A probabilistic model of off-farm work in Scotland

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Un modèle probabiliste de l'emploi des ménages agricoles écossais hors de l'exploitation

Résumé – Il est admis que pour compenser la baisse de revenu annuelle de leurs exploitations les agriculteurs devraient diversifier leurs activités rémunératrices. Les résultats de récentes études faites au Royaume-Uni suggèrent que les agriculteurs sont peu disposés à se tourner vers des activités non agricoles leur procurant de nouvelles sources de revenus.

Afin de savoir si le niveau du revenu agricole détermine la possibilité qu'un membre de la famille occupe un emploi hors de l'exploitation, il faut séparer l'incidence de la composition de la famille de celle du revenu. Un sondage complémentaire auprès des participants du Scottish Farm Accounts Scheme (FAS) fut effectué afin d'obtenir des détails sur la composition des ménages et l'emploi des membres de la famille. Ces informations, ainsi que les données sur le revenu recueillies par le FAS, furent utilisées pour construire un modèle de probabilité d'emploi des ménages agricoles écossais hors de l'exploitation.

Le modèle logit montre que la dimension de l'exploitation et la composition de la famille sont des facteurs permettant de déterminer si un membre de la famille a une chance de travailler hors de l'exploitation. Cette probabilité, réduite à la base par rapport à la taille de l'exploitation, augmente de nouveau pour les entreprises les plus grosses.

La probabilité de travailler hors de l'exploitation s'accroît quand la famille compte de jeunes adultes, surtout des jeunes filles, ainsi qu'en fonction de l'éducation ou de la formation supérieure non agricole de la femme de l'exploitant. Etant donné que seulement 5 % des exploitants de ce sondage travaillent hors de l'exploitation, cette variable semble indiquer que, plus la femme de l'exploitant est jeune, plus il est probable qu'elle travaille hors de l'exploitation (25 % des cas).

On constate qu'un actif plus élevé et un passif exigible par hectare plus faible diminuent la probabilité d'emploi hors de l'exploitation. On pourrait s'attendre à ce que les grosses exploitations agricoles ayant un actif plus élevé et un passif exigible moindre aient un revenu plus élevé; ces variables pourraient alors refléter les effets du revenu. Cependant, comme les chiffres du revenu ne semblent pas significatifs cette interprétation ne peut être retenue. D'autres raisons, y compris l'interaction entre la vie familiale, la vie professionnelle et la date d'achat des terrains, semblent esquisser un rapport entre le travail hors de l'exploitation et le niveau des capitaux propres et du passif. Par ailleurs il se peut qu'un niveau de fortune plus élevé diminue l'empressement des actifs familiaux à chercher du travail hors de l'exploitation.

Mots-clés:
emploi hors de l'exploitation, revenu de l'exploitation, modèle de probabilité

A probabilistic model of off-farm work in Scotland

Summary *– One way that farm households may adjust to downward pressures on farm incomes is by diversifying their sources of earned income. However, a variety of different factors could lead to a farm household having a member with off-farm work. A logit model was estimated to determine whether farm income levels are a determinant of the likelihood of a household member having off-farm employment. The model emphasized the role of the family composition and farm size in influencing whether household members worked off-farm. Although there was evidence that the incomes from farming of households with off-farm work were significantly below those without off-farm work, income variables were not significant in the estimated logit model. Two financial variables appear to be important, higher farm net worth decreased, and higher current liabilities per hectare increased, the likelihood of off-farm work.*

Key-words:
off-farm employment, farm incomes, logit model

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PROMINENCE has been given to the need for farm households in Europe to diversify their sources of earned income as a response to downward pressures on incomes from farming. However, Hill (1992) points out that there is nothing fundamentally new in farm households having other sources of income in addition to farming. Surveys repeatedly show that farm households throughout Europe undertake a wide variety of other gainful activities (see for instance, Gasson, 1988; Brun and Fuller, 1991). Despite this evidence, a survey undertaken in an area of upland Scotland revealed an ingrained reluctance on the part of most farmers to diversify their incomes by undertaking non-agricultural activities (Shucksmith and Smith, 1991). Errington and Tranter (1991) also found that only a minority of the English farmers surveyed expected to respond to the increased financial pressure by diversifying their income sources.

