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Determinants of farmer retirement and farm succession in Finland

Academic Dissertation

Minna Väre

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Determinants of farmer retirement and farm succession in Finland

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Abstract

In the past decade, the Finnish agricultural sector has undergone rapid structural changes. The number of farms has decreased and the average farm size has increased; the number of farms transferred to new entrants has decreased as well.

Part of the structural change in agriculture is manifested in early retirement programmes. In studying farmers' exit behaviour in different countries, institutional differences, incentive programmes and constraints are found to matter. In Finland, farmers' early retirement programmes were first introduced in 1974 and, during the last ten years, they have been carried out within the European Union framework for these programmes. The early retirement benefits are farmer specific and depend on the level of pension insurance the farmer has paid over his active farming years.

In order to predict the future development of the agricultural sector, farmers have been frequently asked about their future plans and their plans for succession. However, the plans the farmers made for succession have been found to be time inconsistent. This study estimates the value of farmers' stated succession plans in predicting revealed succession decisions. A stated succession plan exists when a farmer answers in a survey questionnaire that the farm is going to be transferred to a new entrant within a five-year period. The succession is revealed when the farm is transferred to a successor. Stated and revealed behaviour was estimated as a recursive Binomial Probit Model, which accounts for the censoring of the decision variables and controls for a potential correlation between the two equations. The results suggest that the succession plans, as stated by elderly farmers in the questionnaires, do not provide information that is significant and valuable in predicting true, completed successions. Therefore, farmer exit should be analysed based on observed behaviour rather than on stated plans and intentions.

As farm retirement plays a crucial role in determining the characteristics of structural change in agriculture, it is important to establish the factors which determine an exit from farming among elderly farmers and how off-farm income and income losses affect their exit choices. In this study, the observed choice of pension scheme by elderly farmers was analysed by a bivariate probit model. Despite some variations in significance and the effects of each factor, the ages of the farmer and spouse, the age and number of potential successors, farm size, income loss when retiring and the location of the farm together with the production line were found to be the most important determinants of early retirement and the transfer or closure of farms.

Recently, the labour status of the spouse has been found to contribute significantly to individual retirement decisions. In this study, the effect of spousal retirement and economic incentives related to the timing of a farming couple's early retirement decision were analysed with a duration model. The results suggest that an expected pension in particular advances farm transfers. It was found that on farms operated by a couple, both early retirement and farm succession took place more often than on farms operated by a single person. However, the existence of a spouse delayed the timing of early retirement. Farming couples were found to co-ordinate their early retirement decisions when they both exit through agricultural retirement programmes, but such a co-ordination did not exist when one of the spouses retired under other pension schemes.

Besides changes in the agricultural structure, the share and amount of off-farm income of a farm family's total income has also increased. In the study, the effect of off-farm income on farmers' retirement decisions, in addition to other financial factors, was analysed. The unknown parameters were first estimated by a switching-type multivariate probit model and then by the simulated maximum likelihood (SML) method, controlling for farmer specific fixed effects and serial correlation of the errors. The results suggest that elderly farmers' off-farm income is a significant determinant in a farmer's choice to exit and close down the farm. However, off-farm income only has a short term effect on structural changes in agriculture since it does not significantly contribute to the timing of farm successions.

Index words: Duration, early retirement aid, farm, farming couple, off-farm income, pension, probit model, succession

Viljelijöiden luopumiseen ja sukupolven-vaihdoksiin vaikuttavat tekijät Suomessa

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Tiivistelmä

Suomalaisen maatalouden rakenne on muuttunut nopeasti viimeisen vuosikymmenen aikana. Maatilojen lukumäärä on vähentynyt ja keskikoko kasvanut; myös tehtyjen sukupolvenvaihdosten määrä on vähentynyt.

Tähän kehitykseen ovat osaltaan vaikuttaneet viljelijöiden luopumistukijärjes telmät. Erilaisten politiikkatoimenpiteiden sekä taloudellisten kannustimien ja rajoitteiden on havaittu vaikuttavan viljelijöiden luopumiskäyttäytymiseen eri maissa. Suomessa on ollut vuodesta 1974 lähtien käytössä erilaisia viljelijöiden luopumistukijärjestelmiä, ja viimeisen kymmenen vuoden aikana niitä on toteutettu Euroopan Unionin vastaavan järjestelmän puitteissa. Luopumiseläke on viljelijäkohtainen ja sen suuruus riippuu maksetuista eläkevakuutusmaksuista

Maatalouden rakennekehityksen ennustamiseksi viljelijöiltä on alettu toistuvasti kysellä heidän sukupolvenvaihdossuunnitelmiaan. Aikaisempien tutkimusten perusteella näiden suunnitelmien on kuitenkin havaittu muuttuvan ajan myötä. Tässä tutkimuksessa selvitetään, voidaanko viljelijäkyselyiden tuloksia hyödyntää tulevien sukupolvenvaihdosten määrien ennustamisessa. Kyselyssä selvitettiin, aiottiinko tilalla tehdä sukupolvenvaihdos seuraavan viiden vuoden aikana. Sukupolvenvaihdosaikomusten ja toteutuneiden sukupolvenvaihdosten tarkastelu perustui rekursiivisen probit-analyysin, joka huomioi sekä päätösmuuttujien sensuroinnin että mahdollisen korrelaation. Tulosten perusteella viljelijöiden sukupolvenvaihdossuunnitelmia koskevien kyselyvastausten perusteella ei voida ennustaa toteutuneita sukupolvenvaihdoksia. Siten viljelijöiden luopumispäätöksiä tulisi tarkastella toteutuneen käyttäytymisen eikä tulevaisuu densuunnitelmien perusteella.

