THE OFF-FARM LABOUR FORCE PARTICIPATION OF MAYO FARM HOUSEHOLDS

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Abstract

The objective of this paper is to examine the factors affecting both participation in an off-farm job and the number of hours worked off-farm by couples in farm households in an Irish region. Data from 278 farm households in Co. Mayo was analysed to this end. A multivariate examination of key characteristics, using cluster analysis, was carried out to classify households into different clusters. The analysis comes reasonably close to picking out the four regimes suggested by the presented theoretical model, that is a cluster in which neither the operator or spouse work off-farm, one in which only the spouse works off-farm, one in which only the operator works off-farm, and one in which both work off-farm. This analysis is followed by an econometric analysis of farm operator and spouse labour supply decisions. Both bivariate probit models and multivariate logit models are used to estimate the off-farm labour force participation of operators and spouses. The participation models are followed by estimations of off-farm hours of work supplied by the couple, using appropriate sample selection procedures. For operators, the driving characteristics influencing off-farm labour participation and hours supplied are farm and location characteristics. In contrast, family demographics and education level appear to influence off-farm labour participation and hours supplied by the spouse.

JEL Classification: Q12, R20, J22

Keywords: Off-farm labour supply, agricultural household models, probit model, multinomial logit model.

Introduction

The aim of this paper is to examine the factors affecting the off-farm labour supply of a subset of Irish farm households. Two of the more common econometric strategies in the literature are used to do this, namely, the bivariate probit selection model and the multinomial logit (MNL) selection model. The two econometric models are both directly implied by the well known farm household model (Singh, *et al.*, 1986; Huffman, 1991) but the former is a good deal more common in the literature than the latter. We agree with a previous author (Lee, 1998) that the second method is more satisfactory on theoretical grounds. Empirically, however, in the case of the data examined, the two methods provide complementary results and it was found useful to run both. The bivariate probit selection model yields more information on gender differences in decision-making, while the MNL selection model yields more information on intra-familial interactions and accommodations.

Apart from this direct comparison of estimation methods for the farm household model, which has been carried out once before (Lee, 1998) in the literature, this paper includes in a cluster analysis of farm households, variables that measure social and community participation by household members and participation in farming activities beyond the farm (e.g. regularly availing of farm media services). There is limited information on these variables in the literature (Jensen and Salant, 1985; Streeter and Saupe, 1986), despite their considerable interest and policy relevance.

The paper starts by introducing the theoretical model. It continues with a brief cluster analysis of the farm households as a way of initially exploring the data and of setting up plausible hypotheses for testing. This is followed by the estimation of the two econometric models and an examination of their results. Lastly, the paper concludes with some overall procedural comments and with some broader discussion of the substantive results. Detailed descriptions of the variables and of the sample (from Co. Mayo, in the West of Ireland), as well as a detailed review of the literature relating to farm household models, can be found in Brick (2005), with a brief summary in the appendix of this paper.

Theoretical Model Specification

The farm household model is an extension of the simple household consumption-leisure decision model in which household members maximise total utility, which is constrained by the household's income and time endowment. Expanding on the models of Huffman (1991), Weersink, *et al.* (1998) and Huffman (2001) among others, this model incorporates non-financial impacts on the decision to participate in off-farm work and the number of hours devoted to off-farm work.

The decision units are single-family[1] farm households. Household members' welfare is assumed to be summarized in a single household utility function. Household utility is assumed to depend on:

$$U = U(Y_h, T_{h_i}; H_{h_i}, Z_{h_i}) \quad [1]$$

where:

Y_h – Goods purchased for direct or indirect consumption

T_{h_i} – Home time (i = 1, 2 where 1 = operator and 2 = spouse)

H_{h_i} – Household members human capital variables of e.g. education, work experience etc.

Z_{h_i} – 'Other' characteristics, $Z_{h_i} = \{Z_{ht_i}, Z_{hn_i}\}$,

where:

Z_{ht_i} = other household characteristics,

Z_{hn_i} = non-financial characteristics

Time constraint

Each household member has an endowment of time each year ($\overline{T_i}$). It is assumed that time allocated to leisure (home-time) and farm work is positive, but that hours of work in off-farm employment may be zero, i.e. the individuals in question may not work off-farm.

$$\overline{T_i} = T_{f_i} + T_{of_i} + T_{h_i}, \text{ where } T_{f_i} > 0,\ T_{h_i} > 0 \text{ and } T_{of_i} \geq 0 \quad [2]$$

where:

[1] It is reasonable to assume, in the West of Ireland farm households, that there is only one family living in the household.

(T_{h_i}) = home time

(T_{f_i}) = on-farm work

(T_{of_i}) = off-farm work

Budget constraint

The household has the following sources of income to fund consumption $(P_h Y_h)$:

$$P_h Y_h = P_f Y_f - W_f X_f + W_{of_1} T_{of_1} + W_{of_2} T_{of_2} + V_1 + V_2 \qquad [3]$$

$P_h Y_h$ = cash spent on consumption goods

W_f = input price vector

X_f = quantity of purchased farm inputs

$P_f Y_f - W_f X_f$ = net farm income

Y_f = annual quantity of farm output produced and sold,

V_i = unearned income e.g. grants, subsidies, bonds, stocks, savings, property income,

$W_{of_i} T_{of_i}$ = net income from off-farm work from the operator (1) and spouse (2)

$$W_{of_i} = W_{of_i}(H_{of_i}, Z_{of_i}, L_{of}) \qquad [4]$$

Off-farm wage depends on individual human capital (H_{of_i}), location characteristics (L_{of}) and other job related characteristics (Z_{of_i}).

Farm production

Though most farms produce and sell several outputs, this analysis assumes that one output (Y_f) is produced using the variable farm time (T_{f_i}) and purchased inputs (X_f), including hired labour. Farm labour provided from outside is assumed heterogeneous because of (a) different skills and (b) different supervisory requirements to prevent shirking (Huffman, 1991). The efficiency of farm production is assumed to depend on the farming related human capital (H_{f_i}) of the household members in question and exogenous farm related characteristics (Z_f).

$$Y_f = F(T_{f_i}, X_f; H_{f_i}, Z_f) \qquad \text{where } \partial Y_f / \partial T_f > 0 \qquad [5]$$

The *production function* [5] is substituted into the *budget constraint* [3] to obtain a farm technology-constrained measure of household net cash income [6], where (Z_{of_i}) are exogenous off-farm job related characteristics:

$$\begin{aligned} P_h Y_h &= P_f F(T_{f_1}, T_{f_2}, X_f; H_{f_1}, H_{f_2}, Z_f) - W_f X_f + W_{of_1}(H_{of_1}, Z_{of_1}, L_{of})T_{of_1} \\ &+ W_{of_2}(H_{of_2}, Z_{of_2}, L_{of})T_{of_2} + V_1 + V_2 \end{aligned} \quad [6]$$

The decision problem facing the household is now to simultaneously choose the quantity of consumption goods to purchase, and the hours of farm and off-farm work to maximise household welfare. This can be stated formally as the new function L:

$$\begin{aligned} L = {} & U(Y_h, T_{h_1}, T_{h_2}, X_f; H_h, Z_h) + \lambda[P_f F(T_{f_1}, T_{f_2}, X_f; H_{f_1}, H_{f_2}, Z_f) - W_f X_f \\ & + W_{of_1}(H_{of_1}, Z_{of_1}, L_{of})T_{of_1} + W_{of_2}(H_{of_2}, Z_{of_2}, L_{of})T_{of_2} + V_1 + V_2 - P_h Y_h] \\ & + \gamma_1(\overline{T}_1 - T_{h_1} - T_{of_1} - T_{f_1}) + \gamma_2(\overline{T}_2 - T_{h_2} - T_{of_2} - T_{f_2}) \end{aligned} \quad [7]$$

λ - Lagrange multiplier for marginal utility of income

γ - Lagrange multiplier for the marginal utility of operator/spouse time

The Kuhn-Tucker conditions that arise from equations [7] give conditions that must be met for optimal time allocation by an operator (1) and spouse (2). In particular, they provide the optimality condition for off-farm work:

If $\lambda W_{of_i}(H_{of_i}, Z_{of_i}, L_{of_i}) - \gamma$ or $W_{of_i}(H_{of_i}, Z_{of_i}, L_{of_i}) - \gamma / \lambda < 0$ then the marginal value of an individual's home time or farm work exceed his/her off-farm wage and optimal hours of farm of off-farm work are zero, i.e. $T^*_{of_i} = 0$.

If $\lambda W_{of_i}(H_{of_i}, Z_{of_i}, L_{of_i}) - \gamma$ or $W_{of_i}(H_{of_i}, Z_{of_i}, L_{of}) - \gamma_i / \lambda = 0$ then an individual's off-farm wage equals the marginal value of his/her home time or farm work, and optimal hours of off-farm work may be positive.

Recursive decision model – Positive hours of off-farm work

When the farm household is at an interior solution i.e. has positive off-farm work hours, the decision on farm input quantities can be separated from household consumption decisions. The consumption side is affected by the exogenous variables in the production side via changes in full income. This is known as recursivity[2] in the literature.