It has been argued that the farm household is the appropriate unit of enumeration for studies of the other gainful activities undertaken in conjunction with farming (Fuguitt *et al.*, 1977, Gasson, 1988, Shucksmith *et al.*, 1989). These studies suggest that farmer's wives and other family members can play an important role in farming activities so that changes in household composition result in changes in the available labour, as well as affecting the income needs of the household. Gasson's (1986) results also suggest that female participation rates in the labour market and the family lifecycle can be important determinants of whether a household contains a member who works off farm. Therefore, in order to determine whether farm households will diversify their income generating activities in response to reduced incomes from farming, it is necessary to separate out the effects of family composition from any longer term income effects (Shucksmith *et al.*, 1989).

A survey of 285 co-operators in the Scottish Farm Accounts Scheme (FAS) was undertaken in 1991 to supplement the detailed income data collected by the FAS with data on the composition of the households and the employment of the household members[1]. In order to investigate whether farm income levels are a determinant of the likelihood of a household member having off-farm employment, this data was used to estimate a probabilistic model of off-farm employment The rationale for

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such an approach is presented in the following section. This is followed by a description of the model estimated.

THE ECONOMICS OF AGRICULTURAL HOUSEHOLDS

It is assumed in economic models of agricultural households that households seek to maximise household welfare, which is a function of goods and leisure consumed, subject to the constraint that in the long-run household expenditure cannot exceed household income. The income of an agricultural household is, in turn, dependent upon the available agricultural production technology and the value of household labour supplied to the off-farm labour market (Singh *et al.*, 1986; Nakajima, 1986). The agricultural production technology available will, in part, be dependant upon the substitutability of hired and household labour. Likewise, the value of household labour supplied to the off-farm labour market is not only dependent upon the amount of household labour available and the amount required for farm production, but also upon the off-farm wage rate that household members can command and the preferences of the household between agricultural and off-farm work.

In the simplest agricultural household models, it is assumed that hired and household labour are perfect substitutes and that the household does not have preferences between agricultural and off-farm work. In such models, the supply of household labour to off-farm employment depends upon the amount of household labour available and the quantity of labour required to equalise the marginal value product of agricultural labour with the off-farm wage rate. An increase in the off-farm wage rate would increase the supply of household labour off-farm and/or reduce the quantity of hired labour used for agricultural production. An increase in the price of agricultural output would decrease the supply of household labour off-farm and/or increase the quantity of hired labour used for agricultural production.

The imperfect substitutability of household and hired labour (Lopez, 1984) and household preferences between agricultural and off-farm work (Gasson, 1973, Gillmore, 1986) may however result in a differential between the marginal value product of household labour used for agriculture and the off-farm wage rate. Increases in the off-farm wage rate or decreases in the price of agricultural output will only result in an increase in off-farm labour supply by the household if the off-farm wage rate exceeds by a sufficient amount the marginal value product of household labour used for agriculture.

Thus economic models of agricultural households suggests that off-farm labour supply is determined by the agricultural production possi-

bilities set, the amount of household labour available, the substitutability of household and hired labour, the price of agricultural output, the off-farm wage rate that household labour can command, and the preferences of the household between agricultural and off-farm work.

There are however several difficulties with such models of agricultural households. First, Arrow's (1963, p. 59) **Impossibility Theorem** shows that there is no way to consistently aggregate individual preferences into a welfare function. The results of Gasson (1973) and Gillmore (1986) suggest that farmers prefer farming to other work. In contrast, Gasson (1984, 1992) suggests that farmers' wives may prefer to work off-farm. The assumption of the existence of a household welfare function may therefore be heroic. Second, the off-farm wage rate that household members can command may depend upon their age, education, training, and experience of off-farm work. Shucksmith and Smith (1991) suggest that the off-farm work available to farmers is often lowly paid. Again in contrast however, Gasson (1984) and Symes (1991) suggest that farmers' wives tend to be better qualified and have more experience of off-farm work than their husbands. Third, the results of Lopez (1986) demonstrate the difficulties inherent in estimating agricultural household models where it is not possible to separate the production and consumption decisions of households. Therefore, in an attempt to separate out the effects of differences in farm household composition and agricultural production possibilities from any longer term income effects, a probabilistic model of off-farm work in Scotland was estimated.

