Farmers' Exit Decisions and Early Retirement Programs in Finland

Kyosti Pietola
e-mail: kyosti.pietola@mtt.fi

Minna Vare

Alfons Oude Lansink

Paper prepared for presentation at the Xth EAAE Congress
'Exploring Diversity in the European Agri-Food System',
Zaragoza (Spain), 28-31 August 2002

Farmers' exit decisions and early retirement programs in Finland

Kyösti Pietola*,
Minna Väre* and
Alfons Oude Lansink**

* Agrifood Research Finland (MTT), Economic Research, Helsinki
** Wageningen University, Farm Management Group, Wageningen

Submission for a contributed paper at the EAAE 10th Congress in Zaragoza 2002

Contact person:
Kyösti Pietola
Agrifood Research Finland (MTT), Economic Research
P.O. BOX 3, 00411 HELSINKI, FINLAND
phone: +358-9-50447300
fax: +358-9-5631164
e-mail: kyosti.pietola@mtt.fi

Farmers' exit decisions and early retirement programs in Finland

Abstract: This paper estimates farmer decisions between three discrete occupational choices: exit and close down the farming operation (1), exit and transfer the farm to a new entrant (2), or continue farming and retain the option to exit later on (3). The farmer optimisation problem is formulated as a recursive optimal stopping problem. The unknown parameters are first estimated by a switching-type, reduced form Probit models and, then by the Simulated maximum likelihood (SML) method, controlling for serial correlation in the errors. Serial correlation in the errors is controlled for by the Geweke-Hajivassiliou-Keane (GHK) simulation technique. The results suggest that the timing and the type of farmer exit decisions respond elastically to farmer characteristics, farm characteristics, and economic environment. Early retirement programs and the level of farmer retirement benefits are predicted to play a key role in steering structural development and enhancing family farms in the Nordic agricultural sectors.

Keywords: exit, entry, dynamic programming, switching-type Probit, Simulated Maximum Likelihood

1. Introduction

The agricultural sector is undergoing fast structural development in most European countries. Particularly in Finland, the need for structural change has been obvious since Finland's entry into the EU. At the time of EU entry, Finnish agriculture was characterised by high production costs and by an average farm size that was too small to efficiently utilise modern technologies so as to be competitive in the European Common Market. To get a more competitive agricultural sector, a large number of public policy programs have been designed and applied to Finnish agriculture. Among the policy programs, the temporarily applied and subsidised short-term early retirement programs have played an important role. As a result, the average farm size has been increasing and the number of farms has decreased at an annual rate of five per cent. The number of farms in 1995 was 95,562 and in 2000 it had decreased to 77,896.

The farmers' early retirement programs have two main goals. First, they aim at enhancing the transfer of farms from ageing farmers to new entrants, *e.g.* from parents to their children. This is an important goal to contribute preserving the agricultural structure based on family farms also in the future and to maintaining sufficiently large population in rural areas. The second goal of the early retirement programs is to improve competitiveness in the agricultural sector by transferring resources, such as land and production rights, from exiting farmers to the farmers who will continue in farming and are motivated to get more competitive through expansion of their farm operations. Thus, the timing and the type of occupational choices among elderly farmers play a crucial role in determining the characteristics of the structural change in agriculture. By elderly farmers, we mean farmers that are sufficiently old to have the option to voluntarily exit from farming using a certain pension benefit scheme. Exit from farming implies either closing down the farm operation or transferring the farm to a new entrant. When the farm operation is ceased, the farm's agricultural resources, such as land and production rights, are sold or leased to neighbouring farmers. In previous retirement programs, the farmer also had an option to leave his/her land idle or plant trees on it but these options are not preferred in more recent programs.

Important research and policy questions that emerge then are: What are the factors that determine the timing and the type of exit from farming among elderly farmers, and how do public policies, such as early retirement programs foster these choices. These questions are particularly relevant at present because the farming population is ageing. The large so called "baby-boom generation", born in the late 40's and in the early 50's, is by now approaching an age in which it has the option to retire. The early retirement programs for farmers are also frequently under intensive political debate, because the current short term programs are funded by society and they are costly. Uncertainty over the continuation of the early retirement programs is also a problem for farmers. Uncertainty may significantly increase costs for a young farmer to purchase an insurance scheme that will provide a secure and flexible retirement plan. An indication of this is that the demand for market based early retirement insurance has been increasing rapidly during the last few years. About 30 per cent of farmers already operate in two insurance markets. They buy the obligatory retirement plan in the farmer retirement program and complement it by the market based early retirement plan. Thus, new information is needed in designing programs that have the desired long term effects on farmer exit behaviour, funding of retirement plans, and structural development in agriculture and rural areas.

