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# Off-farm work decisions on Dutch cash crop farms and the 1992 and Agenda 2000 CAP reforms

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**Abstract**

A double hurdle model of off-farm work participation and off-farm labour income was derived and estimated consistent with a farm household model. It was found that rationing and unexpected transaction costs inhibit farm households from participating in off-farm work. The 1992 and the Agenda 2000 CAP reforms are most likely to increase the off-farm employment of arable farm households, but its full effect cannot be realised because of inhibitions to enter off-farm activities. Household and farm characteristics have different impacts on off-farm work participation and on the level of off-farm labour income. © 2000 Elsevier Science B.V. All rights reserved.

*Keywords:* Off-farm work participation; Off-farm labour income; Double hurdle model; Dutch arable farms; CAP reform

## 1. Introduction

The 1992 European Union (EU) common agricultural policy (CAP) reform has changed the relative role of price support and direct income support in arable farming (Oude Lansink and Peerlings, 1996). It reduced the price support for cereals and abolished the deficiency payments for oilseeds. Instead compensatory acreage payments which act as direct income support were introduced. A further reduction in price support in combination with increased compensatory acreage payments will take place in 2000 and 2001 as a result of the decisions taken on Agenda 2000 (European Union, 1999).

These policy changes may affect the labour allocation of farmers between farm and off-farm activities. It may also encourage farmers to diversify their income sources (Hill, 1996). In a farm household, labour is allocated between farm and off-farm work such that the marginal value of farm labour equals the wage rate of off-farm work (Becker, 1965; Gronau, 1973). Literature in off-farm work also indicates (see Hallberg et al., 1991) that farm households' off-farm work decision is dependent on location, farm and non-farm income, and family and financial characteristics (Lass et al., 1991). It is inversely related to farm income because of a substitution and income effect. Non-labour incomes such as income from assets, social security benefits, and direct income support reduce off-farm employment due to an income effect only. Consequently, a change in government policy due to either a price policy or direct income support (e.g.

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coming from the 1992 and Agenda 2000 CAP reforms) may affect the desire of farm households to participate in off-farm work.

However, in the presence of rationing and transaction costs in the labour market, the marginal value of farm labour and the wage rate of off-farm work may not be equal. In such cases, households cannot execute their desired plan to work off their farm (Deaton and Irish, 1984; Blundell and Meghir, 1987). Hence the potential effect of the CAP reforms on off-farm work may not be fully realised.

Capital and technology employed by a farm household, individual's age and education can have either a negative or positive effect on the desire of farm households to participate in off-farm work as they affect both farm and off-farm employment (Lass et al., 1991). Moreover, the relative importance of these factors may differ across households (Lass et al., 1991). Although well documented for North America (see, for example, Hallberg et al., 1991), literature on off-farm work is scarce for the Netherlands and Europe as a whole. Furthermore, previous studies made on off-farm work (Olfert, 1993; Kimhi, 1994, 1996; Hearn et al., 1996; Kimhi and Lee, 1996; Mishra and Goodwin, 1997; Tavernier et al., 1997; Weersink et al., 1998) do not consider rationing in the off-farm labour market.

The objectives of this study are therefore (1) to investigate the effect of farm and non-labour income on the off-farm work decision and determine the implications of the 1992 and agenda 2000 CAP reforms; (2) to investigate the role of other determinants of off-farm work; and (3) to test if Dutch arable farm households are actually inhibited by rationing and unexpected transaction costs to enter off-farm activities.

Off-farm work participation and off-farm labour income are modelled consistent with a farm household model (Singh et al., 1986; Huffman, 1991). Moreover, this paper uses a double hurdle model (Deaton and Irish, 1984; Blundell and Meghir, 1987) and generalised Tobit model (Amemiya, 1984) in which the participation decision and off-farm labour income are jointly estimated using a maximum likelihood estimator (MLE).

The rest of the paper is organised as follows. In the next section, theory and model specifications are discussed. In Section 3, the data and estimation methods are described. Section 4 discusses the results. Section 5 presents the conclusions.