A LOGIT MODEL OF OFF-FARM WORK

Probability models allow the investigation of causal relations when the dependant variable is qualitative (Cramer, 1991). The logit model has particularly appealing characteristics for this type of problem. First, "*... the logit approach assumes a discrete 'event' takes place after the combined effect of certain economic variables reaches some threshold level.*" (Feder and Just, 1977, p. 26). Second, unlike the linear probability model, the estimated probabilities are confined to the zero to one interval required of a probability. Third, it avoids the well documented problems associated with discriminant analysis (Eisenbeis, 1977, Feder and Just, 1977, Barnes, 1984)[2].

[2] The probit model also has these appealing characteristics. Hall & Stark (1986) show that in practice the functions are remarkably similar and therefore the logistic formulation was chosen for its ease of interpretation. Anderson (1972) also shows that a wide range of alternative distributional assumptions are sustainable under this formulation of the model.

Thus, the probability of a household containing a member who had off-farm work was modelled as,

$$\hat{P}i = \frac{1}{1 + e^{-(xiT\hat{\beta})}}$$

where,

$\hat{P}i$ = the estimated probability of a member of household i working off-farm

$i = 1, ..., N$,

x = a vector of variables, Xj, $j = 1, ..., J$, and

$\hat{\beta}$ = a vector of estimated parameters, βj.

Missing data limited the sample that could be used to 221 of the observations. Of these households 151 (68.3%) did not contain a member who had off-farm work and 70 (31.7%) did have a member that worked off-farm. The model initially estimated comprised variables indicating; the size of farm; the number of sons, daughters, and other family members (such as farmers' brothers, sisters, fathers or mothers) of 17 years of age or over; the number of children under 17 years of age; the farmer's age; the school and post-school qualifications obtained by the farmer and wife ; the income from farming; the interest payments of the farm business; and the capital position of the farm business.

It was expected that, by increasing the need for labour on-farm, an increased farm size would decrease the probability of off-farm work. In contrast, an increase in the household labour available was expected, *ceteris paribus*, to increase the probability of off-farm work. As a result of traditional gender roles in farming (Whatmore, 1991) it was expected that farmers' daughters were more likely to have off-farm work than farmers' sons. Children under 17 years of age were expected to decrease the ability of a farmer's wife to work off-farm although the need for extra income could conversely increase the probability of off-farm work. Occupational mobility is usually expected to decline with increasing age (Johnson, 1953, Gallaway, 1967) so that the farmer's age was expected to be inversely related to the probability of off-farm work. Likewise, it is expected that education and training increase occupational mobility. The school and post-school qualifications of farmers and their wives were therefore expected to increase the probability of off-farm work. If low incomes from farming result in farm households having off-farm work then income from farming would be negatively related to the probability of off-farm work. If the financial difficulties of a farm business result in household members working off-farm then it would be expected that higher interest payments and farm business debts would increase the probability of off-farm work, whereas a higher net worth of the business would decrease the probability of off-farm work.

Likelihood Ratio tests (Judge *et al.*, 188, p. 105) were used to test the significance of the parameter estimates. Variables which were not si-

gnificant were deleted from the model. The final model estimated is given in table 1. The British size unit[3] groups are dummy variables. The dummy variable for the size group the farm is in takes the value of one, whilst all of the other size group dummy variables are zero. The variable indicating whether the farmer's wife[4] had undertaken post-school non-agricultural training is also a dummy variable. As shown in table 1, all the dummy variables of farm size were together significant at the 2.5% level of significance (although some of the individual size dummy variables were not significant) and all other variables were statistically significant at acceptable levels.