This paper estimates factors determining farmer decisions between three discrete occupational choices: exit and closing down the farm (1), exit and transfer of the farm to a new entrant (2), or continuing farming and retaining the option to exit later (3). This optimal stopping problem has a recursive structure and, over the continuation period (*i.e.* when farmer continues to farm), it satisfies a certain Bellman's equation. The unknown parameters are estimated by three specifications of a switching-type, reduced form Probit model. The first specification is the standard equation-by-equation Probit model that assumes independently distributed errors with no serial correlation in both equations. The second specification allows the errors to be correlated between equations and is estimated by the multinomial Probit model. The third specification controls for first order serial correlation in the errors by using Geweke-Hajivassiliou-Keane (GHK) -simulation technique (McFadden, 1989; Pakes and Pollard, 1989; Keane, 1993). In the third specification, the unknown parameters are estimated by the Simulated Maximum Likelihood (SML) method.

The results provide insights in how the agricultural market and policy environment, short-term early retirement programs and farmer characteristics affect the timing and the type of exit decisions among elderly farmers. These results provide valuable information for designing policies that aim at improving structural development in the agricultural sector.

2. The ModelThe ModelThe Model

In the general form, farmer decisions are denoted by a binary indicator d_k for k=1,…,3 such that $d_k=1$ if the occupation k with current period indirect utility U_k is chosen and $d_k=0$ otherwise. Value $k=1$ refers to exit and closing down the farm operation; value $k=2$ refers to the exit and transferring the farm to a new entrant, while value $k=3$ refers to the continuation in farming while retaining the option to exit later on. Because the choices are mutually exclusive, the identity $d_1+d_2+d_3=1$ holds between the indicators.

Current period indirect utilities from the two types of retirements (U_1 and U_2) consist of the utility from pension benefits, on-farm housing benefits, leisure etc. Utility is allowed to differ between the two exit types for two reasons. First, closing down the farming operation may, in practice, make a significant contribution to the utility of the retiring farmer compared to the utility from transferring the farm to a new entrant. Second these two exit types have diverse contributions to structural development in agriculture and they can be separated to have different terms in the early retirement programs. Current indirect utility from farming and farm income (U_3) is a function of current prices, subsidies, fixed inputs, farm characteristics, farmer characteristics, and other return shifters.

In the continuation region, the optimal value function, *V,* for this decision problem then solves[1]

$$V(Z(t),t) = \max_{d_k(t)} E\left[\sum_{\tau=t}^{T} \beta^{\tau-t} \sum_{k=1}^{3} U_k(\tau) d_k(\tau) \middle| Z(t)\right] \tag{1}$$

where $\beta>0$ is the discount factor, $E(\cdot)$ is the mathematical expectations operator, and $Z(t)$ is the predetermined state space at time *t*. The state space consists of all factors, known to the firm operator which affect the current period utility (*e.g.* prices, subsidy rates, the level of pension). Equation (1) is maximised choosing the optimal sequence of control variables ($d_k(t)$) over the finite horizon of $t=0,..,T$.

The optimal value function can be rewritten as (Keane and Wolpin, 1994):

$$V(Z(t),t) = \max_{d_k(t)} \{V_k(Z(t),t)\} \tag{2}$$

where $V_k(Z(t),t)$ is the occupation *k* specific value function that satisfies the Bellman equation of the form (Bellman, 1957):

$$V_k(Z(t),t) = U_k(Z(t),t) + \beta E\left[V(Z(t+1),t+1) \middle| Z(t), d_k(t) = 1\right],\ t \le T-1 \tag{3}$$

subject to a certain set of transition equations for the current state $Z(t)$. Note that our notation generalises for the case in which the optimal value function, conditional on exit, is the standard discounted present value, as in Lumsdaine *et al*. (1992)

Augmenting V_{kt} by an error term v_{kt} , occupation *k* is chosen and $d_k(t)=1$ if

$$V_{kt} + v_{kt} > V_{jt} + v_{jt}, \quad \forall j \neq k \tag{4}$$

which implies

$$v_{kt} - v_{jt} > V_{jt} - V_{kt}, \quad \forall j \neq k \tag{5}$$

Thus, the boundaries for choices are determined by the differences between the occupation specific value functions and by the differences of the corresponding errors.

The structural form estimation of (2), (3) and (5) would require a solution for the occupation specific value functions by, for example, numerically iterating on the Bellman equation (3) conditional on some functional specification for the one period indirect utility $U_k(\beta)$ and trial

1 Only the continuation region is considered because the decision to exit is at least partially irreversible.

values for the parameters β. The parameter values could then be updated estimating the behavioural equations given by (5) (*e.g.* Rust 1987). The structural form estimation requires numerical simulation of the expected values for the next period's optimal value functions, *i.e.* for expected maximum for the future revenue streams that are stochastic and dependent on the occupational choices (*e.g.* Keane and Wolpin 1994).