[2] Singh, *et al.*, 1986

N.B. $\gamma_i / \lambda = W_{of_i}(\mathrm{H}_{\mathrm{of_i}}, \mathrm{Z}_{\mathrm{of_i}}, \mathrm{L}_{\mathrm{of}})$

Demand for farm household labour in farming:

$$\mathrm{T}^*_{\mathrm{f_i}} = \mathrm{D}_{\mathrm{T_{f_i}}}(\mathrm{W}_{\mathrm{of_i}}, \mathrm{W}_{\mathrm{f}}, \mathrm{P}_{\mathrm{f_i}}, \mathrm{H}_{\mathrm{f_i}}, \mathrm{Z}_{\mathrm{f}}), \partial \mathrm{T}^*_{\mathrm{f_i}} / \partial \mathrm{W}_{\mathrm{of_i}} < 0 \qquad [8]$$

Home-time demanded by farm households:

$$\mathrm{T}^*_{\mathrm{h_i}} = \mathrm{d}_{\mathrm{T_{h_i}}}(\mathrm{W}_{\mathrm{of_i}}, \mathrm{P}_{\mathrm{h_i}}, \mathrm{V}_{\mathrm{h_i}}, \mathrm{H}_{\mathrm{h_i}}, \mathrm{Z}_{\mathrm{ht_i}}, \mathrm{Z}_{\mathrm{hn_i}}, \overline{\mathrm{T}}_{\mathrm{i}}) \qquad [9]$$

Off-farm labour supply of the farm household:

$$\mathrm{T}^*_{\mathrm{of_i}} = \overline{\mathrm{T}}_{\mathrm{i}} - \mathrm{T}^*_{\mathrm{f_i}} - \mathrm{T}^*_{\mathrm{h_i}} = \mathrm{s}_{\mathrm{T_{of_i}}}(\mathrm{W}_{\mathrm{of_i}}, \mathrm{W}_{\mathrm{f}}, \mathrm{P}_{\mathrm{f}}, \mathrm{P}_{\mathrm{h}}, \mathrm{V}_{\mathrm{h_i}}, \mathrm{H}_{\mathrm{f_i}}, \mathrm{Z}_{\mathrm{f}}, \mathrm{H}_{\mathrm{h_i}}, \mathrm{Z}_{\mathrm{ht_i}}, \mathrm{Z}_{\mathrm{hn_i}}, \overline{\mathrm{T}}_{\mathrm{i}}) \qquad [10]$$

Non-recursive decision model - Zero hours of off-farm work

When neither the operator nor the spouse works off-farm then the model is not recursive. Production and consumption decisions cannot be made independently of one another. The optimal choices on the production side as well as on the consumption side are, therefore, functions of all exogenous variables except the off-farm wage rate. When neither the operator nor spouse works off-farm, the household demand functions are:

Demand for farm household labour in farming:

$$\mathrm{T}^*_{\mathrm{f_i}} = \mathrm{d}^*_{\mathrm{T_{f_i}}}(\mathrm{W}_{\mathrm{f}}, \mathrm{P}_{\mathrm{f}}, \mathrm{P}_{\mathrm{h}}, \mathrm{V}_{\mathrm{h_i}}, \mathrm{H}_{\mathrm{h_i}}, \mathrm{Z}_{\mathrm{ht_i}}, \mathrm{Z}_{\mathrm{hn_i}}, \mathrm{H}_{\mathrm{f_i}}, \mathrm{Z}_{\mathrm{f}}, \overline{\mathrm{T}}_{\mathrm{i}}) \qquad [11]$$

Home-time demanded by farm households:

$$\mathrm{T}^*_{\mathrm{h_i}} = \mathrm{d}^*_{\mathrm{T_{h_i}}}(\mathrm{W}_{\mathrm{f}}, \mathrm{P}_{\mathrm{f}}, \mathrm{P}_{\mathrm{h}}, \mathrm{V}_{\mathrm{h_i}}, \mathrm{H}_{\mathrm{h_i}}, \mathrm{Z}_{\mathrm{ht_i}}, \mathrm{Z}_{\mathrm{hn_i}}, \mathrm{H}_{\mathrm{f_i}}, \mathrm{Z}_{\mathrm{f}}, \overline{\mathrm{T}}_{\mathrm{i}}) \qquad [12]$$

Estimation

In the agricultural household model, rational individuals are assumed to participate in off-farm work when their reservation wage (for farm and home uses of time) is less than the off-farm wage rate offered in the market. The wage offer or off-farm labour demand function is equation [4]. The reservation wage is defined as the marginal value of an individual's time when he/she allocates all of his/her time to farm/home time (and zero to off-farm work). An equation for this relationship is obtained by taking equation [10], setting $\mathrm{T}^*_{\mathrm{of_i}} = 0$, and solving for $\mathrm{W}_{\mathrm{of_i}} = \mathrm{W}_{\mathrm{R_i}}$

$$\mathrm{W}_{\mathrm{R_i}} = \mathrm{R}_{\mathrm{i}}(\mathrm{W}_{\mathrm{f}}, \mathrm{P}_{\mathrm{f}}, \mathrm{P}_{\mathrm{h}}, \mathrm{V}_{\mathrm{i}}, \mathrm{H}_{\mathrm{f_i}}, \mathrm{Z}_{\mathrm{f}}, \mathrm{H}_{\mathrm{h_i}}, \mathrm{Z}_{\mathrm{ht_i}}, \mathrm{Z}_{\mathrm{hn_i}}, \overline{\mathrm{T}}_{\mathrm{i}})$$

where i refers to the i^{th} individual.

Define D_i equal to 1 if $W_{R_i} < W_{of_i}$ and equal to 0 if $W_{R_i} \geq W_{of_i}$. Then

$$\Pr(D_i = 1) = \Pr(W_{R_i} < W_{of_i})$$
$$= l(W_f, P_f, P_h, V_{h_i}, H_{f_i}, Z_f, H_{h_i}, Z_{ht_i}, Z_{hn_i}, H_{of_i}, L_{of}, Z_{of_i}, \overline{T_i})$$

where Pr(.) ≡ probability of an event occurring. Thus, the probability of an individual participating in off-farm work depends on all the exogenous variables that enter his/her reservation wage equations.

Variables that raise the reservation wage reduce the probability of off-farm work, and variables that raise the off-farm wage offer increase the probability of off-farm work. For variables that raise both the reservation wage and wage offer, the net effect on the probability of off-farm work is, a priori, uncertain. Estimates of these participation equations provide information about the marginal effects of exogenous variables on the probability of an individual participating in off-farm work.

Each household is assumed to consist of a maximum of two decision-makers (operator and spouse) each faced with a binary choice 'participation decision'. Four household joint-decision combinations can be identified based on observed labour market activity:

1) Probability neither operator nor spouse works off-farm:

$$P_{00} = \Pr(W_{R_1} \geq W_{of_1}, W_{R_2} \geq W_{of_2})$$

2) Probability the operator works off-farm:

$$P_{10} = \Pr(W_{R_1} < W_{of_1}, W_{R_2} \geq W_{of_2})$$

3) Probability the spouse works off-farm:

$$P_{02} = \Pr(W_{R_1} \geq W_{of_1}, W_{R_2} < W_{of_2})$$

4) Probability both operator and spouse works off-farm:

$$P_{12} = \Pr(W_{R_1} < W_{of_1}, W_{R_2} < W_{of_2})$$

The econometric estimation techniques employed to estimate operator and spouse off-farm labour force participation and hours supplied are discussed later.

Cluster analysis

Before proceeding to the econometric model, a cluster analysis of the sample of operators and spouses is presented. This analysis uses a wide variety of personal, household, farm and location characteristics to fit the farm households into 'clusters' that are as different as possible along the various axes of these characteristics. This initial exploration of the data is useful because it can provide indications of the expected econometric results, which may be used to benchmark these results. In addition, a cluster analysis can at times, provide a richer analysis than econometric models. The process is primarily exploratory (no hypotheses are tested) and uses different criteria than econometrics (distance as opposed to correlation). It can therefore arrive at different, and sometimes more interesting, more meaningful and more comprehensive conclusions than can econometric models.

The variability of the clusters is measured with respect to the means of the classifying variables. If more than one variable is used to define the k-clusters then the distances between clusters are measured in multi-dimensional space. The most straightforward way of computing distances between objects in a multi-dimensional space is to compute the Euclidean distance. Euclidean distances are generally computed from raw data, and not from standardized data. This method has certain advantages, for example, the distance between any two cases is not affected by the addition of new cases to the analysis, which may be outliers (Kaufman and Rousseeuw, 1990). However, the distances can be greatly affected by differences in scale among the variables from which the distances are computed. Cluster analysis requires commensurable variables, that is, the variables must have equal scales. It is, therefore, good practice to transform the variables so they have similar scales, that is, to standardize the variables. In this case, the variables used in the cluster analysis are transformed using the z-transformation.

Two households are excluded from the cluster analysis procedure. These households are excluded as they are being isolated into categories (clusters) on their own due to certain distinguishing features. The farm owned by the first excluded household is very large covering more 190 hectares; the next largest farm is 120 hectares. The second household is excluded due to the high number of hours of community participation of the operator and spouse. In the case of the operator, he participated 40 percent more hours than the next most active participant; the spouse contributed 44 percent more hours than the next most active spouse. By excluding these two households, there remains a total sample size of 276 households available for analysis. The sample size is further reduced to 260 households due to missing values for some of the key variables.

When using the k-means clustering procedure, as is used here, it is necessary to specify the number of clusters before analysing the data. There were no a priori reasons to select a particular number of clusters, therefore several specifications are tested, these include three, four, five and six cluster solutions. The four-cluster solution was found to provide the most interesting information.

Results of cluster analysis for 'operator and spouse' households

The scenario considered focuses on farm households in which there is a spouse present. Forty-two variables are used to classify the 260 farm households into four clusters. These variables include farm, household, operator and spouse characteristics (see appendix). Table 1 summarises the distinguishing characteristics of the four clusters.

Table 1: Distinguishing characteristics of the four clusters

Clusters	**N**	**Distinguishing Features**
One	87	• Neither operator or spouse work off-farm • Small farms – mainly cattle • Lowest number of livestock • A below average proportion rent-in land, hire labour and diversify • Lowest on-farm income • Oldest couples • Lowest level of operator and spouse general education • Twice the average proportion of households in receipt of social welfare payments • Lowest community activity by operator and spouse • Only cluster with no children <18 years old • Highest number of children permanently away • Only cluster not to own a computer • A higher proportion of households in 'marginal' areas than average • A lower proportion of households in 'structurally weak' areas than average
Two	50	• Only spouse works off-farm • Largest farms – mainly cattle and dairy • Twice the average proportion rent-in land • Above average proportion invested on-farm and diversify • Below average proportion of REPS participation • Highest on-farm income • Highest level of farm media use • Lowest proportion of income from grants and subsidies • Young couples • Above average proportion of operators have completed a farm course • Highest on-farm hours by operator • Lowest on-farm hours by spouse • Highest off-farm work experience of spouse • Lowest off-farm work experience of operator • Lowest level of social activity by operator and spouse • Above average community activity of spouse • 78 percent are in the 'structurally weak' DEDs compared to the average of 51 percent
Three	46	• Both operator and spouse work off-farm; in this case the spouse works fewer hours than in the other clusters in which they participate in off-farm work i.e. clusters two and four. • Smallest farms – mainly cattle and dairy • Twice the average proportion of households are diversified • Highest proportion of income from grants and subsidies