## 2. Theory and model specification

Off-farm employment of a farm household, using off-farm labour income as a proxy, can be treated as a latent variable, which may be observed when a household has a desire to participate in off-farm work and is able to find a job in the labour market. In an agricultural household model an individual is willing to participate in off-farm work when his reservation wage ($w_{ri}$) is less than the off-farm wage ($w_{mi}$) net of commuting and expected transaction costs.

The participation decision of a household to work outside his farm ($D_i$), can therefore be modelled as follows:

$$D_i = \begin{cases} 1 & \text{if } w_{ri} < w_{mi} \\ 0 & \text{if } w_{ri} \geq w_{mi} \end{cases}$$

$$\Pr(D_i = 1) = \begin{cases} \Pr(w_{ri} \leq w_{mi}) \\ \Pr(L^o(\pi_i(\cdot), w_{mi}, v_i, P_c, a_i) > 0) \\ \Pr(\alpha' X_i) > -u_i; \quad u_i \sim N(0,1) \end{cases} \quad (1)$$

where the probability of a farmer to participate in off-farm labour ($\Pr(\cdot)$) is assumed to depend on $\pi(\cdot)$ (farm profit[1]), $w_{mi}$ (the market wage rate), $v$ (non-labour income), $P_c$ (price of consumption goods), and $a_i$ (household characteristics); $L^o$ is off-farm labour ; $X$ is a column vector of variables that affect the reservation and market wage; $\alpha'$ is a row vector of parameters; $u_i$ is the error term of the participation decision. The latent variable off-farm labour income ($Y^*$) and observed off-farm labour income ($Y$) can be specified as

$$\begin{aligned} Y_i^* &= Y(\pi_i(\cdot), w_{mi}, v_i, P_c, a_i) + e_i \\ &= \beta' X_i + e_i; \quad e_i \sim N(0, \sigma_e^2), \end{aligned} \quad (2)$$

$$Y_i = \begin{cases} Y_i^* & \text{if } D_i = 1 \\ 0 & \text{if } D_i = 0 \Rightarrow Y^* \leq 0 \end{cases}$$

where $\beta'$ is a row vector of parameters; $e_i$ is an error term.

[1] Farm profit is included in both the participation equation (1) and the off-farm labour income equation (2). The implicit assumption that is made here is that both functions are separable in all elements of $\pi(\cdot)$ (i.e. land, labour, capital and netput prices) and $w_{mi}$, $P_c$ and $a_i$. The separability assumption that is made with respect to labour is especially severe, since it is assumed that the marginal rate of substitution of labour with capital and netput prices is independent of the market wage rate.

### 2.1. Independent models

The ordinary Tobit model assumes that the same stochastic process affects both the participation decision and off-farm labour income. A zero realisation for a dependent variable represents a corner solution or a negative value for the underlying latent dependent variable (Cragg, 1971; Lin and Schmidt, 1984). When a Tobit model is derived from the assumption that the error term of the participation equation and the latent variable are correlated, it is called generalised Tobit model (Amemiya, 1984, pp. 29–33).

Even if farm households are willing to participate in off-farm work, however, rationing in the labour market (Deaton and Irish, 1984; Blundell and Meghir, 1987) and unexpected transaction costs such as search costs, information and other costs may inhibit them to participate in off-farm work. In the presence of inhibition to join the off-farm activities, therefore, a double-hurdle model would be more appropriate than an ordinary Tobit model (Cragg, 1971; Blundell and Meghir, 1987, p. 197). The double hurdle model takes into account that individuals have to pass two hurdles to participate in off-farm work: they have to develop the desire to participate in off-farm work and pass the inhibition to join the labour market. If the correlation between the error terms in the participation decision and off-farm labour income is assumed to be zero, then the model is called independent double hurdle model or in short the model of Cragg (1971). In contrast, if the independence assumption for the error terms of the participation decision and off-farm labour income is relaxed, it is called dependent double hurdle model (Deaton and Irish, 1984; Blundell and Meghir, 1987).