A computationally less demanding approach is to normalise the boundaries of the error distributions by the value of one occupation and approximate only the differences of the occupation specific value functions by a reduced form representation (*e.g.* Dorfman, 1996). Because the choices are based on the differences of the occupation specific indirect utility streams (not on the level of each utility stream) the reduced form is empirically tractable. Approximation errors between the structural optimal stopping model and the reduced form models are found negligible (Provencher, 1997). A reduced form specification has also been the standard in the earlier studies on discrete choices (*e.g.* Green *et al.*, 1996). Since the current period returns of farming are unobserved in the data available in this study, the structural form estimation in a way similar to, e.g. Pietola and Oude Lansink (2001) is not feasible.

In our application, the differences in the value functions are approximated so that at time *t*, firm *i* chooses $d_k^i(t) = 1$ if

$$\varepsilon_{kj,t}^i > X_t^i \beta_{kj}, \forall j \neq k \,. \tag{6}$$

where, $\varepsilon_{kj,t}^i = v_{kt}^i - v_{jt}^i$, $X \in Z$ is a vector of instruments, and β is a vector of parameters. Similarly, $d_k^i(t) = 0$ is chosen if $\varepsilon_{kj,t} < X_t \beta_{kj}$ at least for one $j \neq k$.

The reduced form parameters in β are first estimated by the equation-by-equation Probit and multinomial Probit models. In these estimations, serial correlation of the period-by-period choices are not controlled for. Serial correlation can, nevertheless, be significant since farmer choices are expected to persist over time. Serial correlation may also arise if the next period choices are affected by past shocks (Pakes, 1986). Following Eckstein and Wolpin (1989), this paper controls for serial correlation by simulating the sequence of interrelated choice probabilities using the GHK-simulation technique. The parameters are then estimated by Simulated Maximum Likelihood (SML) (McFadden, 1989; Pakes and Pollard, 1989; Keane, 1993).

For given *k* and *j*, the two boundaries (inequalities) are stacked in (Keane, 1993)

$$(2d_{k,t}^i - 1)\varepsilon_{kj,t}^i > (1 - 2d_{k,t}^i) X_t^i \beta_{kj} \tag{7}$$

Dropping the *kj* subscripts, the sequence of errors $\varepsilon^i = \{\varepsilon_1^i, \varepsilon_2^i, ..., \varepsilon_T^i\}'$ can be further stacked over time $t=1,2...,T$, as $\varepsilon^i = A\eta^i$, where $\eta^i = \{\eta_1^i, \eta_2^i, ..., \eta_T^i\}'$ with $\eta_t^i \sim N(0,1)$. Matrix *A* is a lower-triangular matrix of the Cholesky decomposition of the covariance matrix Σ so that $\Sigma = AA' = E[\varepsilon^i \varepsilon^{i\,\prime}]$. Using these definitions, (7) can be written in its general form as (Keane, 1993):

$$(2d_t^i - 1)\eta_t^i > [(1 - 2d_t^i) X_t^i \beta \; - (2d_t^i - 1)(A_{t,1}\eta_1^i + ... + A_{t,t-1}\eta_{t-1}^i)] / A_{t,t} \tag{8}$$

The GHK simulation technique is to first sequentially draw the errors $\eta_1^i, \eta_2^i, ... \eta_t^i$ from a truncated univariate normal distribution so that they are consistent with the observed choices, *i.e.*, the inequality (8) given above holds for each draw. The simulation is started at time *t=1* by drawing η_1^i (with other η^i's being zero) for each farm *i*, so that the draw is consistent with the observed choice, *i.e.* the draw satisfies the inequality

$$(2d_1^i - 1)\eta_1^i > (1 - 2d_1^i) X_1^i \beta$$

If we observe $d_1^i = 1$ the truncation point consistent with the observed choice is $\eta_1^i > - X_1^i \beta$. Alternatively, if $d_1^i = 0$ the consistent truncation point is $-\eta_1^i > X_1^i \beta$

Next, the truncation point is updated by substituting the first draw, say $\hat{\eta}_1^i$, for η_1^i in (8). The second error η_2^i is drawn using the updated truncation point

$$(2d_2^i - 1)\eta_2^i > [(1 - 2d_2^i) X_2^i \beta \ - (2d_2^i - 1)(A_{1,1}\hat{\eta}_1^i)] / A_{1,1}$$

and substituting this new draw $\hat{\eta}_2^i$, for η_2^i in (8). This procedure is continued until *t=T*. The sequence of these *T* draws is repeated *S* times for each firm *i*.

The second step is to form the corresponding unbiased simulators for the transition probabilities. Because the computation of these transition probabilities follows a well-established procedure and the derivation of these transition probabilities is lengthy, it is omitted here. A detailed description and discussion on computing the transition probabilities is found in Keane (1993, *pp*. 550-554).

Our application has three choice alternatives. Because the choices are mutually exclusive, two binary indicators are sufficient in identifying them. These two binary indicators are defined as follows.

$d_1(t) = 1$, if farmer exits and closes down the farm operation
0, otherwise
$d_2(t) = 1$, if farmer exits and transfers the farm to a new entrant
0, otherwise

The third choice of continuing in farming is observed if $d_1(t)+d_2(t)=0$.