Clusters	N	Distinguishing Features
		• Highest level of spouse participation in on-farm work • Lowest operator on-farm hours • Low level of on-farm income • Highest operator off-farm hours • Highest operator off-farm work experience • Lowest operator housework and care hours • Operator and spouse have highest level of social activities of the four clusters • Above average level operator participation in community activities • Highest number of other adults present • Highest level of spouse participation in community activities • Twice the average proportion of households in 'peri-urban' and 'strongly agricultural' DEDs
Four	77	• Both operator and spouse work off-farm • Mixed farms – mainly cattle • Larger farms and more livestock than cluster three • Lowest level of farm media use • Youngest couples • Highest level of general education of the operator and spouse • Highest proportion of operators having completed farm education • Less than average operator and spouse on-farm hours • Highest housework and childcare hours of both the operator and spouse • Highest community activity for operator • Below average level of social activities by the operator and spouse • Twice the average number of children < 18 years • No other adults or children permanently away • Higher proportion in 'marginal' DEDs and a smaller proportion in 'peri-urban' DEDs than expected

Cluster one (n = 87): neither operator or spouse work off-farm

Cluster one is the largest of the four clusters. It contains the oldest farm couples and neither work off-farm. Predictably given their age, operators in this cluster have the highest number of years of on-farm experience. These are small farms, with an average of 20 hectares, and have mixed livestock with mainly cattle and sheep livestock units. They have the fewest number of livestock units of the four clusters (23 units). Fewer than average rent-in land or use hired labour. This cluster has the lowest level of farm investment and REPS participation of the four clusters. They have a below average level of diversification; the level of participation in diversified activities in this cluster is half the average. Operators report the lowest level of on-farm income of the four clusters, with a relatively high proportion coming from grants and subsidies. They have an average level of farm media use.

Operators and spouses in this cluster have the lowest level of general education of the four clusters. A less than average proportion of operators in this cluster have completed a farm education and are members of a farm group. These older operators report a high number of on-farm hours relative to the number of livestock they own. Operators in cluster two have an average of 80 livestock units (including 32 dairy cows) and report an average of 63 on-farm hours per week. The farms in this cluster have an average of 23 livestock units and report an average of 48 on-farm hours, that is, the farm operators in cluster two work an average of two hours for every livestock unit, compared with cluster two who work less than one hour for every one livestock unit. There are a number of possible explanations for this. It may simply be an overestimation of the number of hours worked by the older operators. It is also possible that older operators require more time to complete similar tasks due to age and/or a lack of farm education or a lack of the most up to date labour-saving equipment. A combination of these reasons is most likely.

On average, neither the operator or spouse works off-farm, though the operator is found to have an average number of years of off-farm work experience. In the case of the spouse, those in this cluster have the lowest level of off-farm work experience of the four clusters. This is the only cluster where the proportion of households in receipt of social welfare payments is above average. Again, this is a predictable result given the age profiles of the operators and spouses being considered.

Operators and spouses have the lowest level of participation in community activities of the four clusters and a below average level of participation in social activities. There are no children under the age of 18 years present; the children of this farm couple are over 18 and, for the most part, living away from home. Less than half the expected proportion of households own a personal computer.

In this cluster there are a below average proportion of households in both the 'strong agricultural' and 'structurally weak' DEDs, and a higher than average proportion of households in 'marginal' DEDs.

Cluster two (n = 50): only spouse works off-farm

Cluster two is comprised of operators and spouses running large, predominately cattle and dairy, farms. In general, they rent-in land and avail of hired labour more than the other clusters do. They earn a higher level of on-farm income than the other three clusters, 40 percent of which comes from grants and subsidies. The operators also have the highest level of farm media use of the four clusters.

The operators in this cluster are younger than the average and work on-farm full-time, that is, they work the highest number of on-farm hours of any cluster and have no off-farm job. They are more highly educated than the average and have a high level of on-farm experience. In addition, a higher than average proportion are members of a farm organisation.

The farm spouses are also younger than the average and work the least hours on-farm of any cluster. These spouses work more off-farm hours than spouses in the other three clusters. In this cluster, the operators report the lowest number of years of off-farm work experience of any cluster and the spouses report the highest number of any cluster. A lower than average proportion of operators and spouses are in receipt of social welfare payments and both spend an average number of hours on housework and childcare.

Both the operator and spouse participate in less than average number of social activities; the least of any cluster. Operators are found to participate in a below average number of hours of community activities; spouses participated at an average level.

These households are comprised of an average number of children less than 18 years old and a greater than average number of other adults. In general, they do not have children living permanently away from home. This suggests that these households are in the stage of the family lifecycle, in which children are in their early teens.

A far higher than expected proportion of the households are in 'structurally weak' DEDs and a far lower than expected proportion are in 'marginal' DEDs.

Cluster three (n = 46): both operator and spouse work off-farm (smaller[3])

Cluster three is comprised of mixed farms with mainly cattle livestock units in which both the operator and spouse work off-farm. These operators do not rent-in land and earn less on-farm income than cluster four, the other 'off-farm' cluster. An above average proportion use hired labour and invested on-farm in the last five years. A below proportion participate in REPS. A distinguishing feature of this cluster is the above average rate of diversification. Twice as many farms in this cluster are diversified compared to the mean proportion expected; this is the highest proportion of the four clusters. Operators have an above average level of off-farm media use but a less than average proportion are members of a farm group.

The average age of an operator and spouse is 51 and 50 years respectively; this is lower than the average. Both the operator and spouse have an above average level of general

[3] Of the two clusters in which both the operator and spouse work off-farm (3 & 4), this cluster has a smaller average farm size

education but it is lower, in both cases, than that of the other 'off-farm' cluster (cluster-4). A smaller proportion of operators have completed a farm education than the mean proportion expected. Operators in this cluster work the least number of hours on-farm and work more hours off-farm than the other 'off-farm' cluster. Operators have the highest level of off-farm work experience of the four clusters. Spouses in this cluster have the highest rate of on-farm participation of the four clusters, at 8 hours per week, compared to the average rate of 5 hours. Spouses work fewer hours off-farm than the other 'off-farm' cluster and have a less than average level of off-farm work experience. Operators in these households contribute fewer hours to housework and care activities than the other three clusters; spouses contributed an average number of hours. Neither the operator or spouse are in receipt of social welfare payments.

Operators and spouses in this cluster contribute the highest number of hours to social activities of the four clusters. Operators contribute an above average number of hours to community activities with spouses contributing more hours than any other cluster.

There is on average one child under the age of 18 in the households and an average of two other adults. This suggests that these households are at the stage of the family lifecycle when the children are beginning or have already left home. This cluster also has the highest proportion of households with a personal computer of the four clusters.

Lastly, households in this cluster are twice as likely to be in 'peri-urban' DEDs than the average household; and there are a higher proportion in 'strong agricultural' DEDs than the average.

Cluster four (n = 77): both operator and spouse work off-farm (larger[4])

The final cluster comprises the youngest operators and spouses who have, on average, 26-hectare cattle and sheep farms. These households have a higher number of livestock than cluster three, the other 'off-farm' cluster. Operators in this cluster have the lowest number of years of farm experience of any cluster, at 15 years. A higher than average proportion rent land and they have the lowest level of farm media use of the four clusters. A higher proportion of operators are participating in REPS than in the other four clusters and an above average proportion invested on-farm in the last five years; with the participation in

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[4] Of the two clusters in which both the operator and spouse work off-farm (3 & 4), this cluster has a larger average farm size

REPS likely fuelling investment. They earn an average level of on-farm income, and receive an above average proportion of this income in the form of grants and subsidies (56%).

The operator and spouse have the highest levels of general education of all four clusters and an above average proportion of operators have completed a farm course. Both the operator and spouse work less than the average number of on-farm hours; though the operators provide more hours than operators in cluster three (the other 'off-farm' cluster). A higher than average proportion of operators are members of a farm group. Operators in this cluster worked fewer off-farm hours on average than the operators in cluster three but the spouses worked more hours off-farm than the spouses in the other 'off-farm' cluster. Both the operator and spouse have an above average level of off-farm experience. Neither the operator or spouse are in receipt of social welfare payments. Seventy percent of the households in which both the operator and spouse work off-farm are in this cluster (Table 2).

They have young families with an average of three children less than 18 years old in the household and no other adults or children living away from home. This explains the above average level of childcare and housework provided by both the operator and spouse. In addition, the couple have a below average level of participation in social and community activities.

The location characteristics of this cluster are generally as expected with just slightly less than expected in 'peri-urban' DEDs and slightly more than expected in the 'marginal' DEDs.

Summary of cluster characteristics

In summary, there are two distinct groups of operators working off-farm. In the two groups where both work off-farm, the spouses work off-farm but to differing extents. The first of these groups are older operators who have mid-sized farms, a small number of livestock and do not rent-in land. They have a lower level of general education than the other off-farm group and the dairy farm group, and they have not completed any formal farm training. These participants work a higher average number of off-farm hours than the other off-farm group. They have an above average level of participation in community activities. They also have the highest level of participation in social activities all groups. The households in this cluster have the highest proportion of other adults in the household. The spouses of these operators work off-farm for fewer hours (14 hours) than the operators (29 hours), and for fewer hours than the spouses (19 hours) of the other group of operators who work off-farm.

The second, and larger, group of off-farm participants are younger operators. They have larger farms and a larger number of livestock than the first group; and they also work more on-farm hours than the other off-farm group. Operators in this cluster have the highest level of general education and a higher proportion of these operators have completed a farm course than any other group. In addition, they are married to the most highly educated spouses. They have an above average level of farm group membership. They have the highest level of participation in community activities of any group. These households also have a larger number of children under the age of 18 than the first group. The spouses of these operators work a similar number of hours off-farm to the operators.

Dairy farm operators tend not to work off-farm. They have the largest farms both in terms of the number of hectares farmed and livestock units. They also rent-in land and have the highest rate of hired labour use. They are younger than average and are well-educated; a high proportion have completed a formal farm education course. They have the highest rate of farm group membership. Their spouses tend to work off-farm and contribute little time to farming. The operators in this group participate in a below average number of community activities. Both the operator and spouse participate in a below average number of social activities. These operators have an average of one child under the age of 18 present.

Older operators do not work off-farm, though many have done so in the past, as they report a significant number of years of off-farm experience. They have a small to mid-range number of hectares and livestock relative to other operators. They do not rent-in land and have no formal farm education. They have an average level of farm media use and a high level of years of farm experience. They have the lowest level of on-farm income. They have the lowest level of general education. They are also the only group to receive social welfare payments, which indicates that many are in receipt of Farm Assist, unemployment payments or pensions. Older operators and spouses participate fewer community activities than all other.