Following the lines of Maddala (1983), Amemiya (Amemiya, 1984, p. 9) and Blundell and Meghir (Blundell and Meghir, 1987, p. 181), the log likelihood function of the Tobit model can be written as:

$$\log L = \sum_{0} \log\left(1 - \Phi\left(\frac{\beta' X_i}{\sigma_e}\right)\right) + \sum_{+} \left[-\log \sigma_e + \log \phi\left(\frac{Y_i - \beta' X_i}{\sigma_e}\right)\right] \quad (3)$$

where the subscript 0 indicates summation over observations with zero off-farm labour income, + indicates summation over observations with positive observed off-farm labour income, and $\Phi(\cdot)$ and $\phi(\cdot)$ refer to the standard normal probability and density functions, respectively.

In the independent double hurdle model, the probability that income ($Y$) is zero is the product of probability that the latent variable off-farm labour income ($Y^*$) is negative and the probability that $Y^*$ is positive. In this case, there is an inhibition to carry out the desire to join the labour market. Consequently, the log likelihood function for the independent double hurdle model is given by Blundell and Meghir (Blundell and Meghir, 1987, p. 186):

$$\log L = \sum_{0} \log\left[1 - \Phi\left(\frac{\beta' X_i}{\sigma_e}\right)\Phi(\alpha' X_i)\right] + \sum_{+} \left[-\log \sigma_e + \log \phi\left(\frac{Y_i - \beta' X_i}{\sigma_e}\right) + \log \Phi(\alpha' X_i)\right]. \quad (4)$$

When $\Phi(\alpha' X_i)$ equals one, the independent double hurdle model reduces to a standard Tobit model. Since the Tobit model is nested into the independent double hurdle model (Lin and Schmidt, 1984), a likelihood ratio test can be used (Greene, 1993, p. 701) to empirically test if farm households are actually inhibited to enter in the off-farm activities.

### 2.2. Dependent models

Relaxing the independence assumption, the two error terms ($u_i$ and $e_i$) are assumed to be joint normal with variance–covariance matrix:

$$\sum = \sigma_e \begin{pmatrix} \sigma_e & \rho \\ \rho & 1/\sigma_e \end{pmatrix}. \quad (5)$$

Then Eqs. (1) and (2) can be written as (Amemiya, 1984, pp. 31–32; Blundell and Meghir, 1987, p. 187), respectively:

$$Y_i^* = \beta' X_i + \rho \sigma_e u_i + e_i^*,$$
$$\Pr(D_i = 1) = \Pr(\alpha' X_i + u_i > 0). \quad (6)$$

It follows that the log likelihood of the generalised Tobit can be rewritten as:

$$\log L = \sum_{0} \log\left[1 - \Phi(\alpha X_i)\right] + \sum_{+} \left[-\log \sigma_e + \log \phi\left(\frac{Y_i^* - \beta' X_i}{\sigma_e}\right) + \log \Phi\left(\alpha' X_i + \frac{\rho}{\sigma_e}\frac{Y_i^* - \beta' X_i}{\sqrt{1-\rho^2}}\right)\right]. \quad (7)$$

When $\rho$ is zero, it reduces to a standard Tobit model. Whereas, the log likelihood of the dependent double hurdle model can be rewritten as:

$$\log L = \sum_{0} \log\left[1 - \Phi(\alpha X_i, \rho)\Phi\left(\frac{\beta' X_i}{\sigma_e, \rho}\right)\right] + \sum_{+} \left[-\log \sigma_e + \log \phi\left(\frac{Y_i^* - \beta' X_i}{\sigma_e}\right) + \log \Phi\left(\alpha' X_i + \frac{\rho}{\sigma_e}\frac{Y_i^* - \beta' X_i}{\sqrt{1-\rho^2}}\right)\right]. \quad (8)$$

When $\rho$ is zero, it reduces to the model of Cragg (1971), if $\Phi(\alpha' X)$ is one it reduces to a generalised Tobit model (Amemiya, 1984), whereas, if $\rho$ is zero and $\Phi(\alpha' X)$ equals one, it reduces to a standard Tobit model.