The log likelihood function, l_t^i, for a single observation has the form

$$\begin{aligned} l_t^i(\beta) &= d_{t,1}^i(\ln P(d_{t,1}^i = 1 \mid J_{t-1}^i, X_t^i, \hat{\beta}) + \ln P(d_{t,2}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta})) \\ &+ d_{t,2}^i(\ln P(d_{t,1}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta}) + \ln P(d_{t,2}^i = 1 \mid J_{t-1}^i, X_t^i, \hat{\beta})) \\ &+ (1 - d_{t,1}^i - d_{t,2}^i)(\ln P(d_{t,1}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta}) + \ln P(d_{t,2}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta})) \end{aligned} \qquad (9)$$

where $P(\cdot)$ are the simulated probabilities, conditional on choices made before time *t* (J_{t-1}), a set of exogenous instruments (X_t), and trial parameters ($\hat{\beta}$). The GHK simulator was based on 20 draws for the error sequence of each firm (*i.e.*, *S*=20). This number of draws has been found to result only in a negligible simulation bias even when the simulated choice probabilities are small (Börsch-Supan and Hajivassiliou, 1993).

The lower-triangular matrices, consisting of the elements that are used in multiplying the simulated error sequences (η*'s*) in the choice equations (for $d_1(t)$ and $d_2(t)$), are denoted by A_1

and A_2. In order to decrease the parameter space and identify the parameters in the model, a set of restrictions was imposed on the elements of A_1 and A_2. All diagonal elements in both *A's* was set equal to one implying that $\Sigma_1[i,i]= \Sigma_2 [j,j]=1$ for all i and j . This restriction corresponds to the standard identification of Probit model so that the variance of the error term is set to one. The elements that are immediately below the diagonal are allowed to be non-zero and equal to each other within A's (i.e. they are allowed to differ between A's). These parameters control for time constant serial correlation in the errors. For identification reasons, all other off-diagonal elements are imposed at zeros.

3. Data

The data on farmer exit decisions, family and farm characteristics, and saved retirement benefits are from the farmers' pension company MELA. The sample is a stratified random draw of 963 farmers among all farmers in the population who were born during the period of 1929-1943 and were active farmers in 1993. The sample is stratified by farmer age such that at each age the share of observations out from the total sample is equal to the corresponding share in the population. Therefore, the sample is a good representation of all farmers belonging to the sampled age group. The study period starts in year 1993 and ends in year 1998. The oldest farmer in the sample was aged 64 years old in 1993 and the youngest was 55 years old in 1998. The sample has been determined so that each farmer in the sample has had an option to retire or continue farming while retaining the option to retire later on.[2] Over the study period farmers have become eligible for the early retirement programs at the age of 55 years, and at the age of 65 he/she will loose the option to delay collecting of retirement benefits.

Farmers who have been obliged to exit farming exogenously have been included in the sample over the continuation period only. All exogenous exits have been dropped in the sample. These cases include, for example, unpredictable serious accidents, health problems, and deaths. Therefore, the sample used in estimation is a random sample among farmers who have had the freedom to endogenously choose optimal timing and the type of exit from farming. Because the exit decisions are irreversible, all farmers are dropped in the sample after exit.

The sample includes 456 farms that were operated by a couple. On these farms, the older person of the couple is defined as the farmer and the younger is defined as the spouse, since the age of the older person of a couple determines their eligibility for the early retirement benefits.

Annual values for price indices are obtained from the Yearbook of Farm Statistics (1998) and, for a given year, they are the same for all farms in the sample. The output price index represents all agricultural output. Subsidy rates are the subsidies paid per hectare of feed barley and they are obtained from the Ministry of Agriculture. The subsidy rates differ by year and farm location.[3] The sample period is characterised by large variation of farm gate prices and subsidy rates per hectare of arable land. Output prices decreased and the subsidy rates increased, particularly at the beginning of 1995 when Finland joined the European Union (EU). Descriptive statistics of the data are in Table 1.

Table 1. Descriptive statistics of the data (units of measurement in parentheses, the total number of farms in the sample is 963).

[2] Note: A farmer age is exogenously determined and, thus, using age as the outlier does not bias estimates.
[3] Feed barley was chosen as the reference crop because it is one of the most commonly grown crops in Finland. It is grown in both Southern and Northern areas.

Model variable	Sample mean	Standard deviation
Farmer age (years)	59.3	3.01
Share of farms located in the North (%) [a]	63.0	-
Land area (hectares)	11.11	16.9
Forest area (hectares)	51.5	63.6
Output price index (1993=1)	0.753	0.16
Subsidy rate (FIM 1,000 per hectare of feed barley)	1.54	0.88
Pension (FIM 1,000 per month)	3.57	0.78
Share of farmers having a spouse (%)	45.0	-

[a] The dummy variable "North" includes Northern and Central agricultural areas in Finland. Using the codes of the subsidy areas, as they are adapted in the agricultural administration, "North" includes all areas from area C1 to the North.