Koska viljelijöiden luopumispäätökset vaikuttavat ratkaisevasti maatalouden rakennekehitykseen, on tärkeää selvittää, mitkä tekijät vaikuttavat viljelijöiden sukupolvenvaihdoksiin ja tilanpidon lopettamiseen sekä miten tilan ulkopuoliset tulot ja tulonmenetykset vaikuttavat näihin päätöksiin. Viljelijöiden havaittuja luopumisvalintoja analysoitiin probit -mallin avulla. Tulosten perusteella tärkeimmät viljelijän luopumispäätökseen vaikuttavat tekijät ovat: viljelijän ja puolison ikä, mahdollisten jatkajien ikä ja lukumäärä, tilakoko, tilan sijainti ja tuotantosuunta sekä mahdollinen tulonmenetys eläkkeelle jäätäessä.

Puolison eläkepäätösten on havaittu aikaisemmissa tutkimuksissa merkittävästi vaikuttavan henkilöiden eläkepäätöksiin. Tässä tutkimuksessa puolison eläkevalintojen sekä taloudellisten kannustimien vaikutusta viljelijäpariskunnan eläkepäätösten ajoitukseen tarkastellaan duraatio -mallin avulla. Tulosten perusteella odotettavissa olevan eläkkeen määrä aikaistaa erityisesti sukupolvenvaihdoksia.

Tiloilla, joilla on kaksi yrittäjää, luopumiseläke valitaan todennäköisemmin kuin tiloilla, joilla on vain yksi yrittäjä. Puolison olemassaolon havaittiin kuitenkin siirtävän eläkkeelle jäämistä myöhemmäksi. Viljelijäpariskuntien havaittiin hakeutuvan erityisesti luopumiseläkkeelle samaan aikaan, mutta puolison jääminen muulle eläkkeelle ei vaikuttanut viljelijöiden luopumispäätöksiin.

Maatalouden rakenteen muuttumisen lisäksi myös viljelijöiden tilan ulkopuoliset tulot ja niiden osuus tilan kokonaistuloista on kasvanut viime vuosina. Tässä tutkimuksessa tarkastellaan tilan ulkopuolisten tulojen sekä muiden taloudellisten tekijöiden vaikutusta viljelijöiden luopumispäätöksiin. Analyysissa tuntemattomat parametrit estimoitiin probit -mallin ja suurimman todennäköisyyden menetelmään perustuvan simuloinnin avulla ottaen huomioon viljelijäkohtaiset tekijät sekä virhetermien korrelaatio. Tulosten perusteella viljelijän tilan ulkopuoliset tulot vaikuttavat merkittävästi päätökseen jäädä eläkkeelle ja luopua tilanpidosta. Tilan ulkopuoliset tulot vaikuttavat maatalouden rakenteen muutokseen kuitenkin vain lyhyellä aikavälillä sillä ne eivät vaikuta merkittävästi sukupolvenvaihdosten ajoitukseen.

Asiasanat: Duraatio, eläke, luopumistuki, maatila, probit, sukupolvenvaihdos, tilan ulkopuoliset tulot, viljelijäpariskunta

Preface

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Helsinki, December 2006

Minna Väre

Contents

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1 Introduction

1.1 Background

1.1.1 Structural change

In most European countries, the agricultural sector is undergoing rapid structural development. Particularly in Finland, the need for structural change has been obvious since Finland's entry into the European Union (EU). At the time of EU entry, Finnish agriculture was characterised by high production costs and an average farm size that was too small to efficiently utilise modern technologies so as to be competitive in the European Common Market (*e.g.* Latukka *et al.*, 1994). Therefore, a large number of public policy programmes have been designed and applied to Finnish agriculture. Temporarily applied and subsidised short-term early retirement programmes have been prominent among these. As a result, the average farm size has been increasing and the number of farms has decreased. The number of farms has decreased from 129,114 in 1990 to 69,517 in 2005. At the same time, the average farm size has increased from 17.34 hectares per farm to 33.3 hectares per farm (Information Centre of the Ministry of Agriculture and Forestry, 2003, 2006).

Most Finnish farms can be characterised as family farms. When defining family farming, one of the constitutional elements has been found to be the farmers' objective of transferring the farm to the next generation within the family (Pfeffer, 1989; Gasson and Errington, 1993). However, the decision not to continue farming often takes place when the farmer is ageing and the farm should be transferred to the next generation (Pfeffer, 1989). As Gale (1993) points out, the survival of family farms is highly dependent on successful intergenerational transfers. Moreover, Weiss (1999) among others has also found strong dependence on farm succession and farm survival. However, at the same time as the number of farms decreases, the number of farm successions has also decreased. Whereas at the beginning of the 1990s about 2,000 farms were transferred to a new entrant annually, at the end of the century the number of farm transfers was less than half of that (Appendix 1) (Pyykkönen, 2001). As a result, the share of young farmers has declined and the average age of farmers has increased from 44.8 years to 47.1 years (Mela, 2006). Both demographic factors and economic forces contribute to the declining entry into farming (Gale, 1993). Gale (1993) also mentions the role of policies in maintaining the traditional structure of farming.