Explanatory variables ($X$'s) were chosen to be expected short-run farm profit, on-farm labour supplied by the head of the household and other family members, land, capital, time, non-labour income such as such as income from assets, social security benefits; household characteristics such as age, education dummies, and family size, macroeconomics conditions such as the consumer price index and average market wage rates. All variables except expected short-run farm profit are assumed to be exogenous. These variables affect both the reservation wage rate and the market wage rate, and can be derived from an agricultural household model (Huffman, 1991).

Expected short-run farm profit has been derived from a normalised quadratic profit function conditional on fixed inputs. It was assumed that output prices were not known at the time decisions were made on planting. Hence, expected rather than realised prices were used. Expected output prices were constructed by applying an AR(1) filter to the price of output. To impose linear homogeneity the profit function is normalised by the price of output (Thijssen, 1992, p. 31). The normalised quadratic short-run profit function has been specified as

$$\pi = a_0 + a_1 P + \sum_{i=2}^{6} a_i Z_i + \frac{1}{2} a_{11} P^2 + \sum_{i=2}^{6} a_{1i} P Z_i + \frac{1}{2}\sum_{i=2}^{6}\sum_{j=2}^{6} a_{ij} Z_i Z_j + a_w W + \varepsilon \quad (9)$$

where $a_{ij} = a_{ji}$; $Z_i$ $(i = 2, \ldots, 6)$ are fixed inputs where $i = 2$ is household head's labour (LF), $i = 3$ is other family members' labour (LO), $i = 4$ is land ($G$), $i = 5$ is capital ($K$), $i = 6$ is technology ($T$) represented by a time trend (1971 = 1), and $P$ is normalised price of variable inputs, $W$ is a weather index (Oskam, 1991) and $\varepsilon$ is an error term which is assumed to be normally distributed.

## 3. Data and estimation

Data on specialised arable farms, covering the period 1971/72–1992/93, come from a stratified sample of farms keeping accounts on behalf of the LEI-DLO farm accounting system[2]. In total 912 individual farms forming an unbalanced panel of 4110 observation were used for the analysis. Summary statistics of the data used are given in Table 1. A more detailed description of the sample used in this study can be found in LEI-DLO (1992).

Family labour constitutes 88% of total labour used on the farm, whereas hired labour makes up for the remaining 12%. 37% of the observations reported no use of hired labour at all. Out of the sample, 47% of the farms have positive off-farm labour income. Furthermore, out of the 4110 observations, 65% of them have medium and higher level agricultural education, 22% of them have lower level agricultural education and 2.7% of them have general education.

Expected short-run farm profit was determined as the expected price of output times output quantity minus the value of variable inputs. There is one output (composed of cereals, sugar beet, potatoes and other outputs) and one variable input (fertiliser, seeds, pesticides, hired labour and other variable inputs). Tornqvist price indices (at 1980/81 prices) were calculated

[2] The willingness of the Agricultural Economics Research Institute to make the data available for this research is gratefully acknowledged.

Table 1
Short description of the data

| | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|
| Output[a] | 290.383 | 216.664 | 26.253 | 2249.924 |
| Variable input[a] | 103.6325 | 60.629 | 10.418 | 510.401 |
| Household head's labour supply[b] | 22.69 | 8.081 | 0.100 | 81.547 |
| Other family members labour supply[b] | 4.885 | 8.649 | 0.000 | 75.100 |
| Capital[c] | 0.242 | 0.174 | 0.0024 | 1.373 |
| Land (1000 ares) | 4.569 | 2.657 | 0.700 | 22.519 |
| Off-farm labour Income[a] | 3.884 | 11.249 | 0.000 | 134.444 |
| Family size | 3.970 | 1.459 | 0.200 | 11.000 |
| Non-labour income[a] | 12.0695 | 16.573 | −82.569 | 291.674 |
| Short term profit (maximised)[a] | 174.380 | 148.128 | −18.283 | 1651.742 |
| Output price | 0.93 | 0.60 | 1.44 | 0.17 |
| Input price | 1.01 | 0.47 | 1.26 | 0.22 |
| Market wage rate | 0.99 | 0.89 | 1.08 | 0.05 |