4. Results

Parameter estimates

Most parameter estimates differ significantly from zero in both choice equations and in all of the three model specifications. The parameter estimates have the same signs with an exception of the output price parameter. Nevertheless, the magnitudes of the parameters differ between the specifications. The mean log likelihood value is in the GHK simulated Probit model –0.165 and in the standard multinomial Probit model –0.177, suggesting that the serial correlation in the errors is significant. Therefore, the results are interpreted below in the GHK specification. These results are, however, robust to model specification so that most of the qualitative results remain unchanged even if the GHK specification is replaced by the multinomial Probit.

Probability of exit through the early retirement programs is decreasing with farmer age. Thus, the highest probability for voluntary exit is immediately when a farmer receives the option to exit. Transferring the farm to a new entrant is decreasing faster with farmer age than closing down the farming operation. This result suggests that if the minimum age requirement of being eligible for the pension benefits is increased, the number of young farmers entering farming is predicted to decrease. Thus, the age limit increase will slow down the structural development in the short run but will hasten it in the long run, because a smaller number of new farmers enter the sector and a larger number of farms will be eventually closed down.

The dummy variable "North" identifying the Northern and Central areas indicates that farmers retire earlier in the North than in the South. Also, a larger share of exiting farmers will transfer the farm to a new entrant in the North than in the South. A possible reason for this result is that the terms of Finland's entry to the EU gave better and more steady income subsidy programs for the farms located in Northern areas than for the farms located in Southern areas. Also the opportunity cost of entering farming is higher in the South than in the North, since demand for labour is stronger and earning possibilities in off-farm occupations are better in the South than in the North.

Increasing land area increases the likelihood of postponing the decision to exit and close down the farm, but it will schedule transferring the farm to a new entrant earlier. The result also supports the view that large farms are more likely transferred to new entrants than small farms.

Large forest areas will postpone all exit decisions but the effect of one additional hectare of forest is smaller than the effect of one additional hectare of arable land.

Decreasing output price is predicted to trigger farmers to exit and close down the farming operation, although the effect is statistically insignificant. The likelihood to transfer the farm to a new entrant is, on the other hand, significantly increasing with output prices. Thus, more transfers occur when the agricultural output market is favourable. The result suggests that the decreased producer prices, resulting from Finland's EU entry in 1995, have significantly decreased the number of new entrants in agriculture. Changes in income subsidy rates do not reschedule exit decisions and closing down the farm operation significantly. The result supports the view that a large number of elderly farmers have not fully adjusted to the EU Common Agricultural Policy (CAP) with lower output prices and higher direct income subsidies. Increased subsidies are, nevertheless, expected to increase the number of farms transferred to new entrants. This result suggests that young entrants are more neutral between income from subsidies *vis à vis* the market than elderly farmers.

The level of saved pension has a significant and similar effect on both types of exit decisions. Higher retirement benefits trigger farmers into exiting early. The result is consistent with farmers' low income levels so that the marginal utility of money is large and the level of pension is important. The level of pension benefits is important also when the farm is transferred to a new entrant (*e.g.* own child), because most Finnish farms are too small for sustaining two families.

The number of exits closing down the farm is significantly increased at the edge of expiration of the early retirement program. The result suggests that farmers have a tendency to delay decisions to exit and close down the farm until the early retirement program is expiring and uncertainty over the terms of the subsequent retirement programs is increased. The financial stress in funding the new programs usually results in intense political debate, which in practice is a threat of decreasing the retirement benefits.

When the farm is transferred to a new entrant, such as own child, the exit is not postponed until the last year but the pension benefits are collected earlier.

If a farmer has a spouse, he or she is predicted to retire earlier than farmers living on their own. This result suggests that couples more easily shift away from agricultural activities than single persons. However, the lower probability of exit and transfer for single persons may also be explained by the fact that single persons less frequently have a successor available.

Table 2. Parameter estimates of the three model specifications (standard errors in parentheses).