When studying farmers' exit behaviour in different countries, institutional differences are found to have an impact (Kimhi and Bollman, 1999). In the European Union, early retirement programmes have been important policy tools to steer structural development in agriculture. Because the early retirement system is voluntary, it is not applied in all member countries. When comparing intergenerational transfers in different countries, Errington and Lobley (2002) found that the managerial responsibility for a farm is handed over earlier in France than in England. This is because France, unlike England, applies the early retirement and installation elements of the Rural Development Regulation of the CAP (Common Agricultural Policy). Also, the succession procedures and practices in different countries vary substantially. For example, in Ireland a successor does not have to purchase the farm from his[1] parents or siblings but has to provide a living for the previous generation from the farm income. This kind of commitment to financial responsibility to the former owners is not the case, for example, in Finland. More details about retirement programmes and succession practices in the context of EU countries can be found, for example, in Blanc and Perrier-Cornet (1993), Caskie (2002) and Bika (2004).

In Finland, an early retirement system for farmers was first introduced in 1974. Since then, there have been several different programmes enhancing the continuity of family farming by promoting the transfer of fixed agricultural resources, such as land, from elderly farmers either to new successors or to other farmers who would like to expand their operations. Early retirement programmes for farmers are frequently under intensive political debate because the current short-term programmes are partially financed by society and are costly. Uncertainty over the continuation of early retirement programs is also a problem for farmers. This uncertainty may significantly increase costs for a young farmer purchasing an insurance scheme that will provide a secure and flexible retirement plan. Thus, new information is needed in designing programmes that have the desired long-term effects on farmer exit and retirement behaviour and structural development in agriculture and rural areas.

At the same time as the agricultural production structure has changed, both farm income and its share of a farm family's total income have been decreasing. In 1990, farm income contributed to 46% of the total income of a farm family. Wages and salaries from off-farm work and other entrepreneurial activities amounted to 30% of total farm family income. In 2001, the corresponding shares were 39% and 32% (Figure 1) (Statistics Finland, 2003).

As well as having an ever increasing importance for farm households, off-farm employment is expected to have an increasing effect on farm household decisions as well. One of the most important decisions of elderly farmers is the timing of retirement and the question of what happens to their farm after their retirement. The off-farm income of elderly farmers is smaller than the off-farm

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[1] In the study, farmer is referred to as being a male and a spouse as being a female. The chosen genders in the text do not rigorously reflect the data. In the data sets used, the genders of the farmer and spouse are unobserved.

income of their younger colleagues. The link between farmers' exit decisions and off-farm income is becoming more and more prominent because it has been increasing steadily over time (Figure 2). Thus, as off-farm work is becoming more and more common and a significant complement to farm incomes, it is crucial to know how off-farm income affects farmers' retirement decisions and farm succession. An important policy question that then emerges is to what extent the gradually increasing off-farm activities and off-farm income, in addition to other financial factors, affect the exit behaviour of farmers and their response to the terms of the farmers' early retirement programmes. We may hypothesise

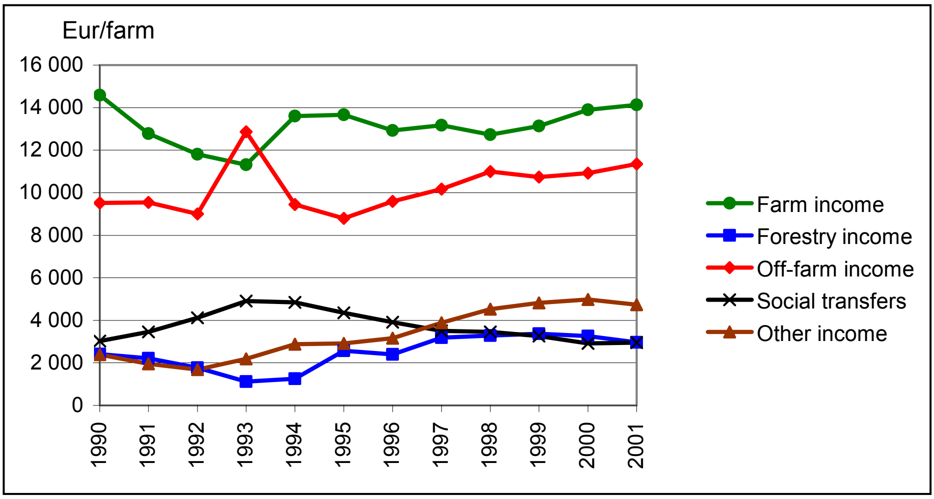

Figure 1. The development of farmers' income in 1990–2001 by income sources using 2001 values (Statistics Finland, 2003).