[a] In 1000 guilders of 1980 prices; SD refers to standard deviation.
[b] In 1000 h per year. Short term profit is computed from the estimated short-run profit function.
[c] In million guilders of 1980 prices.

for the compound variables (i.e. output and variable inputs). Price indices vary over the years but not over the farms, implying that the difference in the composition of the output/input or quality differences are reflected in the quantity. Implicit input and output quantity indices were obtained as the ratio of value and the price indices. Therefore, quantities are measured at constant 1980/81 prices. The market wage rate is the wage rate of hired labour in arable farming and is obtained from the LEI-DLO. Household budgets are calculated using the sum of estimated farm profits and non-labour income data from the LEI-DLO. All prices and profit were normalised by the expected price of output.

Labour is measured in hours worked on the farm and is reported by the farmers in the LEI-DLO accounting system; capital represents capital invested in machinery and livestock and is measured at 1980/81 prices; land represents the cultivated area on the farm and is measured in ares. Other variables included in the profit function are a weather index to correct for weather influences and a time trend to account for technological change.

The expected short-run farm profit function is estimated using a random effects estimator after an OLS estimator was rejected (see also Greene, 1993, pp. 479–480). A random effect estimator was also used for the Tobit model of the off-farm labour income. The panel data nature of the data used was not accounted for in the estimation of the double hurdle model and the generalised Tobit model of off-farm work participation and off-farm labour income; these were estimated using MLE.

## 4. Results

Parameter estimates of the profit function can be found in Table 2. The estimated profit function (9) fits the data well with an adjusted $R^2$ of 0.70. Furthermore, the profit function is monotonically increasing with respect to the fixed inputs (labour, capital, land and technology), decreasing and convex in the normalised price of variable inputs.

First, a Tobit model (3) and Cragg model (4) were estimated in order to test for inhibitions to participate in off-farm activities (Table 3). The Tobit model is rejected significantly[3] implying that farm households are inhibited to execute their desired plan to participate in off-farm activities. The computation of the dependent double hurdle model (8) was, however, found to be onerous and full convergence was not

[3] The likelihood-ratio test statistics was computed as $\chi^2 = 2(\ln L_{TR} + \ln L_P - \ln L_T) = 2(5969.83 + 2696.71 - 9502.53) = 835.99$, where $\ln L_R$, $\ln L_P$, and $\ln L_T$ stand for the log likelihood of the truncated regression model, Probit model and Tobit model, respectively.

Table 2
Estimate of the normalised profit function[a]

| Explanatory variables | Parameter (standard errors) | Explanatory variables | Parameter (standard error) |
|---|---|---|---|
| Constant | −192.81 (2.236) | LF × $G$ | 0.0113 (0.007)$^{NS}$ |
| $P$ | −124.35 (12.778) | LF × $K$ | −0.0459 (0.115)$^{NS}$ |
| LF | 2.748 (0.201) | LF × TO | 0.0042 (0.005)$^{NS}$ |
| LO | 0.820 (0.180) | LO × LO | 0.00047 (0.002)$^{NS}$ |
| $G$ | 36.378 (0.862) | LO × $G$ | 0.00511 (0.007)$^{NS}$ |
| $K$ | 440.59 (13.820) | LO × $K$ | −0.109 (0.116)$^{NS}$ |
| $T$ | 8.424 (0.460) | LO × T | −0.635 (0.0042)$^{NS}$ |
| $P \times P$ | 94.034 (11.964) | $G \times G$ | −0.028 (0.035)$^{NS}$ |
| $P \times$ LF | −0.453 (0.122) | $G \times K$ | 1.059 (0.508) |
| $P \times$ LO | −0.128 (0.100)$^{NS}$ | $G \times T$ | 0.051 (0.020) |
| $P \times G$ | −15.352 (0.521) | $K \times K$ | −11.767 (9.537)$^{NS}$ |
| $P \times K$ | −84.26 (8.307) | $K \times T$ | −0.039 (0.328)$^{NS}$ |
| $P \times T$ | −2.114 (0.420) | $T \times T$ | 0.066 (0.020) |
| LF × LF | 0.00013 (0.002)$^{NS}$ | $W$ | 135.29 (20.675) |
| LF × LO | −0.371 (0.002) | Adjusted $R^2$ | 0.70 |