Table 1. **Estimated parameters of the logit model**

Variable	Estimated coefficient	Standard error	Likelihood ratio test	Significance
Intercept.	3.59120574	1.236042	–	–
8 to < 16 BSU	– 0.0728466	0.762296		
16 to < 24 BSU	– 1.5865415	0.877787		
24 to < 40 BSU	– 1.5293753	0.868908	13.09	2.5%
40 to < 100 BSU	– 1.2982179	0.961531		
100 + BSU	1.13370133	1.46381		
Number of daughters of 17 years of age or over	4.12134256	1.203928	33.86	0.5%
Number of sons of 17 years of age or over	1.13033949	0.397859	12.19	0.5%
Post-school non-agricultural education or training of farmer's wife	1.11154267	0.455246	5.99	2.5%
Farmer's age	– 0.0743212	0.018677	24.76	0.5%
Net worth	$-5.03 \cdot 10^{-6}$	$1.94 \cdot 10^{-6}$	9.19	0.5%
Current liabilities per hectare	0.0008949	0.00047	3.39	10%
% of total output accounted for by pig and poultry enterprises	0.07266982	0.03596	5.29	2.5%

a) Value of loglikelihood function = – 92.01447743

b) Value of loglikelihood function of model only containing an intercept term = – 137.9900347

c) Likelihood ratio tests were conducted separately by successively re-estimating the model with the restriction that each parameter was equal to zero (or that all the dummy variables of farm size were equal to zero together).

d) The minimum farm size requirement of the FAS is 4 BSU so that the model is estimated with respect to the 4 to < 8 BSU size group.

[3] The British size unit (BSU) is a measure of the economic size of a farm. BSUs are calculated from standard gross margins estimated for the period 1978-80. One BSU is equal to 2,000 European currency units (ECU) of standard gross margin.

[4] It should be noted that three individuals identified in the sample as being the farmer were female. In all three cases however they were not living with spouses. The term "farmer's wife" is therefore merely descriptive. No implication is intended regarding their involvement or otherwise in farming activities.

The overall goodness of fit of the model was tested by comparing the loglikelihood of the estimated model with that of a model that only included an intercept term using the likelihood ratio test (Judge *et al.*, 1980, p. 601). The test is analogous to an F test where all the parameters of a linear regression model are equal to zero. The chi-square value of 91.95, with 12 degrees of freedom is significant at the 0.5% level so that the null hypothesis that the model has no explanatory power can be rejected with a fair degree of confidence[5].

Collins and Green (1982) note that the estimated coefficients of a logit function show the effect of a change in the variable on the log-odds ratio or threshold. Cramer (1991, p. 8) therefore suggests the use of quasi-elasticities, defined as:

$$\eta j = \frac{\partial P(x)}{\partial LogXj}$$

which shows the percentage change in the probability given a one percent increase in the variable. These quasi-elasticities are presented in table 2.

Table 2.
Quasi-elasticities of the logit function

Variable	Quasi-Elasticity
8 to < 16 BSU	– 0.003
16 to < 24 BSU	– 0.064
24 to < 40 BSU	– 0.067
40 to < 100 BSU	– 0.070
100 +	0.007
Number of daughters of 17 years of age or over	0.091
Number of sons of 17 years of age or over	0.091
Post-school non-agricultural education or training of farmer's wife	0.048
Farmer's age	– 0.791
Net worth	– 0.232
Current liabilities per hectare	0.058
% of total output accounted for by pig and poultry enterprises	0.017

The values of these quasi-elasticities are conditional upon the point at which they are calculated. The sample means of the variables were used here.

The estimated model demonstrates the importance of farm size and household composition in determining whether a farm household contains a member who works off-farm. The elasticities of the dummy

[5] An alternative test suggested by Judge *et al.* (1980) is the pseudo-R^2. The estimated ρ^2 is 0.333. Although theoretically this statistic can vary between zero, indicating no predictive power, and one, indicating perfect prediction, the interpretation of statistics that fall between these extremes is not clear. Thus ρ^2 is purely noted for interest.

variables of farm size show that increasing farm size is initially inversely related to the probability of the household having off-farm work. This relationship changes however for the largest farm size group showing that a farm being in this size group increases the probability of a member of the household having off-farm work. This is similar to the 'U' shaped relationship between farm size and multiple job holding noted by Gasson (1983).