The cluster analysis does not exactly pick out the regimes of the theoretical model, it would be surprising if it did given the number of variables included in the analysis, but it comes reasonably close. In general, cluster one corresponds loosely to the regime where neither partner works off-farm; cluster two corresponds to the regime where only the spouse works off-farm; cluster four corresponds to the regime where both work off-farm. Only cluster three is unclear: both partners tend to work off-farm, but the operator a good deal more then the spouse – thus, cluster three can be said to roughly correspond to the regime where only the operator works off-farm; of the 46 households in cluster three, 33 operators work off-farm compared to 22 spouses (Table 2).

Table 2: Cluster regime by operator/spouse off-farm participation

	Cluster				
	1	**2**	**3**	**4**	**Total**
Off-Farm Participation					
Both	0 *(0.0)*	1 *(1.8)*	16 *(28.1)*	40 *(70.2)*	57 *(100)*
Operator only	3 *(8.1)*	5 *(13.5)*	17 *(45.9)*	12 *(32.4)*	37 *(100)*
Spouse only	19 *(27.5)*	27 *(39.1)*	6 *(8.7)*	17 *(24.6)*	69 *(100)*
Neither	65 *(67.0)*	17 *(17.5)*	7 *(7.2)*	8 *(8.2)*	97 *(100)*
Total	87 *(33.5)*	50 *(19.2)*	46 *(17.7)*	77 *(29.6)*	260 *(100)*

From an examination of these clusters, an indication of what can be expected from the econometric analysis emerges, for example, age will negatively affect off-farm participation of both the operator and spouse, or having dairy cows will negatively affect operator participation, particularly where both the operator and spouse are working off-farm. Given that the econometric analysis has fewer variables (for degrees of freedom reasons), it could be that the cluster analysis turns out to be richer, although it is more ad hoc.

Econometric analysis

A bivariate probit model can be employed to estimate participation decisions for both the operator and spouse as it allows interdependency between participation decisions in the sense that the decision of each individual is a function of, among other things, the choice of the other individual. A less common alternative in the literature is to use the MNL form to model participation, based on the households' indirect utility function (Lee, 1998). One advantage of the MNL model is that it provides a more direct representation of the four decision-making regimes outlined above than does the bivariate probit.

In fact, a theoretical problem exists with the commonly used bivariate probit model of off-farm participation, in that for both operator and spouse no distinction is made between the two regimes (per participating or non-participating person) implied by the four decision-making combinations[5]. The actual estimates, say, for the operator's part of any estimated bivariate probit are a weighted average of those from the two regimes in which a participating or non-participating operator might find himself or herself. An MNL estimation (of four categories, or 'regimes': a household with no off-farm participants, with an operator only, with a spouse only or with both operator and spouse participating) does not suffer from this flaw, although it may suffer from other flaws, if the *independence of irrelevant alternatives* (IIA) assumption does not hold. The MNL model is a maximum likelihood method that is an extension of the simple logit model for dichotomous dependent variables; therefore, MNL can be used when a study involves a polychotomous dependent variable. The disturbance term of the equations, the errors, are assumed to be independent across both individuals and equations. To use the MNL, the data need to meet the IIA assumption. The IIA property holds that the ratio of the choice probabilities of any two alternatives (in response categories) are not influenced by any other alternatives (Kennedy, 1998). In other words, the inclusion of any category in the model should not affect the relative odds or probabilities of any of the other categories. The IIA assumption is satisfied by performing a Hausman diagnostic test (Hausman and McFadden, 1984). The test is performed by comparing the estimated coefficients of the model with all dependent categories.

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[5] Lee, 1998 – "(the univariate/bivariate model)…is problematic because it does not take into account that the reservation wage of one member cannot be defined independently of the job status of the other members" p 96

If the IIA is not rejected, dropping a category from the dependent variable and estimating a model with the observations in the remaining categories should result in estimated coefficients that are statistically identical, for the remaining categories, to the 'full' model that includes all of the categories. The Hausman test is performed by comparing the coefficients in the full (unconstrained) model to the coefficients from each of several constrained model, which result from dropping one of the categories from the dependent variable. Rejection of the IIA implies that the disturbances are not independent across categories. In which case, the model should be re-estimated with another method such as multinomial probit, that allows for such non-independence.

It is interesting to compare results from these two participation models. Differences in the overall pattern of the results, if they emerge in the estimations, are likely to be due to the implications of differences in regimes for behaviour. Operators working off-farm in households where the spouse also works off-farm, for example, may well face a different set of parameters than those in households where the spouse does not.

Once participation is modelled, the next step is to model the labour supply decision, that is, the number of hours supplied to an off-farm job. Sample selection bias is a potential problem in estimating the off-farm labour supply equations due to the truncated nature of the dependent variable. Generally, any estimate of an hours regression that does not factor in selection bias suffers from an omitted variable problem, namely the impact of selection on hours. The Heckman procedure seeks to remedy this bias by estimating the odds of selection, that is, the odds of working off-farm; this estimate of the omitted variable is known as the inverse Mill's ratio.

The most common version of the Heckman procedure is to estimate in two stages. In the first stage, a probit is estimated on the decision to work off-farm with data from all participants and non-participants; and the inverse Mill's ratio is calculated. A second stage is then undertaken with the estimation of an Ordinary Least Squares (OLS) model on hours using data from those individuals who participated while including the inverse Mill's ratio to account for selection bias. Alternatively, a single stage estimation process using a likelihood function can be carried out. Occasionally, some ill-conditioning in the data can lead to the two-step procedure being the only viable one. Semi-parametric estimation of the selection variable is also possible if the normality assumption is in doubt.

The Heckman procedure needs to be adapted to the bivariate probit situation if it is found that a bivariate probit is necessary when testing for that specification (if there is no correlation between the two error variables of the bivariate probit, that is, the cross-equation correlation coefficient is insignificant, then univariate probits suffice and the usual univariate Heckman procedure is appropriate). In the MNL case a more complex selection mechanism is defined in Bourguignon*, et al.* (2004).

If the selection variables are found to be insignificant, in either the two-step (bivariate) probit case or the multinomial case, then the hours equations can be efficiently re-estimated using OLS.

One problem that should not be ignored when using a selection procedure in an hours model like this, without wages data, is that unlike with earnings models, no variables can be found a priori that affect participation and not the quantitative dependent variable (in this case hours). If precisely the same X variables are used in the hours and participation estimations, then identification can only take place through the non-linearity of the probit (or multinomial logit) model. This is not very satisfactory, and in the specifications below the use of region type variables as identifiers is examined.

The results of two models, the bivariate probit selection model and the MNL selection model, are presented below (Table 4). Some variables are significant in both models and some in only one or other of the models. What is at stake in the comparison of the two models is, firstly, the possible gain from the congruence with theory, if there is one, of the MNL model vis-à-vis the far more commonly estimated bivariate probit. Secondly, a comparison of the complementary kinds of information yielded by the two models. In the bivariate probit model, variables that are strongly gender specific irrespective of regime are likely to show through more strongly than in the MNL, for example, the effects of market or farm characteristics, or the effects of having young children. While in the MNL it is expected that extra information will be gained on variables that involve intra-familial accommodations, for example, the effects, once again, of having young children or of having other adults in the house.

It should be noted that a standard reduced-form labour supply equation is employed; this relates hours of off-farm work to variables pertinent to wages, farm, personal, household, and location characteristics.

Farm characteristics are generally found to have a negative impact on both participation and the number of off-farm hours supplied by the operator and spouse. Initial expectations are that farm size, the presence of dairy cows, years of operator farm experience and the presence of a diversified enterprise on-farm will all have a negative impact on participation and off-farm hours worked.

Age is generally included in quadratic form to illustrate life-cycle effects. Most studies find a positive impact for age and negative for age-squared on both participation and labour supply. This indicates that age has a positive impact up to a point then starts to have a negative impact as individuals get older. General education has been found to have a positive impact on both participation and hours worked by most authors. General education raises the individual's human capital stock, which has a positive impact on potential market earnings, thereby raising the relative wages off-farm compared to on-farm. Farm specific education has the opposite effect, raising the relative wages of on-farm work through an increase in farm specific human capital.

It is expected that the presence of children would have a stronger impact on the spouses' decisions than on the operators, and for the presence of younger children to have a stronger effect than the presence of older children. This is generally the case presented in the literature. For spouses childcare issues associated with the presence of young children appear to curtail both participation and hours of off-farm work and for operators the financial burden of the presence of young children increases participation and off-farm hours. However, the results for the operator are found to be more ambiguous than those of the spouse, changing from positive to negative in different studies.

The location variables included here account for regional differences in DEDs and distance from the nearest town. As the 'marginal' DEDs are used as the control group one would expect that an operator or spouse residing in one of the other four rural areas would have a higher probability of working off-farm than those residing in the 'marginal' area. The 'structurally weak' area may be an exception as the characteristics of this area are quite similar to those of the 'marginal' area. Such indicators of rural type have not been included in other studies so a comparison is not possible. However, the distance an operator/spouse lives from a town or city is included as an indictor in many studies. It is generally found that the further a person resides from key labour markets the less likely they are to participate in off-farm work; however, the impact on off-farm labour hours is more ambiguous.

It is clear from the outset that the hired labour variable, the community and social participation variables are potentially endogenous. It is therefore decided to exclude them from the econometric analysis.

Data

The data used in the econometric analysis is the subset of 278 'operator and spouse' households from the overall sample of 351 households. Of the 278 households, 175 (63%) have at least one member of the farm couple working off-farm.

Table 3: Joint off-farm work decisions by 'operator and spouse' farm households in Co. Mayo

	Spouse works off-farm		
Operator works off-farm	Yes	No	Total
Yes	59	43	102
No	73	103	176
Total	132	146	278

Five categories of variables influence participation and supply of off-farm labour; farm characteristics (Z_f), household and family characteristics (Z_{ht}), human capital characteristics (H), non-financial characteristics (Z_{hn}) and location characteristics (L_{of}). A number of binary and categorical variables are included as characteristics of the farm and participants. As noted by Lass*, et al.*, (1989), in an ideal situation a production function would also be estimated and the estimated values included in the participation and supply models but due to data constraints this is not possible. Means, standard deviations and units of measurement for the variables used in the analysis are presented in the appendix.