[a] $P$ is the ratio of input to output price; LF is on-farm labour supplied by the household head; LO is on-farm labour supplied by other family members; $G$ is land in ares; $K$ is capital; $T$ is technology represented by time trend; $W$ is Weather index; NS means not significant at 5% level; $\rho = 0.74$.

Table 3
Parameter estimates of the probability of participation in off-farm work (POFW) and the level of off-farm labour income (OFLI)[a]

| Explanatory variables | Tobit model | Generalised Tobit model | | Independent double hurdle model | |
|---|---|---|---|---|---|
| | | POFW | OFLI | POFW | OFLI |
| Constant | −59.9 (9.2) | −5.629 (0.589) | 32.04 (74.66) | −5.625 (0.587) | 0.91 (61.87) |
| log expected farm profit | −3.13 (0.66) | −0.141 (0.044) | −2.28 (1.80) | −0.141 (0.042) | −17.91 (3.45) |
| log non-labour income | 0.266 (0.25)$^{NS}$ | −0.010 (0.016)$^{NS}$ | 0.34 (0.31)$^{NS}$ | −0.010 (0.016)$^{NS}$ | 0.38 (1.73)$^{NS}$ |
| Family size | 0.87 (0.24) | 0.061 (0.015) | −0.059 (0.67)$^{NS}$ | 0.061 (0.015) | −0.40 (1.67)$^{NS}$ |
| Medium and higher agricultural education | 1.8 (1.3)$^{NS}$ | | −1.49 (1.98)$^{NS}$ | | −12.42 (9.78)$^{NS}$ |
| Lower agricultural education | 1.0 (1.3)$^{NS}$ | | −1.01 (2.16)$^{NS}$ | | −9.90 (10.26)$^{NS}$ |
| General education | 5.1 (2.2) | 0.299 (0.126) | −0.41 (4.74)$^{NS}$ | 0.299 (0.123) | −0.92 (15.12)$^{NS}$ |
| Age | 0.97 (0.26) | 0.091 (0.017) | −0.48 (1.07)$^{NS}$ | 0.092 (0.015) | −2.90 (1.95)$^{NS}$ |
| Age square | 0.024 (0.005) | −0.001 (0.0005) | 0.008 (0.024)$^{NS}$ | −0.002 (0.0003) | 0.053 (0.041)$^{NS}$ |
| log LF | −6.07 (0.73) | −0.232 (0.050) | −5.04 (2.42) | −0.233 (0.049) | −28.37 (3.29) |
| log LO | −0.22 (0.28)$^{NS}$ | 0.029 (0.024)$^{NS}$ | −0.57 (0.36)$^{NS}$ | 0.029 (0.025)$^{NS}$ | −0.58 (1.84)$^{NS}$ |
| log land | 5.84 (0.99) | 0.50 (0.063) | 0.14 (5.40)$^{NS}$ | 0.50 (0.063) | 0.57 (6.41)$^{NS}$ |
| log capital | 1.52 (0.81) | 0.073 (0.051)$^{NS}$ | 1.6 (1.2)$^{NS}$ | 0.073 (0.052)$^{NS}$ | 12.69 (5.0) |
| Time | 0.63 (0.30) | 0.006 (0.019)$^{NS}$ | 9.28 (3.97) | 0.006 (0.019)$^{NS}$ | 3.99 (1.51) |
| Consumer price index | 3.11 (2.33) | −0.057 (0.019)$^{NS}$ | 6.0 (3.1)$^{NS}$ | −0.066 (0.015)$^{NS}$ | 56.9 (16.8) |
| Average market wage rate | −1.11 (2.33)$^{NS}$ | 0.014 (0.014)$^{NS}$ | −4.78 (3.7)$^{NS}$ | 0.014 (0.015)$^{NS}$ | −12.06 (10.99)$^{NS}$ |
| Family participation in farm work | | −0.077 (0.057)$^{NS}$ | | −0.075 (0.057)$^{NS}$ | |
| $\sigma_e$ | 17.51 (0.30) | 14.45 (0.86) | 14.45 (0.86) | | |
| $\rho$ | | | | 0.081 (1.13)$^{NS}$ | |
| log likelihood | −9502.53 | −10622.75 | −10622.75 | (−2696.71) + (−5969.83) = −8666.54 | |