The estimated elasticities of the number of sons and daughters, of 17 years of age or over, in the household are identical. This does not however imply that adult sons and daughters are equally likely to have off-farm work. The elasticities were estimated at the means of the sample used to estimate the model and the mean number of adult sons per farm was 0.344 as against a mean number of adult daughters of 0.109. Thus a one percent increase in the number of sons represents a larger absolute increase than a one percent increase in the number of daughters. On additional adult daughter in the household is therefore more likely to result in the household containing a member who has off-farm work than is an additional adult son. The indications obtained from the survey is that the education or training of farmers' daughters seems to be geared towards an off-farm career. Over 70% of farmers' daughters left school with advanced qualifications ('H' Grade, 'A' Level, or equivalent qualification obtained at about 17 years of age) and over 65% had a non-agricultural post-school qualification[6] . The reason for this may either be that, due to the traditional gender roles in farming, farmers are unwilling to pass the managerial control of farms to daughters (Hastings, 1984), or as suggested by Gasson (1987) that farmers' daughters do not aspire to following in their fathers' footsteps.

As shown in table 3, inclusion of other variables indicating the composition of the farm households did not significantly improve the logit model. The probability of a household having a member with off-farm work was not significantly effected by the presence in the household of other family members (for instance farmers' brothers, sisters, fathers, or mothers) of 17 years of age or over, or the presence in the household of children under 17 years of age.

The importance of family composition in explaining whether the household contains a member who works off-farm could be an indication that stage of the family lifecycle is a key determinant of the probability of a household member having off-farm work. It is however also possible that more sons and daughters working off-farm than farmers and their wives could be the result of longer term trends. Farmers' sons and daughters are more likely to have school and post-school qualifications

[6] In contrast only approximately 27% of farmers' sons left school with an advanced qualification and, whilst 53% had a post-school qualification, only 20% had a non-agricultural qualification.

than their parents and female participation rates in the non-farm labour force have increased as the role of women in society has changed. That said, although evidence from England and Wales suggests that farmers try either to incorporate willing sons into the farm business or to set them up on their own farms (Symes, 1990), it should be recognized that farmers' sons and daughters do not necessarily themselves become farmers or marry farmers (Symes and Appleton, 1986, Gasson, 1987). Symes (1990) suggests that the better education received by farmers daughters might be the result of farmers' plans for inheritance and succession. It may not therefore be strictly accurate to compare the education of farmers and wives with that of their sons and daughters since better educated sons and daughters of farmers may be those who leave the farming population.

Table 3. **Estimated parameters of two household composition variables** (not included in the final logit model)

Variable significance	Estimated coefficient	Standard error	Likelihood ratio test
Number of household members (other than the farmer, farmer's wife, sons or daughters) of 17 years of age or over	0.29258	0.48480	0.35
Number of household members under 17 years of age	0.02045	0.26900	0.006

The parameters were estimated by separately incorporating each of these variables into the model presented above. Likelihood ratio tests were conducted by treating the model after the inclusion of the additional variable as the unconstrained model and the model presented previously as the constrained model.

The logit model shows that the possession of a post-school non-agricultural qualification by the farmer's wife increases the probability of off-farm work. In part, this is likely to be a reflection of the greater labour mobility of better educated individuals, and it may even indicate that in order to obtain off-farm work farmers' wives have undertaken appropriate training[7]. Variables indicating the school qualifications obtained by farmers' wives were not however significant. Since only 5% of farmers worked off-farm[8], the non-significance of variables indicating the school or post-school qualifications obtained by farmers is unsurprising.

[7] In which case this variable would not be completely exogenous.