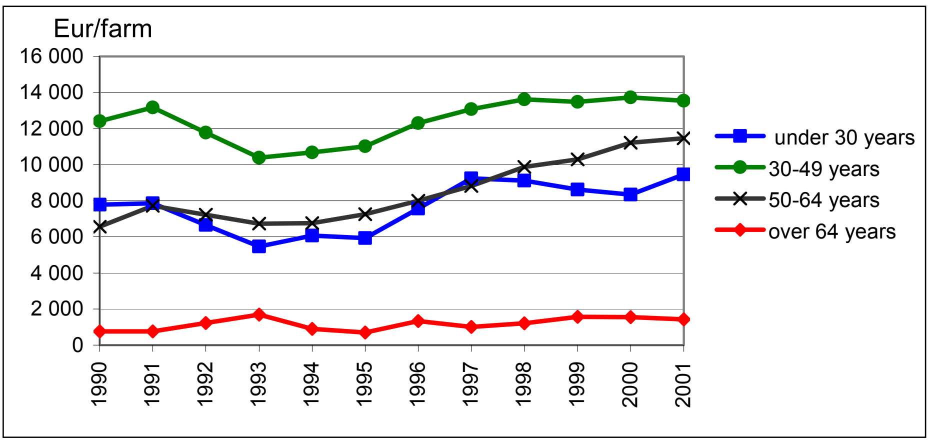

Figure 2. The development of farmers' off-farm income by farmer age groups in 1990–2001 using 2001 values (Statistics Finland, 2003).

that off-farm labour income may particularly alter decisions to exit and to close down the farm, which, in turn, may affect the transfer of resources, such as land and production rights, from the exiting farms to farms who would like to expand their production. In earlier studies, off-farm income has been found both to stabilise the farm household (Kimhi and Bollman, 1999), for example in cases of farm income variability and policy changes (Mishra and Goodwin, 1997), and to accelerate farm exits (Goetz and Debertin, 2001).

1.1.2 Retirement behaviour

Recently, the joint retirement decisions of couples have received attention. It has been suggested, *e.g.* because of the willingness of the couples to spend their leisure time together (Ruuskanen, 2004) and financial effects, that it is important to model the retirement decisions of both spouses together (Blau, 1997, 1998). Most studies on individual retirement behaviour analyse the retirement probability of wage workers. When comparing the retirement behaviour of farmers and wage workers, it is to be noticed that a farmer may continue farming activities after starting to receive pension benefits. However, joint retirement is expected to involve farming couples especially. This is partly because of the restrictions of the farmers' early retirement system, according to which all farm entrepreneurs have to give up farming activities when one of them is applying for the early retirement scheme. It may also be that one spouse alone will not be able to take care of all farming activities. Similarly, when transferring the farm to a new entrant, the transfer typically involves all the farming property and activities.

As the timing and type of retirement choices among elderly farmers play a crucial role in determining the characteristics of structural change in agriculture (Kimhi and Lopez, 1999), it is important to establish which factors determine these choices. In addition, new information on the retirement behaviour of farming couples is needed. Furthermore, it is important to find out how public policies, such as early retirement programmes, foster these choices. In this study, elderly farmers mean farmers who are old enough to be eligible to have the option to voluntarily exit from farming using an offered early retirement scheme.

New information on the effects of farm and family characteristics, economic incentives and off-farm work on farming couples' retirement behaviour is especially needed now since the large so-called baby-boom generation born in the late 1940s and early 1950s is approaching retirement age. This is also why farm succession is expected to take place on many farms in the next few years.

In order to predict and construct scenarios about the future development of the agricultural sector, questionnaires have become important sources of information. Lately, farmers have frequently been asked about their investment and production plans and their plans for succession. Further, many earlier studies on farm succession and farm retirement are based on farm surveys. However, the difference between planned and realised investments in agriculture can be great (Honkanen, 1983; Kuhmonen, 1995; Valkeeniemi, 1998). Since farmers' succession plans have been found to be time inconsistent (Glauben *et al.*, 2004a), we do not know the value of the farmer's stated plans as given in surveys in predicting actual exit behaviour. For example, after a survey made for the Pellervo Economic Research Institute by Farm and Food Facts in 1999, it was estimated that about 11% of Finnish farms would be transferred to new entrants during the years 2000–2006. This would mean about 1,300 farm transfers annually (Pyykkönen, 2001). According to the registers of the Farmers' Social Insurance Institution (Mela), there have been about 505 farm transfers per year during the years 2000–2005 that utilised the farmers' early retirement scheme. Since it has been approximated that about every second farm succession utilises the farmers' early retirement system, it seems that the number of farm transfers based on the farm survey has been overestimated by one- fourth when that number is compared to the number of farm transfers actually taking place. In addition, the type of farms being transferred to new entrants may differ from that anticipated by the survey. As the number and type of farms transferred to new entrants significantly affects the future development of the farming structure, new information on farmers' stated succession plans and their real succession behaviour is needed.

1.2 Objectives and outline of the study

The objective of this study is to produce new information on farmers' retirement and exit decisions and the factors affecting them. In the study, farmers' succession plans and the realisation of these plans, farmers' exit decisions, and the timing of early retirement are analysed. As early retirement involves all farming activities, the analyses are made on the level of the farm.

The study includes a description of the farmers' early retirement system, earlier literature, the theoretical background, and four empirical approaches on farm succession and retirement. The results provide new information for the evaluation of past and current plans and for the design of future retirement systems and policies aiming at improving structural adjustment in the agricultural sector.

Issues of particular interest include:

- How do farmers' succession plans and actual succession behaviour correspond to each other?

- What are the key determinants of farmers' early retirement and the different types of exit outcomes?

- How do farm and farm family characteristics and agricultural and forestry income affect farmers' retirement decisions and the choice of pension system?