[a] NS means not significantly different from zero at 5% level. LF is on-farm labour supplied by the household head; LO is on-farm labour supply by other family members.

Table 4
Quasi-elasticity of the probability off-farm work participation and elasticity of off-farm labour income[a]

| Explanatory variables | Effect on profit | Off-farm work participation | | | Off-farm labour income | | |
|---|---|---|---|---|---|---|---|
| | | Direct effect | Indirect effect[b] | Total effect | Direct effect | Indirect effect | Total effect |
| Expected farm profit[c] | | −0.06 | | −0.061 | −0.97 | | −0.97 |
| Output price | 1.02 | | −0.061 | −0.061 | | −0.99 | −0.99 |
| Non-labour income | | $0.004^{NS}$ | | $0.004^{NS}$ | $0.020^{NS}$ | | $0.020^{NS}$ |
| Family size | | 0.100 | | 0.10 | $0.090^{NS}$ | | $0.090^{NS}$ |
| Medium and higher agricultural education | | | | | $-0.470^{NS}$ | | $-0.47^{NS}$ |
| Lower agricultural education | | | | | $-0.110^{NS}$ | | $-0.11^{NS}$ |
| General education | | 0.003 | | 0.003 | $-0.022^{NS}$ | | $-0.002^{NS}$ |
| On-farm labour supplied by household head | 0.300 | −0.090 | −0.020 | −0.11 | −1.550 | −0.290 | −1.840 |
| On-farm labour supplied by other family members | 0.014 | $0.010^{NS}$ | −0.001 | −0.01 | $-0.030^{NS}$ | −0.013 | −0.043 |
| Land | 0.550 | 0.200 | −0.030 | 0.17 | $0.030^{NS}$ | −0.530 | −0.500 |
| Capital | 0.490 | $0.030^{NS}$ | −0.030 | 0.00 | 0.700 | −0.480 | 0.220 |
| Time | 0.510 | $0.030^{NS}$ | −0.030 | 0.00 | 2.830 | −0.500 | 2.330 |
| Average market wage rate | | $0.120^{NS}$ | | $0.120^{NS}$ | $-1.450^{NS}$ | | $-1.450^{NS}$ |
| Consumer price index | | $-0.030^{NS}$ | | $-0.030^{NS}$ | 3.600 | | 3.600 |

[a] NS indicates insignificantly different from zero at 5% level for the estimated coefficients.
[b] The indirect effect comes through the effect on the expected short-run farm profit.
[c] When the output price increases by 1%, short-run expected farm profits increase by 1.02%.

possible to achieve (Results of the dependent double hurdle model are not given in this paper). Next, the generalised Tobit model (7) was estimated. The correlation coefficient ($\rho$) is not significantly different from zero indicating that it is not worthwhile to use the parameter estimates of the generalised Tobit model for further analysis. Hence, the results of the independent double hurdle model have been used for further analysis and interpretations. The results are summarised in terms of *quasi-elasticities*[4] (Cramer, 1991, p. 8) for the probability of participating in off-farm work and *elasticities* for the off-farm labour income (Table 4).