[8] This proportion is particularly low when compared to other samples and it is likely to be the result of two factors. First, the minimum farm size (4 BSU) requirement of the FAS. Second, in order to ensure that the FAS sample complies with EC regulations 79/65 and 1859/82 concerning the Farm Accounts Data Network, it is intended that a) the farmers should be at least engaged in running the farm, b) that the farm should provide work for at least one person, and c) that *"Part-time farmers who also have substantial involvement in other associated agricultural activities, such as contracting or wholesaling, should be excluded"* (SOAFD, 1990). As Hill (1986) points out this may bias the sample.

The age of farmers was significant in explaining the probability of a household having a member with off-farm work. Given that only 5 % of the farmers who participated in the survey worked off-farm it is unlikely that this variable is only indicating the fact that younger farmers are more likely to work off-farm. Since younger farmers are likely to have younger wives it is probable that the farmer's age variable is also indicating that farmers' wives (25 % of whom worked off-farm) are more likely to work off farm the younger they are. Symes (1991) points out that younger farmers' wives tend to come from a wider social background so that they are more likely to have *"... begun a career unrelated to farming prior to marriage"* (p. 88).

The survey showed that on average the **cash income**[9] from farming of households without off-farm work, at £25,685, significantly exceeded that of households with off-farm work at £17,724. In addition, the farm businesses of households with off-farm work also paid significantly higher interest charges at £71 per hectare than the farm businesses of households without off-farm work, at £44 per hectare. As shown in table 4 however neither of these variables significantly improved the logit model.

Table 4. **Estimated parameters of income and financial variables** (not included in the final logit model)

Variable (a)	Estimated coefficient	Standard error	Likelihood ratio test	Significance
Net farm income (b)	0.00002	0.00001	1.72	–
Cash income	$-6.764 \cdot 10^{-6}$	0.000012	0.34	–
Interest per hectare	– 0.00031	0.00772	0.002	–
Loan service ratio	– 0.24998	0.30938	0.65	–

a) The parameters were estimated by separately incorporating each of these variables into the model presented above. Likelihood ratio tests were conducted by treating the model after the inclusion of the additional variable as the unconstrained model and the model presented previously as the constrained model.

b) Net farm income is *"... the return to the principal farmer and spouse for their manual and managerial labour and investment in tenant's capital"* (MAFF, 1992).

The **solvency ratio**[10] proposed by Le Jeannic (1989) and Dietsch (1989) was slightly modified in order that in Scottish circumstances it reflects the ability of a farm business to meet its loan service obligations using the actual revenue generated from trading. This ratio is hereinafter referred to as the loan service ratio and is defined as,

$$\text{Loan Service Ratio} = \frac{\text{Interest + Loan Repayments}}{\text{Cash Income + Interest}}$$

[9] Cash income is the difference between revenue actually received by a farm business and the expenditure that it actually incurred (MAFF, 1992).

[10] Financial charges divided by gross profit before financial charges and taxation.

This ratio differentiates between financial difficulties arising from two causes. If the ratio is negative the total business receipts were less than business expenditure before financial costs[11]. A cash injection, either from a changed capital position or from a transfer into the business, would have been required to fund trading. If the loan service ratio is greater than one, although business receipts would have been greater than business expenditure before financial costs, they would have been insufficient to meet these financial costs. The former situation is likely to result from trading difficulties, the latter as a result of relatively high levels of borrowing. Although the loan service ratio is derived from cash income and interest payments, and that the farm businesses of households with off-farm work were more likely to have a ratio exceeding one, as can be seen from table 4 inclusion of this variable did not significantly improve the logit model.

The logit model does however show that a higher net worth and lower current liabilities per hectare decrease the probability of off-farm employment. There are a variety of reasons why such a relationship might arise. Firstly, in that larger farm businesses with a higher net worth and lower current liabilities would be expected to be generating higher farming incomes, these variables could be reflecting an income effect. However since income variables were not significant this interpretation is perhaps doubtful.