- How does spousal retirement affect farmers' retirement decisions and the timing of retirement?

- How do economic incentives and off-farm income affect the type and timing of farmers' retirement decisions?

The study is organised as follows. Chapter 1 (introduction) continues with a short presentation describing Finnish early retirement channels and farmers' early retirement systems. Chapter 2 reviews the data and the methods used in earlier studies on farm retirement and individual retirement decisions (literature review). The main results of earlier studies are presented. Farm and family characteristics and economic incentives affecting an individual's retirement behaviour are discussed. In Chapter 3, the theoretical and operational framework for this study is presented. Subsequent empirical models are further introduced and the data types used in this study are described. Chapters 4, 5, 6 and 7 include empirical analyses. Each of these empirical models analyses farmers' exit behaviour from different perspectives focusing on different issues and using different data. First, farmers' succession plans based on farm surveys and the realisation of these plans are compared (Chapter 4). Next, the factors affecting farmers' retirement decisions and their choice of pension scheme are analysed (Chapter 5). In addition, the effect of spousal retirement status (Chapter 6) and the effect of off-farm income on the type and timing of farmers' retirement decisions are analysed (Chapter 7). Chapter 8 presents a conclusion and discusses the main findings, policy implications and suggestions for further research.

1.3 Early retirement channels

In Finland, retirement has been possible before the actual old-age retirement according to different early retirement schemes. These schemes, with their date of introduction and the target group, are listed in Table 1 (Lilja, 1990; Hakola, 2002).

Table 1. Early retirement schemes in Finland, private sector.

Retirement scheme	Date of introduction	Target group
Disability pension	1962	Disabled
Unemployment pension	1971	Long-term unemployed
Farmers' early retirement pension	1974	Farmers
War veterans' pension	1983	Veterans of the war
Individual early retirement	1986	Reduced work ability/ long work history
Early old-age pension	1986	
Part-time pension	1987	

All these retirement channels have eligibility criteria and age restrictions, as their intention is to restrict the access of a specific retirement channel only to the target group. For the disability pension, the main criterion is illness or a reduced ability to work. The disability pension is the only pension scheme that is available to all age groups. The individual early retirement pension is also a disability pension, but it has a minimum age requirement of 60 years. For the unemployment pension, the criterion is long-term unemployment, and the age restriction is similarly 60–64 years. The age restriction for the early old-age pension is 60–64 years. The early old-age pension entails a permanent neutral reduction in pension benefits, which is why it is less popular than other early retirement schemes. As individual early retirement and the unemployment pension will be abolished in 2005, the lower age limit for early retirement will be 62 years (Börsch-Supan, 2005). The part-time pension was originally targeted to persons aged 60–64 years, reducing working hours according to set rules. After the year 2000, the age limit has been 56 years, and as part of the 2005 reform, it is now 58 years (Lilja, 1990; Hakola, 2002; Finnish Centre for Pensions and The Social Insurance Institution of Finland, 2005; Börsch-Supan, 2005). The lower age limit for farmers' early retirement programmes has been 55–64 years. These programmes are described in more detail in Section 1.4.

In 2004 a total of 16.5 billion euros were paid as pensions in Finland. At the end of 2004, there were 1,338,000 pension recipients. Of all pension recipients, 68.6% received an old-age pension, 5.2% received an early old-age pension, 4.0% received an unemployment pension, 20.0% received a disability pension, 0.9% received an individual early retirement pension, 2.7% received a part-time pension, and 2.5% received an early retirement pension for farmers. In addition, pensions were paid to 260,000 surviving spouses and 26,000 children. The number of pension recipients has grown by 189,000 (16%) between 1989 and 2004 (Finnish Centre for Pensions and The Social Insurance Institution of Finland, 2006).

In 2005, there were 142,000 farmers receiving an old-age pension, 13,200 farmers receiving a disability pension, 1,200 farmers receiving an unemployment pension and 46,000 farmer spouses or children receiving pension benefits. This means that one-seventh (32,700) of all farmers' pensions are early retirement pensions (Mela, 2006).

Almost 58,000 persons retired in 2004. Nearly half of those retired on a disability pension, one-third directly on an old-age pension, and one-fifth on an unemployment pension. Further, 1,000 farmers retired on a farmers' early retirement pension (Finnish Centre for Pensions and The Social Insurance Institution of Finland, 2006).

At the beginning of 2005, the Finnish old-age pension system was renewed and became more flexible. Since 2005, an individual can retire between the ages of 63 to 68 (the so-called flexible retirement age). The longer one chooses to work after the lower age limit, the higher the old-age pension benefit is (Börsch-Supan, 2005). However, since the study period in this work dates before 2000, the renewal has no effect on this study.

Besides the public pension channels described above, voluntary pension schemes are also available to farmers. These schemes are not, however, presented here.

1.4 The farmers' early retirement system

1.4.1 Main characteristics of the farmers' early retirement system in Finland

In Finland, farmers' early retirement programmes were first introduced in 1974. Since then, there have been several programmes of short duration that included (i) a change of generation pension, (ii) a farm closure pension and (iii) a farm closure compensation (Figure 3) (Wilmi, 1994; Mela, 2003). Later on, the change of generation pension and the farm closure pension measures have been included in the early retirement aid for farmers.