Off-farm participation

A bivariate probit model is estimated for the sample of farm couples. The cross-equation correlation coefficient (ρ) for the bivariate probit model for operator and spouse off-farm participation is negative but not significantly different from zero in this case. This implies that the participation decisions of the operator and spouse are not jointly determined. Given this result, two univariate probit models are estimated for the operator and spouse. The results of the two univariate probit models and their marginal effects[6] are presented in Table 4.

An MNL participation model is also estimated. The four values of the dependent variable correspond to the four household regimes derived from the theoretical farm household model:

Off-farm participation regimes

(y = 1) Only the operator participates
(y = 2) Neither the operator nor spouse participates
(y = 3) Only the spouse participates
(y = 4) Both operator and spouse participate

Its close correspondence to the theoretical model is, as stated above, one of the reasons to choose the MNL specification.

For the probits, the pseudo R^2 measures for operator and spouse are 0.40 and 0.23. The models correctly predicted 79 percent of the actual outcomes for operators and 73 percent for spouses. Heteroscedasticity is rejected for both the operator and spouse specifications.

The pseudo R^2 for the MNL model is .32 and the IIA is not rejected. When the IIA is not rejected, dropping a category from the dependent variable and estimating a model with the observations in the remaining categories should result in estimated coefficients that are statistically identical, for the remaining categories, to the 'full' model that includes all of the categories.

Lee (1998) notes that the natural interpretation of the coefficients of MNL models is; how the relative 'attractiveness' of the regime in question, in comparison to regime 2 (the regime where neither the operator or spouse works off-farm), is affected by an increase in the corresponding variable by one unit.

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[6] The marginal effect is the change in the probability for an infinitesimal change in each independent continuous variable and, the discrete change in the probability for dummy variables.

Table 4: Univariate probit and MNL participation estimates

		Univariate Probits				MNL		
		Operator		Spouse		Regime 1 Operator only	Regime 3 Spouse only	Regime 4 Both
		Coefficient [Absolute t – stat]	Marginal effect	Coefficient [Absolute t – stat]	Marginal effect	Coefficient [Absolute t – stat]	Coefficient [Absolute t – stat]	Coefficient [Absolute t – stat]
Farm characteristics								
Area		-0.01 [1.81]*	-0.003	-0.005 [1.18]	-0.002	-0.013 [1.13]	-0.007 [0.76]	-0.034 [2.24]**
Diversification		-0.536 [1.54]	-0.133	-0.092 [0.31]	-0.037	-0.174 [0.22]	0.413 [0.66]	-0.870 [0.99]
Farm experience	Operator	-0.017 [1.31]	-0.005	0.019 [1.80]*	0.007	-0.001 [0.03]	0.063 [2.52]**	-0.002 [0.07]
Presence of dairy cows		-0.988 [3.61]***	-0.243	0.103 [0.48]	0.041	-0.800 [1.31]	0.442 [1.02]	-1.927 [2.81]***
Use of farm media		0.001 [0.01]	0.000	-0.019 [0.18]	-0.007	0.106 [0.38]	0.089 [0.42]	-0.008 [0.03]
Personal characteristics								
Operator age		0.089 [0.70]	0.027			0.235 [0.84]	0.076 [0.44]	0.112 [0.37]
Operator age squared		-0.002 [1.44]	-0.001			-0.004 [1.41]	-0.001 [0.97]	-0.003 [1.05]
Spouse age				0.147 [1.79]*	0.059			
Spouse age squared				-0.002 [2.20]**	-0.001			
Highest level of education achieved	Operator	-0.003 [0.02]	-0.001	0.093 [0.83]	0.037	-0.005 [0.01]	0.177 [0.73]	0.166 [0.56]
	Spouse	0.09 [0.69]	0.027	0.319 [3.01]***	0.127	0.134 [0.45]	0.474 [2.25]**	0.788 [2.49]**
Farm education	Operator	-0.094 [0.42]	-0.028	-0.06 [0.32]	-0.024	-0.500 [0.97]	-0.165 [0.40]	-0.155 [0.29]
	Spouse	0.852 [1.55]	0.310	-1.327 [2.57]**	-0.398			
Household characteristics								
No. of children < 5 years old		-0.295 [1.33]	-0.089	-0.300 [1.55]	-0.119	-0.245 [0.50]	-0.358 [0.75]	-1.299 [2.25]**
No. of children 5-11 years old		0.099 [0.78]	0.030	-0.262 [2.41]**	-0.104	0.080 [0.27]	-0.361 [1.38]	-0.240 [0.78]
Total number of children 12-17 years old		-0.131 [1.02]	-0.039	0.15 [1.26]	0.060	-0.439 [1.32]	0.038 [0.16]	0.086 [0.28]
No. of other adults (≥ 18 years old)		0.114 [1.08]	0.034	-0.141 [1.45]	-0.056	0.281 [1.13]	-0.106 [0.50]	-0.010 [0.04]

	Univariate Probits				MNL		
	Operator		Spouse		Regime 1 Operator only	Regime 3 Spouse only	Regime 4 Both
	Coefficient [Absolute t – stat]	Marginal effect	Coefficient [Absolute t – stat]	Marginal effect	Coefficient [Absolute t – stat]	Coefficient [Absolute t – stat]	Coefficient [Absolute t – stat]
No. of children living permanently away	0.017 [0.18]	0.005	-0.164 [2.38]**	-0.065	-0.223 [0.96]	-0.343 [2.67]***	-0.089 [0.37]
Location characteristics							
Peri-urban	0.733 [2.15]**	0.251	0.068 [0.23]	0.027	1.538 [1.80]*	0.246 [0.40]	1.261 [1.60]
Very strong agricultural	0.881 [1.78]*	0.321	0.073 [0.17]	0.029	2.770 [2.20]**	0.952 [0.94]	1.620 [1.25]
Structurally Weak	0.569 [1.96]**	0.169	-0.14 [0.58]	-0.055	1.089 [1.48]	-0.333 [0.70]	0.738 [1.12]
Highly diversified	1.255 [1.66]*	0.464	-0.115 [0.22]	-0.045	2.470 [1.44]	-0.761 [0.58]	1.858 [1.06]
Km to nearest town (population >5,000)	-0.012 [1.61]	-0.004	-0.007 [1.09]	-0.003	-0.010 [0.57]	-0.005 [0.39]	-0.033 [1.92]*
Constant	0.651 [0.21]		-3.08 [1.48]		-2.076 [0.29]	-2.119 [0.42]	2.362 [0.31]
Observations	271		271			271	
Log likelihood	-106.76		-145.56			-247.419	
Pearson's chi^2 (249)	301.08		260.93				
Pseudo R^2	0.3999		0.2247			0.3164	
LR chi^2 (21)	142.26		84.38		LR chi^2 (60)	229.01	
Correctly classified	79.34%		73.06%				

*significant at 10%; ** significant at 5%; *** significant at 1%

In analysing the results, the bivariate probit models are discussed first on a variable-by-variable basis. At the end of each paragraph the MNL results are then compared.

Farm characteristics

In the literature, farm characteristics are found to have a stronger impact on the participation decision of operators than spouses.

Farm size: the number of hectares farmed is found to have a negative impact on the probability of participation of the operator and spouse, though it is only significant in the case of the operator. An increase in the number of hectares farmed by one hectare decreases the operators' probability of working off-farm by 0.3 percent. This result is expected a priori and is the result most commonly found in the literature (Lass, et al., 1989; Findeis, *et al.*, 1991; Pfaffermayr, *et al.*, 1991; Kimhi, 1994). It is likely that operators of larger farms have less flexibility in supplying labour to off-farm jobs than operators of smaller farms do, due to the larger time commitment required on a larger farm. However, from the MNL results it can be seen that this effect is only significant in regimes where both partners work off-farm. The implication is that intra-familial interactions come into play in regimes one and three, but that this flexibility is not possible in regime four.

Diversification: in the survey respondents were asked about their diversified on-farm activities. The diversification variable included here is a dummy for participation in an alternative on-farm enterprise. It is found in the bivariate probit model that having a diversified enterprise on-farm reduces the probability that the operator will work off-farm but the result, although close to, is not significantly different from zero. It has a negative but insignificant impact on spouse participation. It is likely that, in some cases, diversification is seen as an alternative to off-farm participation. The MNL results do not show any significant effect.

Farm experience: the number of years an operator has been the main decision maker on the farm has a negative impact on the probability of participation of the operator but this effect is not significantly different from zero. A similar result is obtained by Furtan, *et al.* (1985), Pfaffermayr, *et al.* (1991) and Benjamin and Guyomard (1994); however, their results are significant. For spouses, an additional year of operator on-farm experience raises the probability of off-farm participation by 0.7 percent. This result is in contrast to that attained by Furtan, *et al.* (1985) and Benjamin and Guyomard (1994) for spouses. This suggests that on-farm experience of the operator may raise his/her reservation wage through increased farm specific human capital, but likely reduces that of the spouse (whose marginal productivity on the farm probably declines). This interpretation appears to be validated by the MNL model as a significant coefficient only occurs for the regime where the spouse only participates off-farm.

Dairy: a result commonly found in the literature is that the presence/number of dairy cows on-farm significantly reduces the probability of off-farm participation of farm operators (Sumner, 1982; Gould and Saupe, 1989; Findeis, *et al.*, 1991; Lass and Gempesaw, 1992; Findeis and Lass, 1994; Corsi and Findeis, 2000; Keeney and Matthews, 2000). In this case, the presence of dairy cows reduces the probability of off-farm participation of operators by 27 percent at the mean and has a positive but insignificant impact on the probability of spouse participation. This result for operators reflects the time intensive nature of dairy farming and the higher than average income level associated with dairy farm households.

The MNL results suggest that the negative participation effects of dairying are only for the regime where both spouses participate; dairying appears to be a discrete lifestyle choice for the household as a whole rather than a marginal decision of individuals.

Farm media: the use of farm media is not found to have a significant effect on the probability of off-farm participation of either the operator or spouse.