Variable	Exit and closure			Exit and transfer		
	Single-eq.	Multinom.	GHK	Single-eq.	Multinom.	GHK
Intercept	-2.9790	-3.8063	-3.0662	-5.4996	-4.9411	-5.5339
	(0.6903)	(0.1666)	(0.7121)	(0.7704)	(0.1340)	(0.7847)
Farmer age	-0.0326	-0.0415	-0.0351	-0.0563	-0.0568	-0.0566
	(0.0187)	(0.0045)	(0.0185)	(0.0179)	(0.0297)	(0.0179)
North	0.1069	0.1283	0.1239	0.1898	0.1895	0.1933
	(0.1468)	(0.1192)	(0.1292)	(0.1226)	(0.1447)	(0.1172)
Land area	-0.0100	-0.0057	-0.0103	0.0091	0.0064	0.0091
	(0.0055)	(0.0008)	(0.0056)	(0.0035)	(0.0013)	(0.0034)
Forest area	-0.0037	-0.0028	-0.0037	-0.0004	-0.0012	-0.0004
	(0.0015)	(0.0011)	(0.0015)	(0.0008)	(0.0006)	(0.0008)
Output price	-0.3397	0.7335	-0.3555	2.5046	2.0013	2.5226
	(0.6324)	(0.1800)	(0.6565)	(0.6822)	(0.2094)	(0.6998)
Subsidy rate	0.0633	0.1056	0.0600	0.1514	0.1318	0.1518
	(0.1210)	(0.1013)	(0.1196)	(0.1373)	(0.0147)	(0.1414)
Pension	0.2951	0.3160	0.3036	0.2795	0.3046	0.2829
	(0.0884)	(0.0230)	(0.0868)	(0.0755)	(0.0446)	(0.0744)
Last year	0.4233	0.2739	0.3981	-0.2026	-0.0154	-0.1989
	(0.1246)	(0.0963)	(0.1339)	(0.1642)	(0.0823)	(0.1638)
Spouse	0.4200	0.4695	0.4232	0.3951	0.3984	0.3998
	(0.1190)	(0.1199)	(0.1245)	(0.1054)	(0.0347)	(0.1034)
Error structure:						
AR(1)	-	-	-0.3522	-	-	0.0633
Covariance [a]	-	0.9220	-	-	0.9220	-

[a] Instantaneous covariance between the errors of two choice equations.

Elasticity estimates

Elasticity estimates suggest that the likelihood of voluntary exit through the early retirement programs decreases elastically with farmer's age (Table 3). Farmers in Northern and Central areas of the country have a 38% higher probability to close down the farm and a 55% higher probability to transfer the farm to new entrant, using the early retirement programs, than farmers in Southern areas. The farm land area has quite an elastic, though opposite effect on the timing of exit with the closure and exit with the transfer. The effect of forest area on closing down the farm is elastic and its effect is negligible on the timing of transferring the farm to a new entrant.

Table 3. Elasticity estimates of the response probabilities. [a]

Model variable (description of the change in the parentheses)	Per cent change in the response probability	
	Exit and closure	Exit and transfer
Farmer age (+ 1 year)	-9.1*	-13*
North (from South to North)	38	55*
Land area (+1%)	-0.91*	0.71*
Forest area (+1%)	-0.53*	-0.050
Output price (+1%)	-0.72	4.6*
Subsidy rate (+1%)	0.25	0.55
Pension (+1%)	3.0*	2.4*
Last year (from previous year to the last year)	130*	-33
Spouse (from a couple to a single person)	-70*	-64*

[a] Changes in response probabilities are evaluated at the sample averages for continuous model variables. The dummy variables have values: "North"=0; "Last year" =0, and "spouse"=1. That is, the "base farm" is located in South, pension program is not about to expire, and the farmer has a spouse.

* An asterisk denotes significance at 5% level.

The probability of transferring the farm to a new entrant increases very elastically with output prices. Similarly, the retirement benefits have very elastic and positive effects on the response probabilities. Uncertainty caused by the expiration of the temporary retirement programs double the probability of closing down the farm in order to collect the retirement benefits. Furthermore, the elasticity estimates suggest that single farmers are about 70 % less likely to exit and use the early retirement benefits than couples.

Simulation

The results of the GHK model are simulated with respect to farmer age and with respect to the price and subsidy changes caused by Finland's EU entry. The effects of the EU entry are important to obtain a better understanding of how the price and subsidy changes experienced at the beginning of 1995 are predicted to affect long term structural development in the agricultural sector. [4]

Simulation with respect to farmer age has a particular goal to seeking an answer for the policy change which increases the minimum age of being accessible for the early retirement benefits from the current 55 years to 58 years. This policy change is expected to have two effects. First, it will postpone exit decisions for farmers between ages 55 and 58 since at that age they no longer would have the option to exit, *i.e.*, access to the pension benefits. Second, the parameter estimates suggest that the postponed exit decisions will also decrease the share of farms transferred to new entrants among all exit cases.

The probability of transferring the farm to a new entrant will decrease faster with farmer age than the probability of closing down the farm operation (Figure 1). Three fourths (75%) of farmers who voluntarily exit at the age of 55 years are predicted to transfer their farm to a new entrant and a fourth of them (25%) will close down the farm. At the age of 65, the probability of transferring the farm to a new entrant is decreased by 9 per cent units. Two thirds (66%) of farmers exiting at the age of 65 will transfer the farm to a new entrant and the remaining third will close down the farm.

A reform, which increases the minimum age requirement from 55 years to 58 years, will delay the exit decisions as highlighted in Figure 2. The reform will decrease the number of farms transferred to new entrants more, both in relative and absolute terms, than the number of farms closed down. The number of farms transferred to new entrants through the early retirement program is predicted to decrease by 40 per cent, whereas the number of closures will be decreased by 30 per cent. If, for example, 1,000 farmers become 55 years of age, 220 of them are predicted to transfer the farm to new entrants and 84 of them are predicted to close down the farm through the current early retirement program. Under the reformed program the corresponding numbers are predicted at 130 and 55.