The programmes have had different goals, from reducing overproduction to improving farming structure. Despite these agricultural policy goals, farmers' early retirement schemes utilise pension policy tools and measures. For example, the farm closure pension was aimed at balancing agricultural production and forming larger farms. The aim of the change of generation pension was to improve the farmer age structure by enhancing farm successions on viable farms. Farm closure compensation, on the other hand, aimed at securing the livelihood of retiring farmers by removing fields of low quality from production. This measure was not, however, as significant as others (Wilmi, 1994; Pietiläinen, 2004).

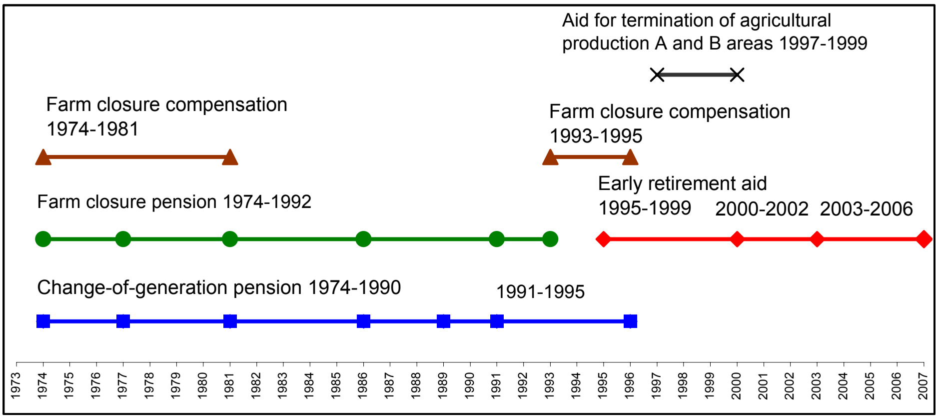

Figure 3. Farmers' early retirement systems in Finland. The spots, crosses etc. denote reformations in the law on farmers' early retirement systems.

In 1974–2002, according to these programmes, farmers aged between 55 and 64, who either ceased production on their farms by selling or leasing agricultural resources to neighbouring farms (farm closure pension) or transferred their farm to new entrants (change of generation pension), received retirement benefits that corresponded to the disability pension of the farmer. Retirement was also possible by reforestation of the land or by lay-land agreement (farm closure pension and compensation) (Wilmi, 1994; Mela, 2003). The restrictions and age limits involved in different schemes during the study period are described in more detail in Appendix 1.

In this study, farmers' early retirement is analysed in Chapters 5–7. The study period runs from 1993 to 1998. Farmers' early retirement is here divided into farm succession and farm closure cases according to what happens to the farm after retirement. Thus, the division is independent of the retirement scheme utilised. Farm succession includes transferring the farm to a new entrant either in terms of change-of-generation pension (1993–1995) or the early retirement aid system (1995–1998). The new entrant may be a family member or not. Farm closure, on the other hand, includes the sale or lease of agricultural resources to other farmers, the reforestation of the land and lay-land agreements. These retirement options may be based either on farm closure compensation (1993–1995), early retirement aid (1995–1998) or on the aid for the termination of agricultural production in A and B areas (1997–1998).

The early retirement benefits are farmer specific and depend on the level of pension insurance that the farmers have purchased over their active farming years. The payments also depend on the farm's size and production line. Thus, the expected pension benefits are based on a long period of farming and cannot be easily increased shortly before retirement (Mela, 2003).

Since 1995, Finland has carried out farmers' early retirement programmes within the EU framework for these programmes. At the beginning of Finland's EU membership, a special aid for the termination of agricultural production in the southern parts of the country (A and B subsidy regions) was also applied. The lump sum compensation provided for the stopping of agricultural production and for the sale of the fields to other farmers. The amount of farms applying for this aid scheme was very small, however.

The latest early retirement aid for farmers was in force during the years 2003–2006. According to the regulations, the lower age limit for retiring farmers in farm successions was 55 years during the years 2003–2004, but the limit raised to 56 years for the period 2005–2006. When retiring by selling the fields to another farmer, the age limit was 57 years. Since 2004 it has also been possible for farmers aged 60–64 years to retire by renting out the fields. In 2004, there were 200 farms rented out in order to receive the farmers' early retirement benefits (Mela, 2003). In 2007–2010, the reformed aid system will be applied.

1.4.2 Number of farmers utilising the system

During the years 1974–1992, over 39,900 farmers retired from farming according to the rules of the farm closure pension. Retiring removed 23,900 farms from agricultural production, most of which by non-cultivation agreement. The total land area removed from production by non-cultivation and reforestation agreements was over 151,600 hectares. This is over 7% of the total arable land area operated by all farmers insured in Mela in 1974 when the farm closure pension first came into force. During the years 1974–1995, altogether 33,800 farms were transferred to new entrants by the change of generation pension system (Mela, 2006).

The annual number of farmers exiting farming by means of the different farmers' early retirement schemes was highest in the late 1980s and early 1990s (Figure 4). Since that time, the number of farms applying for these programmes has been decreasing. In 1990 there were 2,507 farms applying for farmers' early retirement programmes, whereas in 2005 the corresponding number was only 945. Out of these farms, 1,602 were transferred to new entrants in 1990; the corresponding number in 2005 was only 622 (Appendix 1). It has been estimated that about half of farm successions utilise the farmers' early retirement system.