Personal characteristics

Age: Ideally, all of the relevant personal characteristics for operators would be included in the spouses' participation equation and vice versa, however, attempting to include operator and spouse age in both equations led to severe multicollinearity problems. For this reason only own-age effects are considered. The results are as expected a priori; as found by other authors, age has a quadratic effect on the probability of off-farm participation operators and spouses, that is, as age increase the probability of working off-farm increases at a decreasing rate. For operators, the results are not significant. However, the results for spouses suggest that the probability of off-farm participation peaks at 36 years and reduces thereafter. The MNL estimation does not provide any significant results for age.

Education: education is included here as the highest level of education attained. There are four levels; less than or equal to primary school, lower secondary, upper secondary and third level. Own education has the predictable positive impact on the probability of off-farm participation of both the operator and spouse. This indicates that increased levels of education increase the off-farm wages of both the operator and spouse by more than it raises their reservation wages. However, the result is only significantly different from zero for the spouse. An increase of one education level of the spouse increases their probability of working off-farm by 13 percent at the mean. This result for spouses is also found by many authors (Furtan*, et al.*, 1985; Gould and Saupe, 1989; Huffman and Lange, 1989; Lass*, et al.*, 1989; Findeis*, et al.*, 1991; Lass and Gempesaw, 1992; Benjamin and Guyomard, 1994; Kwon*, et al.*, 2003).

In addition, it is observed that in this sample operators are more frequently employed in off-farm jobs where formal education is not as important as experience. For example, it is found that operators are most frequently employed in manufacturing, driving and labouring jobs. On the other hand, spouses in this sample are found to be involved in jobs where returns to education are more likely to be significant, such as clerical jobs and nursing. Cross-education effects are not found to be significant; that is, operator education has no impact on the probability of spouse participation and vice versa.

The MNL results suggest that education effects are stronger for the regime with both members participating off-farm than for the regime where only the spouse participates. Possible interpretations of this result are discussed in the conclusion.

Farm specific education: The spouse's farm education is significant in the bivariate probit model in the expected direction. Only 11 spouses received an agricultural education and none work off the farm. The variable is not significant in the MNL model and is not included. Operator farm education is not significant in either specification.

Household characteristics

Children: three variables are included in the specification to account for the presence of children in the household. The three age groups included are, less than five years old, 5-11 years old and 12-17 years old. A priori one would expect the number of children present, particularly younger ones, to have a stronger impact on the probability of spouse participation than on operator participation. This is often found to be the case in the literature (Gould and Saupe, 1989; Lass and Gempesaw, 1992; Benjamin and Guyomard, 1994; Lim-Applegate*, et al.*, 2002; Bharadwaj and Findeis, 2003). Similar results are found here. The presence of children appears to have a much stronger impact on the probability of spouse participation than that of the operator. The number of children under five years old reduces the probability of both operator and spouse participation; the result is not significantly different from zero for either the operator or spouse. Each additional child under the age of five years reduces the probability of off-farm work for the spouse by 17 percent at the mean. The negative coefficient for spouses is a common result in the literature for the number of young children present in the household. Furtan*, et al.* (1985), Gould and Saupe (1989), Lass and Gempesaw (1992), Benjamin and Guyomard (1994), Kimhi (1996), Lim-Applegate*, et al.* (2002) and Bharadwaj and Findeis (2003) all find that young children have a significant negative impact on the probability of off-farm participation of the spouse.

The number of children aged between 5-11 years does not have a significant impact on the probability of participation of the operator. However, it does have a significant negative impact on the probability of off-farm participation of the spouse. One additional child aged between 5-11 decreases the probability of spouse participation by 10 percent at the mean. A similar result for spouses is found by Huffman and Lange (1989), Tokle and Huffman (1991), Benjamin and Guyomard (1994), Weersink*, et al.* (1998) and Lim-Applegate*, et al.* (2002). The numbers of young children present clearly raise the reservation wage of spouses reflecting the higher opportunity costs of home production and off-farm work time in the presence of young children when compared to households where there are no children present.

The presence of older children, those aged 12-17 years old, are not found to have a significant negative impact on the probability of the operator or spouse working off-farm. However, the sign of the coefficient for spouses has changed to positive which could reflect the fact that older children require a lower level of childcare hours and often contribute to household work hours.

In the MNL model, the effect of children is only registered as significant for those less than 5 years old for the regime in which both members are participating off-farm (regime 4) suggesting once again that intra-family accommodations are probably being made in households in regime 3.

Other adults: the presence of other adults, that is household members other than the operator and spouse who are over 18 years old, has no significant impact on the probability of participation of either the operator or spouse.

Children permanently away: the number of children of the operator and spouse who live permanently away from the family home has no impact on the probability of off-farm participation of the operator. However, an increase of one child living permanently away reduces the probability of the spouse working off-farm by 6 percent at the mean. It is possible that children living permanently away contribute financially (indirectly) to the household, if only by leaving home and reducing the financial drain on the household. This effect comes through in the MNL model for the regime where the spouse only participates, suggesting that income effects are stronger for a spouse whose partner is not working off the farm.

Location

Rural type: there are five different rural types under consideration in this study, 'peri-urban', 'very strong agricultural', 'structurally weak', 'highly diversified' and 'marginal' (see appendix for definitions). In this case, the 'marginal' DEDs are used as the control group. Rural type is not found to significantly affect the probability of spousal participation in an off-farm job. The results are, however, much stronger for the operators. Operators in 'peri-urban', 'very strong agricultural', 'structurally weak' and 'highly diversified' DEDs are significantly more likely to participate off-farm than operators in 'marginal' DEDs. In fact, operators in 'peri-urban' and 'structurally weak' DEDs are 27 percent more likely to work off-farm at the mean than operators in 'marginal' DEDs, and those in 'highly diversified' DEDs are 46 percent more likely to work off-farm at the mean than those in the 'marginal' DEDs. Given the statistical profiles of the rural typologies these results are as expected and therefore strengthen the validity of the typologies.

The MNL model results are slightly weaker. Households in 'peri-urban' and 'structurally weak' areas are more likely to be in regimes where only the operator works off-farm.

Kilometres to nearest town: the distance variable is included to act as a proxy for location relative to significant labour markets. The towns are Ballina, Castlebar, Westport and Galway. The number of kilometres from the nearest town with a population greater than 5,000 has a negative but insignificant impact on the probability of operator and spouse participation. A similar result for operators is found by Sumner (1982) and Huffman and Lange (1989).

The MNL results suggest that the effect of distance is only significant for entry into the regime with both spouses participating off-farm (regime four). This ties in with previous results (e.g. regarding farm size effects) concerning the flexibility of farm families in regime four.

Off-farm labour supply

The off-farm labour supply models for the operator and spouse are estimated using Heckman's two-stage procedure to adjust for possible sample selection bias. Sample selection bias is rejected for these data, with *lambda* emerging as insignificant in both the operator and spouse estimations. Thus, the OLS coefficients also apply to those not observed working off-farm in the survey. The results of the OLS estimations of off-farm labour supply hours for the operator and spouse are presented in Table 5. To control for possible heteroscedasticity, t-statistics for robust standard errors are reported.

When the MNL is estimated using the sample selection coefficients as defined by Bourguignon*, et al.* (2004), sample selection is not a problem in any of the regimes (using bootstrapped standard errors with 1,000 replications). Thus, hours are estimated using OLS for all regimes (regime two is the referent regime, and all hours are zero). Robust standard errors are used for regime three because the Breusch-Pagan test indicates heteroscedasticity.

Table 5: OLS estimates of the off-farm labour supply hours of the farm operator and spouse

		OLS		MNL		
		Operator	**Spouse**	**Regime 1 Operator only**	**Regime 3 Spouse only**	**Regime 4 Both**
				OLS	OLS	OLS
		Coefficients [r] [Absolute t – stat]	Coefficients [r] [Absolute t – stat]	Coefficients [Absolute t – stat]	Coefficients [r] [Absolute t – stat]	Coefficients [Absolute t – stat]
Farm characteristics						
Area		-0.176 [2.13]**	0.003 [0.07]	-0.344 [2.73]***	0.050 [0.85]	0.163 [1.09]
Diversification		-1.938 [0.65]	-1.748 [0.52]	-7.473 [1.11]	-5.444 [1.18]	-3.796 [0.53]
Farm experience	Operator	-0.032 [0.25]	-0.130 [1.27]	0.016 [0.06]	0.007 [0.05]	-0.081 [0.41]
Presence of dairy cows		-6.128 [2.17]**	5.441 [3.26]***	-5.436 [1.11]	8.756 [3.56]***	-10.673 [1.84]*
Use of farm media		0.946 [1.02]	0.833 [0.95]	-0.828 [0.34]	2.186 [2.16]**	2.611 [1.31]
Personal characteristics						
Operator age		0.717 [0.54]		0.359 [0.14]		4.723 [1.97]*
Operator age squared		-0.007 [0.45]		-0.005 [0.18]		-0.062 [2.23]**
Spouse age			1.276 [1.38]		3.298 [2.05]**	
Spouse age squared			-0.015 [1.39]		-0.030 [1.71]*	
Highest level of education achieved	Operator	-0.037 [0.04]	-1.256 [1.26]	1.609 [0.58]		
	Spouse	0.723 [0.52]	1.485 [1.40]		1.141 [1.03]	
	Operator and spouse					-0.884 [0.74]
Farm education	Operator	1.117 [0.53]	-1.775 [0.86]	-3.043 [0.66]		
	Spouse	0.777 [0.16]	-4.065 [0.63]		(dropped)	
	Operator and spouse					0.105 [0.03]
Household characteristics						
Number of children < 5 years old		-1.372 [0.67]	0.464 [0.30]	-0.756 [0.22]	1.157 [0.40]	-6.151 [1.57]
Number of children 5-11 years old		0.894 [0.95]	-3.272 [3.27]***	-1.102 [0.62]	-2.590 [1.68]*	-2.537 [1.09]

	OLS		MNL		
	Operator	Spouse	Regime 1 Operator only	Regime 3 Spouse only	Regime 4 Both
			OLS	OLS	OLS
	Coefficients [r] [Absolute t – stat]	Coefficients [r] [Absolute t – stat]	Coefficients [Absolute t – stat]	Coefficients [r] [Absolute t – stat]	Coefficients [Absolute t – stat]
Number of children 12-17 years old	0.349 [0.32]	-0.982 [1.03]	-2.445 [0.83]	-2.083 [1.62]	-0.043 [0.02]
Number of other adults (≥ 18 years old)	1.222 [1.38]	-0.939 [0.93]	0.107 [0.05]	-2.776 [2.12]**	2.024 [1.06]
Number of children living permanently away	0.873 [0.85]	-0.825 [0.85]	2.644 [1.07]	-2.508 [2.03]**	2.21 [0.80]
Location characteristics					
Km to nearest town (population >5,000)	-0.035 [0.58]	0.01 [0.17]	-0.077 [0.60]	-0.012 [0.14]	0.048 [0.39]
Constant	17.708 [0.65]	6.331 [0.29]	47.959 [0.90]	-65.597 [1.70]*	-21.467 [0.41]
Observations	99	132	40	73	59
R^2	0.2636	0.2214	0.4797	0.3955	0.3102
Prob. > F	0.0102	0.0008	0.192	0.0006	0.2504
Adjusted R^2			0.1545		0.0696
Root MSE	9.179	9.545	10.589	9.203	11.311
	F(17, 81) = 2.19	F(17, 114) = 2.72	F(15, 24) = 1.48	F(14, 58) = 3.36	F(15, 43) = 1.29

*significant at 10%; ** significant at 5%; *** significant at 1%

Farm characteristics

Farm size: the number of hectares farmed has a significant negative impact on the number of hours supplied to an off-farm job by an operator. An increase in farm size of one hectare decreases the number of hours worked off-farm by 0.2 hours per week. This again reflects the fact that operators of larger farms have less flexibility when it comes to allocating time to off-farm work. This result for operators is also found by Pfaffermayr, *et al.* (1991), Mishra and Goodwin (1997) and Keeney and Matthews (2000). Farm size has no effect on the on-farm hours of the spouse.