---

[4] Similar to the elasticity estimates given above, the simulations are executed around the sample means of continuous model variables (other than the simulated variables). The simulated farm is located in the South (*i.e.*, dummy variable North =0), farmer has a spouse (Spouse=1), and the pension program is not expiring (Last year=0).

Figure 1. Probability of voluntary exit through early retirement programs as a function of farmer age.

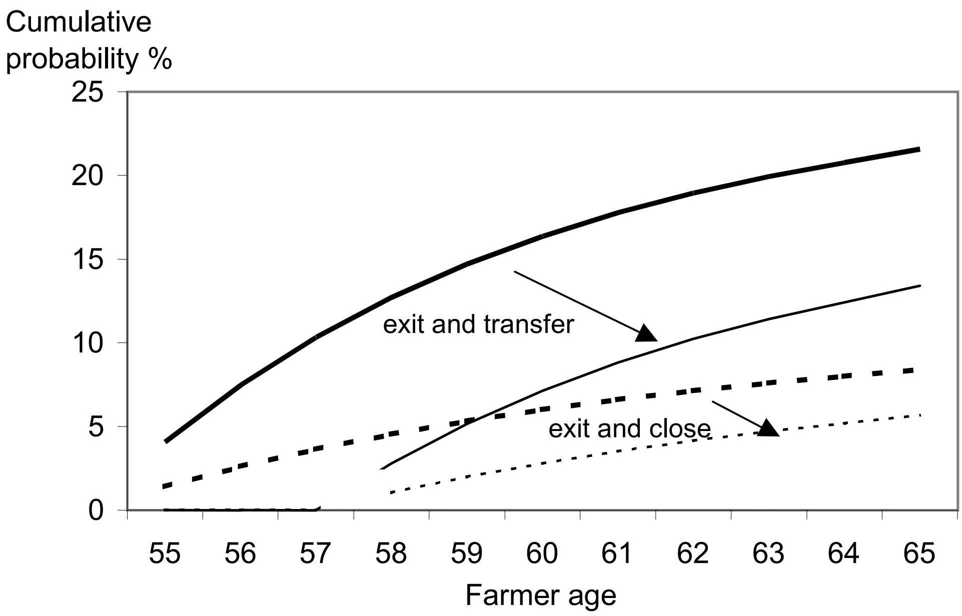

Figure 2. The effects of increasing the minimum age requirement from 55 to 58 years on the cumulative exit rates. Bold continuous and dotted lines: before the reform; thin lines: after the reform.

Price and subsidy changes between 1994 and 1998, which were caused primarily by Finland's entry into the EU, have decreased the probability of transferring the farm to a new entrant by two thirds (Figure 3). The probability of closing down the farm has, on the other hand, increased. The results suggest that the share of farms transferred to new entrants among voluntarily exiting farmers was, at 1994 prices, 71% and, at 1998 prices, it had decreased to 53%. European agenda 2000 reform, which decreases producer prices and increases direct income subsidies, is predicted to further delay farmer exit decisions closer to the age of 65 years and decrease the share of farms transferred to new entrants among the exiting farmers.