In total, over 68,000 farms have benefited from farmers' early retirement programmes in Finland over the last 30 years (Figure 4, Appendix 1). At the same time, the number of farms and the farm population insured by the Farmers' Social Insurance Institution (Mela) has decreased and the average farm size has increased (Appendix 1). Mela is the separate, governmental body responsible for administrating the earnings-related pensions for the agricultural population.

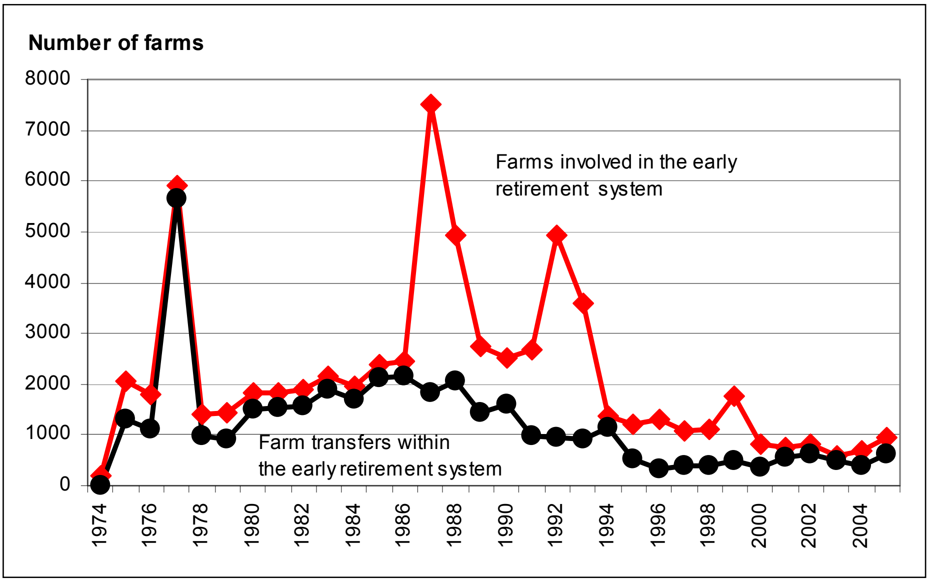

Figure 4. Number of farms and farm transfers within the farmers' early retirement system in 1974 to 2005.

In practice, purchasing pension insurance from Mela has been obligatory for all farmers. It is also a precondition for applying for a farmer's early retirement scheme.

The cost of pension payments related to farmers' early retirement programmes was 152.4 million euros in 2004. The sum was about 1% of total pension costs (Finnish Centre for Pensions and The Social Insurance Institution of Finland, 2006).

The average total pension of all Finnish pensioners was 1,022 euros per month at the end of 2004. Out of the 32,700 retired farmers receiving a pension according to the farmers' early retirement systems, 9,500 received early retirement aid, 22,000 received a farm closure pension, 750 received a change of generation pension and 150 received farm closure compensation in 2005. The average early retirement aid was €728 per month, farm closure pension was €441 per month, change of generation pension was €710 per month and farm closure compensation €472 per month (Mela, 2006).

In 2005, farmers retired on average at the age of 60.1 years. This is about one year higher than the average retirement age amongst all workers. Among those farmers retiring under the farmers' early retirement scheme, the average retirement age was 58.2 years (Viitala, 2006).

1.4.3 The farmers' early retirement system in the EU

In the European Union, regulations on enhancing farm successions and improving the farming structure were first introduced in 1988. Up to 1992, in practice, only Germany applied a farmers' early retirement scheme based on these regulations. According to the scheme, a farmer, aged 58–64 years, received an early retirement pension if he stopped cultivating his land, reforested it or sold it. In 1992, new regulations were introduced for farmers' early retirement systems in the EU (EU Reg. 2079/1992). The aim of these regulations was both to secure the income of retiring farmers and to help to replace them with other farmers more able to improve the livelihood of the continuing farms. The age limit for retiring farmers was lowered to 55 years. Being voluntary, this system was applied in less than ten EU member states (Caskie *et al*., 2002; Bika, 2004). In 1999, this second wave of regulation was replaced by the Community aid scheme for early retirement from farming included in the Rural Development Regulation (EC Council Regulation 1257/1999). This aid scheme includes no restrictions concerning full-time farming as was a pre-condition in the earlier schemes (HE, 1992:194; 1994:162; 1999:131). Having both social and structural objectives, the design of the EU early retirement scheme varies by country and depends largely on national objectives. For example, the subsidy level for retired farmers has been found to vary greatly between member countries (Caskie *et al*., 2002; Bika, 2004).

2 Earlier studies

In this chapter, earlier studies on farm retirement and individual retirement decisions are reviewed. Different types of data and methods used in earlier studies are described, and the main results are presented. The aim of the chapter is to form the basis for the choice of approaches in this study.

2.1 Data types used in earlier studies

Earlier studies on farm retirement are primarily based on farm surveys, where farm succession is observed either *ex-post* or *ex-ante*. The most common approach is to investigate future succession plans of farm operators *ex-ante* on the basis of a farm survey. The respondents are asked about the probability and timing of family succession and whether a farm successor is already determined. Examples of studies following this approach include Kimhi and Lopez (1999), Kimhi and Nachlieli (2001), Glauben *et al.* (2004a), Hennessy (2002), Mishra *et al.* (2004) and Tietje (2004). Errington and Lobley (2002) have also carried out identical surveys of different countries and analysed the differences in succession plans and patterns between countries. Similarly, Glauben *et al.* (2004b) have followed the same approach when comparing farm transfers in Northern Germany and Austria.

