant	-4.690	-2.115	**	-1.559	-1.176			

Correlation	Coefficient	Std. Err.		chi2(1)	Prob>chi2
with spouse	- 0.263	0.131	**	3.944	0.0470

*** Significant at 1%
** Significant at 5%
* Significant at 10%

Our estimates of the age variable predict a typical inverted U effect on off farm participation. However, estimate is significant only for operator. In this case one more year of age increases by 0.03% the probability of participating in off – farm work. As expected, schooling has a positive effect on off – farm participation, in both case. One more year of schooling increases respectively by 0.01% and by 0.02% the operator's and the spouses' off – farm participation. Estimates are significant at 1%.

Presence of preschool-aged children has a different effect on operator and spouses. Signs are as expected, positive for operator and negative for spouse. However, estimates are not significant. Presence of school-aged children has the same effect of the previous variable. The expected sign for spouse is not confirmed, and estimates are significant. However, the marginal effect is, on average, negative, but its value is very low. Finally, as expected, presence of children in working age affects negatively off – farm participation of our agents. Estimates are not statistically significant, while marginal effect is about 0.03%. The presence of family members above working age and who declared to contribute to the household domestic work (Substitutes), affects negatively off – farm participation decision. Estimated signs are contrary to expectations, however estimates are not significant. Relatively to territory and zone dummy variables, our estimates show that the location of the farms in Northern regions positively affects off – farm participation only for spouses. The estimate is significant and the marginal effect shows that residence in the North of Italy increases, on average, by 0.013% the probability of off – farm participation. For the operator the estimated negative sign is opposite to predictions, however it is not significant. The location of farms in Southern regions negatively affects off – farm participation, as predicted, but the estimation is not significant. The estimated sign of the mountain dummy variable is consistent with predictions; in fact, it affects positively the operator off – farm participation, and negatively the spouse. In this latter case, estimation is statistically significant and the marginal effect is equal to 0.06%.

Belonging to the residential farm type (Farm3)[9] has a significant and positive influence on the off-farm participation of both the operator and the spouse, in assessing the relevance of this variable, we must take into consideration that this variable includes farms with a larger share of farm work and also that only less than 4% of total households belong to this type.

Conversely, the indicators of high labour intensity sector of production (Dairy and Vegfruit) are not statistically significant. The value of land is significant only in the operator equation and it has a negative influence, possibly indicating the presence of a wealth effect .The estimated sign of the local unemployment rate is positive, indicating an additional worker phenomenon. However, the estimates are not significant. One possible explanation of this may be the basis of calculus of the unemployment rate, at provincial rather than at local level, so that the unemployment rate refers to a too wide an area for the purpose of being relevant to farmers' decisions; it is possible that estimation would improve should available data allow for calculation of a more local unemployment rate.

Conclusions and directions for future work

A better understanding of off-farm participation decisions could be useful for further implementation of Common Agricultural Policy reform. Two of the challenges addressed by the rural development policy are in fact the presence in rural areas of a) income lower than the average, mainly due to ageing working population and great dependency on the primary sector, and b) higher unemployment relative to the rest of the territory. To know what variables affect off-farm participation decisions can, for example, allow the policymaker to select the best policy measure to increase the diversification of farm households towards non-agricultural activities in order to increase global household income. In addition, some studies have found that off-farm work has a positive influence on the exit probability of farmers (Weiss 1997 and 1999). As a consequence, a better knowledge of the rules that regulate off-farm participation can be of help in understanding the speed of structural adjustment in farm sectors.

Results suggest policy actions for the purpose of encouraging off-farm participation: education appears to be positively and significantly correlated with off-farm participation, both of the operator and of the spouse; therefore any policy geared at improving the level of education in general is likely to increase off-farm participation. The number of children in school age is positively correlated with the operator's off-farm participation, and negatively correlated with the spouses' off-farm participation. The interpretation seems to be that when children begin to be expensive, the operator looks for extra income outside the farm, while the spouse is still looking after the children. Policies geared at providing services replacing the need to look after the children at home should therefore increase the off-farm participation of spouses.

In view of the importance of the topic considered, further research is commendable. In particular, an estimation of the number of hours allocated to farm and off-farm work is desirable. Further work should also explicitly consider the problem of disequilibrium; contrary to the assumption of this paper, not off-farm participation could reflect lack of job opportunities rather than an optimising solution.