Secondly, it could be a result of the interaction of the family and business lifecycles (Gasson *et al.*, 1988, pp.18-20). Younger farmers and their wives are more likely to have off-farm work than their older counterparts. They are also likely to be expanding their businesses thereby incurring higher levels of debt than more established households. Likewise, families that contain young adults who are working off-farm may also contain similarly aged children who are joining the farm business. The need to incorporate these children into the farm businesses might be a spur for further expansion or adaptation of the farm (Potter and Lobley, 1992) resulting in higher debt levels.

Thirdly, given that the timing of land purchase is an important determinant of the capital employed in a farm business (Harrison, 1975), the relationship between debt levels and off-farm employment may reflect that, in order to buy into farming, newer entrants to farming are having to combine farming with off-farm work. Lastly however the relationship may just be indicating that higher levels of wealth decrease the willingness of household members to supply their labour off-farm.

Finally, the logit model suggests that households are more likely to have off-farm work where pig and poultry enterprises account for a lar-

[11] That is when cash income before interest charges is negative. This is the only instance when the ratio can be negative since interest charges and capital repayments have a minimum of zero.

ger proportion of total farm output. This result is somewhat surprising since off-farm work tends to be associated with less intensive farming enterprises (Gasson, 1988) although it is in keeping with the results of De Vries (1993) and Davies and Dalton (1993).

FARM LOCATION

It is possible that the probability of a household having a member who works off-farm is influenced by the location of the farm. As distance and a lack of services in rural areas combine to make commuting costly and time-consuming, off-farm employment is likely to be more common on farms that are closer to urban areas.

Unfortunately, in order to ensure the anonymity of co-operators, the FAS datasets only identify the region and district within which a farm is located. The heterogeneity of conditions in these administrative areas together with the relatively small number of observations scattered across Scotland prevented meaningful analysis of the effect of farm location.

However, a subset of the FAS records (those required for the European Union's Farm Accounts Data Network) contained a variable indicating whether a farm was located above or below 300 meters. Only 14% of the households located above 300 meters had a member who worked off-farm whereas 33% of the households located below 300 meters had someone who worked off-farm. Given that households below 300 meters are likely to be closer to Scottish centres of population this result is not surprising. The logit model was estimated using the subset for which the altitude variable was available and it was found that the altitude variable was not significant in explaining the probability of the household having a member who worked off-farm. The variable while crude is the only one available for a subset of farms.

THE PREDICTION OF OFF-FARM WORK

Estimated logit models may be used to predict the incidence of the event modelled[12]. Siebert (1983) shows that the choice of probability on which to make a priori classification depends upon the losses that arise from misclassification. There are two types of misclassification that can arise, either a true hypothesis is rejected (type I error) or a false hy-

[12] Cramer (1991) describes how to predict the aggregate incidence of the event.

pothesis is accepted (type II error). If the costs of a type I and type II errors are identical then the optimal probability to use is 0.5 which minimises the number of observations misclassified. At this probability 55.7% of households with off-farm employment and 90.7% of households without off-farm work are correctly predicted. That is there are 44.3% (31) type I errors and 26.4% (14) type II errors.

CONCLUSIONS

The estimated logit model reveals farm size and family composition to be important determinants of whether a farm household had a member that works off-farm. It was found that the probability of off-farm work initially decreases with increasing farm size and then increases again on the largest farms. Adult daughters living in the household are also particularly likely to have off-farm work.

Although the objective of this study was to separate out the effects of family composition from those of income from farming the estimated model did not contain a farm income variable and whilst other variables might in part be capturing income effects, this is far from clear. It must, however, be borne in mind that the minimum size limit on farms included in the FAS together with rules for drawing the sample may have biased the sample away from those farms which are adjusting to falling farm incomes by taking up off-farm work. That said, the model does not unequivocally support the hypothesis that households facing declining incomes from farming or increased financial pressure will adjust by working off-farm.

Of course, declining incomes from farming and increased financial pressure could result in an increase in the number of households with off-farm work by forcing from the industry those that will not adjust. Such households may well be replaced by newcomers for whom working off-farm in combination with farming is more acceptable.

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