Expected short-run farm profit has a significant negative impact on both the participation decision and the level of off-farm labour income, but with stronger impact on the level of off-farm labour income than on the desire to participate. Non-labour income did not show any significant effect on both the participation decision and off-farm labour income. An increase in the output price by 1% increases expected short-run farm profit by 1.02% and the desire to participate in off-farm work decreases by 0.06%, and decreases the off-farm labour income by 0.99% on the average. Hence the 1992 and Agenda 2000 CAP reforms which decrease price support are most likely to increase off-farm employment of farm households.

Family size, general education and age of the household head have a significant effect on the participation decision, but an insignificant effect on the level of off-farm labour income. Family size increases the households' desire to participate in off-farm work, which is consistent with the theory. Households with a larger family size have relatively higher marginal utility of income and a stronger desire to participate in off-farm work. General education of the household head has a little but positive significant effect on the participation decision (Huffman, 1980). Agricultural education does not show any significant effect on the off-farm work decision at all. Age and age squared of the household head show a significant quadratic age pattern on the participation decision which is consistent with the life-cycle hypothesis (Sumner, 1982). On the average, the desire of households to participate in off-farm work reaches its peak at the household head's age

[4] We use quasi-elasticity for the participation decision since for a probability response quasi-elasticity is unit free.

of 41 years. This implies the prevalence of dual employment among young farmers and full time farming among older farmers (Benjamin and Guyomard, 1994). However, neither age nor age squared showed any significant effect on the level of off-farm labour income.

When the on-farm labour supply of the household head increases, both the desire to participate in off-farm work and the off-farm labour income decrease. The direct effect of other family members' on-farm labour supply is not significantly different from zero in both the participation decision and the level of off-farm labour income, but it has a little effect indirectly through its effect on expected short-run farm profit.

Farm characteristics such as land, capital and technology have a negative indirect impact on both the off-farm work participation decision and the level of off-farm labour income. Whereas the direct effects of capital and technology are positive for off-farm labour income, they are not significantly different from zero for the participation decision. Consequently capital and technology have a net negative effect on the participation decision and a net positive effect on the level of off-farm labour income. Land has a significant positive direct effect and negative indirect effect on the desire to participate in off-farm work. The direct effect dominates the indirect effect and the net effect turns out to be positive. But its direct effect on the level of off-farm labour income is not significant and the net effect turns out to be negative. The positive net effect of capital and technology on the level of off-farm labour income may be due to the fact that capital and technology employed by households have a labour saving character. The net positive effect of land on the off-farm work participation decision is a strange result, which cannot be explained within the framework of a neo-classical economic theory.

The consumer price index normalised by the price of output shows a large and significant positive effect on the level of off-farm labour income and a negative but insignificant effect on the off-farm work participation decision. This illustrates that as the consumption price increases the marginal utility of leisure decreases and the intensity of off-farm work increases. The average market wage rate, which is invariant across households, does not show any significant effect on the off-farm work decision.

## 5. Conclusions

The results confirm that farm households are inhibited by rationing and unexpected transaction costs to participate in off-farm activities. Expected short-run farm profit and on-farm labour supplied by a household head have a strong negative impact on the off-farm work decision of a household. Whereas, non-labour income, on-farm labour supplied by other family members and agricultural education do not show any significant impact on the off-farm work decision. Family size and general education show a positive effect on the desire of households to participate in off-farm work, but not on the level of off-farm labour income. Age of the household head shows a significant quadratic pattern in the participation decision only.

The policy implication is that government subsidies aimed at increasing household's income through price policies may have a negative impact on the off-farm employment of farm households. Whereas, direct income support does not create a disincentive for households to participate in off-farm work. Hence, the 1992 and Agenda 2000 CAP reforms, decreased price support in combination with direct income support, are most likely to increase off-farm employment of arable farm households in the Netherlands. However, in the presence of the inhibition to join off-farm activities, the potential impact of the CAP-reforms cannot be fully realised. The results also imply that there is an alternative policy option for government intervention if there is a need to make households diversify the ways in which they gain their livelihood. In the long run, the government can pursue policies such as promoting education to enable farm households to secure off-farm jobs more easily. In the short-run, off-farm employment can be increased by reducing inhibitions, such as farm households' access to various information sources, to join off-farm activities.

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