References

Benjamin, C., Corsi A., Guyomard, H. (1996) "Modelling Labour Decisions of French Agricultural Households", *Applied Economics* 28: 1577-89;

Bharadwaj L. and Findeis J.L. (2003) "Off-farm Work Among Farm Women: Motivations, Earnings, and Benefit Receipt", Paper prepared for presentation at Annual Meeting of the American Agricultural Association, Montreal, Canada , July 27-30, 2003;

Bjørnsen H. (2004) "Off-farm labour participation of farm couples. A bivariate random coefficients approach", Norvegian Institute for Urban and Regional Research. Oslo, Norway;

[9] Farm type 3 is the only farm type included in the estimation; the other farm types have been excluded due to multicollinarity. Given the criteria used to build such a group there is no risk of equivalence with the dependent variable, in fact not all the farm3 operators partecipate to the off-farm labour market and not all the participating operators in the sample are in the farm3 group.

Caiumi, A., and F. Perali. (1997) “Female Labor Force Participation: A Comparison between Urban and Rural Families”, *American Journal of Agricultural Economics* 79: 595–601;
Cappellari L., S.P. Jenkins “Multivariate probit regression using simulated maximum likelihood”, *Stata Journal*, StataCorp LP, vol. 3(3): 278-294;
Castagnini R., F. Perali, C. Salvioni, N. Tommasi (2003) “Una tipologia delle imprese agricole basata sui dati dell’inchiesta socioeconomica Ismea”, Società Italiana di Economia Agraria "Nuove tipologie di impresa nell'agricoltura italiana". Atti del XXXIX Convegno di Studi SIDEA. Florence: Centro stampa 2P;
Eurostat (2000) “Incomes of Agricultural Sector Households”, Luxembourg;
Eurostat (2002) “Incomes of Agricultural Sector Households”, Luxembourg;
Huffman W.E (1991) “Agricultural Household Models: Survey and Critiques”, In M.C. Hallberg, Findeis J.L. and D.A. Lass (eds), *Multiple Job-Holding among Farm Families.* Ames, Iowa State Univeristy Press: 79-111;
Huffman, W.E e H. El-Hosta (1997) “Off-farm work participation, off-farm labour supply and on farm labour demand of US farm operators”, Iowa State Staff Paper n. 290;
Huffman, Wallace E., and Mark D. Lange (1989) “Off-Farm Work Decisions of Husbands and Wives: Joint Decision Making”, *Review of Economics and Statistics* 81 XXI: 471-80;
Kimhi, A. (2004) “Family composition and off-farm participations in Israeli farm households”, *American Journal of Agricultural Economics* 86: 502-512;
Lass, D. A., and C. M. Gempesaw (1992) “The Supply of Off-Farm Labor: A Random Coefficients Approach”, *American Journal of Agricultural Economics* 74: 400-411;
Lim-Applegate, H., Rodriguez G. and Olfert R., (2002) “Determinants of Non-Farm Labour Participation Rates Among Farmers in Australia”, *The Australian Journal of Agricultural and Resource Economics* 46: 85-98;
Mishra A. K., El-Osta H., Morehart M. J., Johnson J.D., and Hopkins, J. W., (2002) “Income, Wealth, and the Economic Well-Being of Farm Households”, Farm Sector Performance and Well-Being Branch, Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 812. Washington, DC;
Oluwole A.B and Findeis J.L., (2001) “An Econometric Analysis of Off-Farm Labour Participation among U.S. Farm Families, 1977-1998”, Paper prepared for presentation to the American Agricultural Economics Association 2001 Annual Meeting. Chicago, Illinois;
Ocse (2003). Farm Household Incomes. Paris;
Sumner, D.A. (1982) “The Off-Farm Labor Supply of Farmers”, *American Journal of Agricultural Economics* 64(3): 499-509;
Tokle, J.G. and W.E. Huffman (1991) “Local Economic Conditions and Wage Labor Decisions of Farm and Rural Nonfarm Couples”, *American Journal of Agricultural Economics.* 73: 652-670;
Weiss, C. R. (1997) “Do They Ever Come Back Again? The Symmetry and Reversibility of Off-Farm Employment”, *European Review of Agricultural Economics* 24(1): 65-84;
Weiss, C. R. (1999) “Farm Growth and Survival, Econometric Evidence for Individual Farms in Upper Austria”, *American Journal of Agricultural Economics* 81(1): 103-116;
Woldehanna T., A.O. Lansink and J. Peerlings (2000) “Off-farm decisions on Dutch cash crops farms and the 1992 and Agenda 2000 CAP reform”, *Agricultural economics* 22: 163-171.