The MNL specification suggests that farm size affects off-farm hours of operators in those households in regime one (operators only participating). This variable thus strongly affects operator's hours only when the spouse is not working off-farm.

Diversification: having a diversified enterprise does not have a significant impact on the number of hours supplied off-farm by either the operator or spouse.

Farm experience: the number of years an operator has been the main decision maker on-farm does not have a significant impact on the number of hours supplied off-farm by the operator or spouse in the bivariate model. There are no significant effects in the multinomial model.

Dairy: as expected a priori the presence of dairy cows on the farm has a significant negative impact on the number of hours supplied by the operator. Operators on farms where there are dairy cows present work six less hours off-farm than farm operators who have no dairy cows. This result reflects the labour intensive nature of dairy farming. That is, dairy operators in particular have far less flexibility in allocating time to off-farm work than operators of other farm types. Lass and Gempesaw (1992), Findeis, *et al.* (1991) and El Osta, *et al.* (2003) all find similar results for operators of farms with dairy cows. The presence of dairy cows is found to have a significant positive impact on the off-farm hours of the spouse. Spouses on farms where dairy cows are present provide five more off-farm hours than those on farms where there are no dairy cows. This result is contrary to the results of other authors, who generally find a negative impact on spouse hours from the presence of dairy cows (Lass, *et al.*, 1989; Findeis and Lass, 1994; Weersink, *et al.*, 1998; Keeney and Matthews, 2000).

The MNL results suggest that these extra hours are worked only by spouses in households in regime 3. This again suggests discrete decision making in these households: dairy farming appears to reduce the probability of being in regime 4, but to increase the probability of going from part-time to full-time for those spouses already in regime 3.

Farm media: the level of farm media use by the household has a positive impact on the number of hours participated by the operator and spouse but the results are not significant. In the MNL model, it is found that a higher level of farm media use increases the number of hours worked in regime 3 (spouse only working off-farm).

Personal characteristics

Age: operator and spouse age are not found to have a significant impact on the number of hours worked off-farm by operators and spouses in the bivariate model. This is not true in the MNL specification, where the quadratic age pattern emerges significantly for operators in the regime in which both work off-farm (regime 4) and for spouse age in the regime in which only the spouse works (regime 3).

Education: the level of general education or of farm education attained appears to have no effect on the number of hours worked off-farm by operators or spouses, and it is not found to be significant in the MNL.

Household characteristics

Children and other adults: the number of children present in the household does not have a strong effect on the number of hours worked off-farm by the operator or spouse in the bivariate model. In fact, the only significant result here is the reduction of 3.3 hours by the spouse from the presence of one additional child aged between 5-11 years. The result is only significant in the regime in which only the spouse is working off-farm. The corresponding result for the operator has a positive coefficient which suggests that operators work more off-farm, when there is an additional child aged 5-11 present, perhaps due to the greater financial demands.

The number of other adults present in the household (exc. operator and spouse) has a positive impact on the number of hours supplied by the farm operator and a negative impact on the spouse but neither result is significantly different from zero. The number of children living permanently away has a negative but insignificant effect on the number of off-farm hours supplied by the operator or spouse.

The number of other adults present and the number of children living away significantly reduce hours supplied in regime three, suggesting, as did the participation model results, that income effects are probably strongest in this regime. That is, having older children eases the financial burden on spouses who no longer need to work off-farm.

Location

Kilometres to nearest town: the number of kilometres an operator or spouse lives from the nearest town with a population of 5,000 people or more has no impact on the number of hours they work off farm.

Selection Variables: as stated previously there are no variables excludable by theory from the hours equation to identify the selection process. In these estimations, the location variables are dropped because, given that information on distance from the nearest town is included, it is felt that the nature of the area itself is likely to affect participation more than hours. It is clear that this is an ad hoc identification procedure. However, in all the estimations, using a variety of specifications, none of the selection variables are found to be significant in any of the regimes.

Significant econometric results

Table 6: Off-farm participation and labour supply models – significant results summary

Participation		Univariate Probits		MNL		
		Operator	Spouse	Regime 1 Operator only	Regime 3 Spouse only	Regime 4 Both
Farm characteristics						
Area (hectares)		- sig	-	-	-	- sig
Farm experience (years)		-	+ sig	-	+ sig	-
Presence of dairy cows		- sig	+	-	+	- sig
Personal characteristics						
Spouse	Age		+ sig			
	Age squared		- sig			
Highest level of education achieved (Spouse)		+	+ sig	+	+ sig	+ sig
Farm education (Spouse)		+	- sig			
Household characteristics						
No. of children < 5 years old		-	-	-	-	- sig
No. of children 5-11 years old		+	- sig	+	-	-
No. of children living permanently away		+	- sig	-	- sig	-
Location characteristics						
Peri-urban		+ sig	+	+ sig	+	+
Very strong agricultural		+ sig	+	+ sig	+	+
Structurally weak		+ sig	-	+	-	+
Highly diversified		+ sig	-	+	-	+
Km to nearest town (population >5,000)		-	-	-	-	- sig
Hours		OLS		MNL		
		Operator	Spouse	Regime 1 Operator only	Regime 3 Spouse only	Regime 4 Both
		[r]	[r]	OLS	OLS [r]	OLS
Farm characteristics						
Area (hectares)		- sig	+	- sig	+	+
Presence of dairy cows		- sig	+ sig	-	+ sig	- sig
Use of farm media		+	+	-	+ sig	+
Personal characteristics						
Operator	Age	+		+		+ sig
	Age squared	-		-		- sig
Spouse	Age		+		+ sig	
	Age squared		-		- sig	
Household characteristics						
No. of children 5-11 years old		+	- sig	-	- sig	-
No. of other adults (≥ 18 years old)		+	-	+	- sig	+
No. of children living permanently away		-	-	+	- sig	+

Summary of econometric analysis and overall conclusions

Overall, from both models, and from both sets of estimations (participation and hours), it is found that farm and location characteristics have the most significant effect on the probability of off-farm participation of the operator; area farmed and having dairy cows present having a significant negative impact. While, residing in 'peri-urban', 'very strong agricultural', 'structurally weak' or 'highly diversified' areas all have significant positive impacts on the probability of operator participation.

For farm spouses what emerges is that personal and household characteristics have the most significant impact on probability of off-farm participation. A high level of farm experience of the operator and a high level of general education of the spouse have a significant positive impact on the probability of spouse off-farm participation. A large number of children aged 0-11 or children living permanently away have a negative impact on the probability of spouse participation. For both the operator and spouse age is found to have a quadratic impact on the probability of participation of the operator and spouse, however, the result is only significant for the spouse (peaking at 36 years old).

These are important, useful results, which make it clear that household structure, farm and location characteristics have gender-differenced effects.

The value added to the results from estimating the MNL model is also clear. Its congruence with theory is extremely useful for drawing conclusions that are not possible from examination of the bivariate probit results alone. It has been seen that for example, for farm size and for 'presence of dairy cows' and ‘children permanently away’, the multinomial model provides information that enriches that given by the probit models.

Large farm size only reduces the probability of participating in the regime in which both the operator and spouse work off-farm. This indicates that these couples face greater time constraints on-farm, which in turn implies a lack of flexibility when it comes to making the decision to work off-farm. This is true particularly for the operators, since the probit models indicate that this variable affects operators far more than spouses.

The presence of dairy cows has a significant negative affect on operator off-farm participation. It significantly reduces the probability of being in the regime in which both are working off-farm and has a positive (though not significant) impact on the probability of being in the 'spouse only' regime. It also has a positive impact on hours worked in the 'spouse only' regime. This leads to the conclusion that on farms where dairy cows are present it is more likely that the operator is working full-time on-farm and the spouse is working full-time off-farm.

Having more children permanently away only affects the probability of being in the regime in which only the spouse works off-farm. This indicates that income effects are stronger for spouses when operators are not working off-farm, that is, the likelihood is that the spouse is working off-farm to supplement household income because of the financial needs of the children, and when they are no longer living in the household that financial burden is lifted and the off-farm income is no longer required. It is notable that this effect is also strong on hours worked in regime 3, and not just participation.

From the MNL hours model, operator age and age^2 are significant for hours only in the regime in which both are working off-farm, and spouse age/age^2 are significant for hours in the regime in which only spouses are working. The MNL model appears to be catching an effect not caught by the bivariate probit model because of the conflation of regimes of the latter when modelling for hours of either operator or spouse.

The effects of increased education are also interesting when the results of the different models are compared. From the bivariate probit models, it emerges that only spouse's education matters for participation. The operator's participation appears not to be affected by their education levels (because of the occupation groups they work in). When the multinomial results are considered, education of the spouse is found to significantly increase the probability of a household being in the regime in which only the spouse works (compared to regime two) and increases it even more for being in the regime in which they both work. The latter result is an interesting one. It could be the case that a higher educated spouse reduces the shadow value of home time for the operator. Another possibility is that higher educated (higher wage) spouses are more likely to marry operators already working off-farm, or with a propensity to do so later in life. This result is in agreement with that found by Lee (1998).