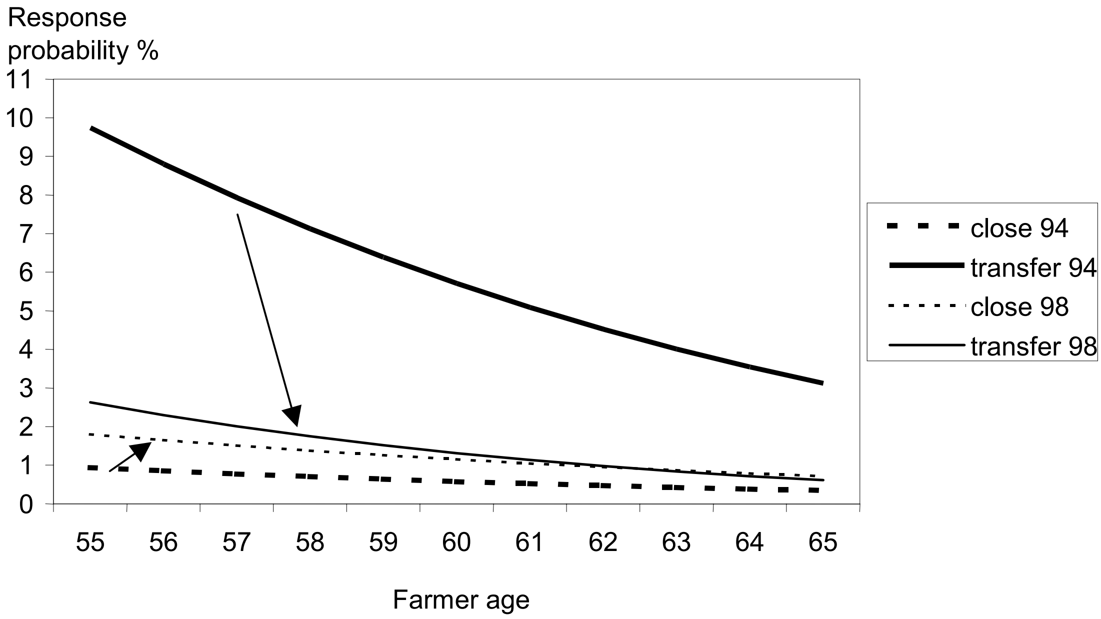

Figure 3. Probability of voluntary exit through the early retirement plans at 1994 and 1998 prices and subsidy rates.

5. Concluding remarks

This paper estimates the timing and the type of exit decisions among farmers who have the option to exit from farming or continue farming while retaining the option to exit later. The results suggest that the timing and the type of farmer exit decisions respond elastically to farmer and farm characteristics and economic environment, such as farmer age, farm land area, prices and retirement benefits.

Policy reforms that alter farmer access to early retirement benefits are predicted to have important consequences for structural development in agriculture. Increasing the minimum age for a farmer being eligible for the early retirement plan, for example, will first slow down structural development since farmers cannot exit as early as before. Nevertheless, as the exit decision is delayed and the age of farmer is increased, the probability to transfer the farm for new entrant will decrease. Less young farmers will enter farming and the structural development will be accelerated in the long run. This result may be an indication that if a farmer has a potential entrant, *e.g.* his own child, he should have incentives to transfer the farm for the new entrant before the potential entrant has moved away from the farm and has found a steady utility in other occupations with higher income, more leisure etc.

Farmer decision to exit also responds very elastically to agricultural prices and to the level of farmers' retirement benefits. The decreased output prices, *e.g.* caused for the most part by Finland's entry into the EU, have significantly decreased the number of new entrants into agriculture. If the forthcoming reforms of the CAP further decrease output prices, it will be a challenge for a high cost country with low population density, such as Finland, to maintain an adequate number of young farmers entering farming and staying in rural areas. Besides output prices, the early retirement programs and the level of farmer retirement benefits play a key role in maintaining the family farm type structure in the Nordic agricultural sectors.

References:

Bellman, R. (1957). Dynamic Programming. 339 p. New Jersey.

Börsch-Supan, A. and Hajivassiliou, V. A. (1993). Smooth unbiased multivariate probability simulators for maximum likelihood estimation of limited dependent variable models. *Journal of Econometrics* 58:347-368.

Dorfman, J. H. (1996). Modeling multiple adoption decisions in a joint framework. *American Journal of Agricultural Economics* 78: 547-557.

Eckstein, Z. and Wolpin K.I. (1989). The specification and estimation of dynamic stochastic discrete choice models. *The Journal of Human Resources* 24: 562-598.

Green, G., Sunding D., Zilberman D. and Parker D. (1996). Explaining Irrigation Technology Choices: A Microparametric Approach. American Journal of Agricultural Economics 78(November):1064-1072.

Keane, M. P. (1993). Simulation estimation of panel data models with limited dependent variables. In G.S. Maddala, C. R. Rao and H.D. Vinod, (eds.), *Handbook of Statistics*. Amsterdam: Elsevier, 11: 545-571

Keane, M. P. and Wolpin K.I. (1994). The solution and estimation of discrete choice dynamic programming models by simulation and interpolation: Monte Carlo evidence*. The Review of Economics and Statistics* LXXVI: 648-672.

Lumsdaine R.L., Stock J.H. and Wise D.A. (1992). Three models of retirement: computational complexity versus predictive validity. In: Wise, D. (ed), *Topics in the Economics of Aging*. Chicago: University of Chicago.

McFadden, D. A. (1989). Method of simulated moments for estimation of discrete response models without numerical integration. *Econometrica* 57: 995-1026.

Pakes, A. (1986). Patents as options: some estimates of the value of holding European patent stocks. *Econometrica* 54: 755-784.

Pakes, A. and Pollard J. (1989). Simulation and the asymptotics of optimisation estimators. *Econometrica 57; 1027-1057.*

Pietola, K. and Oude Lansink A. (2001). Farmer response to policies promoting organic farming technologies in Finland. *European Review of Agricultural Economics* 28; 1-15.

Provencher, B. (1997). Structural versus reduced-form estimation of optimal stopping problems. *American Journal of Agricultural Economics* 79: 357-368.

Rust, J. (1987). Optimal replacement of GMC bus engines: an empirical model of Harold Zurcher. *Econometrica* 55:999-1033.

Yearbook of Farm Statistics 1998. (1998). Information Centre of the Ministry of Agriculture and Forestry, Helsinki.