The MNL results are also useful in analysing what can probably best be thought of as discrete household-level lifestyle choices. It can be deduced from the results that farm households appear to have the following options among the elements in their choice set:

(i) work on-farm in dairying and let the spouse only participate off-farm (full-time); or

(ii) do not participate in dairying and let both spouse and operator participate off-farm.

Other, no doubt overlapping, elements in this choice set can also be deduced:

(iii) have young children and do not participate off-farm at all;

(iv) have young children and let one or other of the spouses participate off-farm (it does not seem to matter which), but working less hours than other off-farm participants; or

(v) do not have young children and let both members work long hours off-farm.

With regard to the long-term trends in Irish farming, it is likely that as time passes and the average age of farm operators and spouses falls (as it has been, and is likely to continue doing) farm households will become more and more likely to participate off-farm, whether in regimes one, three or four. A countervailing trend is that on those farms that become larger over time, there will be fewer households in regime four. A progressively stronger off-farm rural economy is likely to have stronger effects on operator off-farm participation and hours (increasing both). Smaller family sizes, more childcare (even from other adults in the home) and the non-availability of other sources of income (in this sample, from older children permanently away) are likely to increase spousal participation and hours.

It is interesting, also, that we have seen from the cluster analysis that there is some link between off-farm work and social and community activities. The direction of causation is not clear, so these variables have not been included in the econometric models. But in the long-term it is likely that involvement in local networks and helping to build up local social capital will play an important part in rural and community development, and is likely to be an important issue in future settlement patterns and lifestyle choices. This is an under-investigated area. From our data it is clear that households where both parents work off-farm tend to be highly involved in community work, while households where only the operator works off-farm tend to partake in many social activities (this is also related to the age structure in these households). Households where neither partner works off-farm do less of both types of activity than all other type of household.

For policy makers it is important in general not to have a 'one-size fits all' policy. The dynamics are different in households where one parent is working off-farm than in households where two parents are or where no one is. It also matters which spouse is working off-farm. An increase in cheaper good quality childcare provision, for example, is likely to have different effects in different types of household. Changes in education have different effects, for the operator and the spouse; most operators' off-farm work is in sectors where there is little premium for education – construction and transport, primarily. This could be quite important in the long term, as the effects of the new agricultural policy manifest themselves, and operators may look for better paying and more permanent work off-farm. As these changes in CAP come into effect, it is likely also that the number of small dairy farms will decline. A shift away from dairy farming among small farmers is, we have seen, very likely to lead to quite dramatic lifestyle changes.

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Appendix

Table 7: Rural District Electoral Division (DED) Types (McHugh and Fitzpatrick Associates, 2000 p iii)

Rural Area Type 1: Peri-Urban Areas
Rural areas close to the main urban centres broadly corresponding to immediate urban areas of influence. High population density, relatively low reliance on farming and high levels of commuting to work. The largest single Area Type in population terms.
Rural Area Type 2: Very Strong Areas
Large areas of the country, mostly in the South and east where farming continues to be strong. A relatively less "urbanised" population profile than Area 1, i.e. lower average education levels, lower female participation, and more manufacturing than services.
Rural Area Type 3: Strong Adjusting (to output restrictions) Agricultural Areas
DEDs throughout much of the East and South also with strong agriculture, but with a less advanced transition to non-agricultural activity. Areas are generally experiencing the challenge of adjusting to agricultural output restrictions.
Rural Area Type 4: Structurally Weak Areas
A large number of DEDs involving disadvantaged areas, with high levels of dependence on directly subsidised agriculture (as opposed to price supports) Concentrated in the North West but also extends to parts of the North Midlands, the South and Mid-West. Defining attributes are older farmers, small farms, declining farmer numbers, and a low level of non-manufacturing employment.
Rural Area Type 5: Marginal Areas
These are more agriculturally disadvantaged than Type 4 and are clustered mainly in the most remote West and North West. While overall demographic viability is somewhat stronger than Type 4, perhaps due to a high incidence of part-time occupations, unemployment nevertheless remained high in 1996.
Rural Area Type 6: Highly Diversified Areas
This type, involving a relatively small number of people, represents almost a "post-agricultural" rural economy. It involves areas of high natural amenity, which attracts high levels of non-farming residents who have migrated. Areas involved include Connemara, Clare, Wicklow and areas along the Shannon.

Table 8: Cluster analysis: Operators and spouses (n=260)

			Mean	Cluster			
				1	**2**	**3**	**4**
Farm characteristics							
Area farmed		Hectares	26.9	20.1	46.7	19.5	26.3
Farm experience		Years	24.0	33.8	25.6	19.0	14.8
Dairy Cows		Livestock units	8.5	1.4	31.8	2.1	5.3
Cattle		Livestock units	22.7	13.9	40.3	20.0	22.8
Sheep		Livestock units	7.3	7.6	7.5	3.9	9.0
Rent land		Dummy	0.37	0.17	0.60	0.33	0.48
Hired labour - exc. agriculture contractors		Dummy	0.18	0.08	0.38	0.20	0.14
Farm investment (1997 - 2003)		Dummy	0.74	0.51	0.88	0.87	0.84
Diversification		Dummy	0.10	0.05	0.12	0.26	0.05
REPS		Dummy	0.57	0.49	0.54	0.50	0.71
Annual on-farm income (inc. grants and subsidies)		Ordinal 1-7	2.6	1.8	4.2	2.1	2.7
On-farm income from grants and subsidies		%	0.52	0.53	0.39	0.59	0.56
Level of farm media use		Min (0) – Max (1)	0.44	0.43	0.50	0.47	0.39
Operator/Spouse characteristics							
Age	Operator	Years	53.5	65.0	50.8	51.3	43.6
	Spouse		49.9	60.2	46.2	49.6	41.0
Highest level of education completed	Operator	Ordinal 1-4	1.92	1.29	2.22	1.98	2.39
	Spouse		2.47	1.63	2.90	2.57	3.06
Farm education	Operator	Dummy	0.45	0.31	0.50	0.43	0.60
Farm hours	Operator	Avg. per week	45.6	47.6	63.0	32.2	40.0
	Spouse		5.0	6.3	2.9	8.0	3.1
Farm group member	Operator	Dummy	0.54	0.38	0.90	0.30	0.64
Off-farm hours	Operator	Avg. per week	13.0	0.6	2.6	29.0	24.1
	Spouse		15.3	5.7	19.4	14.2	24.0
Total years of off-farm work experience	Operator	Years	14.2	13.6	6.4	22.7	14.8
	Spouse		12.5	7.6	17.1	11.9	15.5
Social welfare payments (exc. children's allowance)	Operator	Dummy	0.4	0.8	0.1	0.2	0.2
	Spouse		0.1	0.3	0.0	0.0	0.1
Housework and childcare hours	Operator	Avg. per week	2.3	1.7	2.5	1.6	3.4
	Spouse	Ordinal 1-8	5.3	4.7	5.2	5.3	6.0
Community and social activities							
Hours of community activities	Operator	Avg. per month	3.5	1.2	1.3	5.7	6.2
	Spouse		2.4	2.0	2.5	2.8	2.4
Number of social activities	Operator	Avg. per month	9.9	9.6	6.9	15.0	9.3
	Spouse		9.4	8.5	6.1	16.0	8.6
Household characteristics							
Total number of children < 18 years old			1.3	0.2	1.4	0.8	2.5
Number of other adults			0.86	0.75	0.98	1.87	0.31
Number of children permanently away			1.4	3.2	0.8	0.9	0.2

			Mean	Cluster			
				1	2	3	4
Personal computer in the household		Dummy	0.54	0.26	0.58	0.80	0.68
Location characteristics							
Peri-Urban		Dummy	0.19	0.18	0.12	0.37	0.13
Strong Agricultural			0.05	0.02	0.04	0.09	0.05
Structurally Weak			0.51	0.43	0.78	0.39	0.49
Marginal			0.22	0.31	0.06	0.13	0.27
Highly Diversified			0.04	0.06	0.00	0.02	0.05
N			**260**	**87**	**50**	**46**	**77**

Table 9 shows the Euclidean distance between the final cluster centres. Greater distances between clusters correspond to greater dissimilarities. Cluster one is equally dissimilar to clusters two and four.

Table 9: Euclidean distance between final clusters

		Cluster			
		1	2	3	4
Cluster	**1**	-	5.287	4.321	5.269
	2	5.287	-	4.767	3.781
	3	4.321	4.767	-	3.426
	4	5.269	3.781	3.426	-

Table 10: Summary statistics for variables in participation and supply models

Variable label		Type	Obs	Mean	Std. Dev.
Current off-farm job	Operator	Dummy	278	0.37	0.48
	Spouse		278	0.47	0.50
Off-farm hours	Operator	Avg. per week	102	36.16	10.19
	Spouse		131	31.47	9.82
Farm characteristics					
Farm size		Hectares	277	27.56	20.99
Farm experience	Operator	Years	277	23.88	12.64
Diversification		Dummy	278	0.09	0.29
Dairy cows		Dummy	278	0.26	0.44
Use of farm media		1 – Not at all 2 – Slight extent 3 – Moderate extent 4 – Great extent 5 – Very great extent	278	3.26	0.89
Personal characteristics					
Age	Operator	Years	275	53.25	11.76
	Spouse		275	49.72	10.93
Highest level of education achieved	Operator	1 – <= Primary 2 – Lower secondary 3 – Upper secondary 4 – Third level	278	1.90	0.98
	Spouse		278	2.46	1.03
Farm education completed	Operator	Dummy	278	0.46	0.49
	Spouse		278	0.04	0.20
Household characteristics					
Number of children < 5 years old			278	0.21	0.54
Number of children 5 – 11 years old			278	0.47	0.89
Number of children 12 – 17 years old			278	0.60	0.88
Number of other adults (≥ 18 years old)			278	0.84	1.05
Number of children living permanently away			278	1.42	2.10
Location characteristics					
Peri-urban areas		Dummy	278	0.19	0.39
Strongly agricultural areas			278	0.05	0.22
Structurally weak areas			278	0.50	0.50
Highly diversified areas			278	0.04	0.19
Marginal areas			278	0.22	0.41
Km to nearest town (population > 5,000)			278	25.20	16.08