Another approach has been to analyse (actual) succession *ex-post* by investigating panel data on farm households. In these studies, information on the farm operator's age at different time periods is used to identify farm succession as having taken place (for example, Kimhi, 1994a; Kimhi and Bollman, 1999; Stiglbauer and Weiss, 2000). Pietola *et al.* (2003) follow yet a different empirical approach using register data on farm retirement, which has allowed them to study actual retirement *ex-post* on the basis of panel data. On the other hand, Pfeffer (1989), Gale (1993), Weiss (1999), Kimhi (2000), and Goetz and Debertin (2001) base their analyses on farm census data.

Similarly to farm retirement studies, many studies on individual retirement probability are based on surveys. For example, household survey data (Samwick, 1998; Kerkhofs *et al.,* 1999), time-use survey data (Huovinen and Piekkola, 2002) and longitudinal survey data sets (among others, Gustman and Steinmeier, 1986; Berkovec and Stern, 1991; Blau, 1997, 1998; Blau and Riphahn, 1999; Börsch-Supan, 2000; Gustman and Steinmeier, 1986, 2000) have been used when studying retirement. These studies are based on *ex-post* information whereas for example Chan and Stevens (2004) have based their study on the effects of incentives on individual retirement expectations on longitudinal *ex-ante* survey data.

Panel data has been used for example by Lilja (1996) when studying early retirement in Finland (panel data from Finnish Labour Force Surveys). Similarly, Hakola (2002) has used wide individual data from the Employment Statistics of Statistics Finland, supplemented by information provided by different registers on taxation, employment, and pensions, when studying the retirement of Finnish elderly employees. Extensive register data records have been utilised among others by Hernoes *et al.* (1997), Dahl *et al.* (2000) and Karlstrom *et al.* (2004) when analysing retirement decisions. Large data records on civil service personnel have been utilised by Asch *et al.* (2005) when studying the effect of financial incentives on retirement. In contrast, Stock and Wise (1990) utilise the pension plans of the older salesmen of one large firm when estimating the effects of pension plan provisions on retirement rates.

Because of the time-inconsistency of the retirement plans, *ex-post* survey or register data are more reliable data sources compared to *ex-ante* survey answers. When using register data, it is also usually possible to achieve larger data sets with more observations than is possible with survey data. However, register data may be rather limited, consisting only of few variables on the retirement behaviour and financial situation of the observed individuals. Furthermore, in surveys it is possible to ask more about the background, attitudes and intentions of the respondent.

2.2 Methods used in earlier studies

Earlier studies on individual retirement decisions and farm retirement behaviour have used, among other methods, different types of binary models, option value models and duration models. For example, Pfeffer (1989) has used binary logit models when studying the stability of German farms. Also *e.g.* Hennessy (2002) has used a logit model when studying farm succession probability on Irish farms.

Probit models have been used by Kimhi and Bollman (1999) among others when comparing farmers' exit decisions in Canada and Israel, by Kimhi and Nachlieli (2001) when studying the likelihood of intra-family intergenerational succession on Israeli family farms, and by Goetz and Debertin (2001) when studying the factors affecting a number of young entrants and the cessation of farming in the United States. Similarly, Huovinen and Piekkola (2002) have used probit models in their study on early retirement and time-use in Finland, as have Pietola *et al.* (2003) in their study on the timing of exits and the type of exit from farming in Finland. Tietje (2004) has also used a probit model when analysing farmers' succession plans in Northern Germany.

Multinomial logit models have been used *e.g.* by Stiglbauer and Weiss (2000) when studying actual succession decisions on Upper Austrian farms, by Dahl *et* *al.* (2000) when analysing the transition to different early retirement pathways in Norway, and by Kimhi (2000) when analysing the effect of off-farm work on farm exit probability in Israel.

Kimhi (1994) has used a censored regression model when analysing the optimal timing of farm transferral. Gale (1993), on the other hand, has used a log-linear regression model, and Kimhi and Lopez (1999) have used a multivariate regression model when studying the importance of farmers' succession plans. Glauben *et al.* (2004a) have used a bivariate probit model and a sample selection model when analysing the probability of family succession and the timing of succession in Austria. Similarly, Weiss (1999) has used a sample selection model when studying farm survival and growth in Austria.

Among others, Stock and Wise (1990), Samwick (1998), Chan and Stevens (2004) and Asch *et al.* (2004) have used option value models when studying the effect of pension incentives on the timing of retirement and subjective retirement expectations. Besides Stock and Wise (1990), Gustman and Steinmeier (1986, 2000), among other researchers, have used structural models in their retirement studies. Berkovec and Stern (1991) have used dynamic programming and the method of simulated moments when studying job exits and the retirement behaviour of older men. Karlstrom *et al.* (2003) have used dynamic programming in their study on the effects of public old-age pension system rules and economic incentives on workers' retirement decisions in Sweden. Kerkhofs *et al.* (1999) have used a dynamic model when studying the relative size of incentive effects and health on individual retirement decisions. Blau (1997, 1998) has used a dynamic discrete choice model when studying the joint labour force behaviour of older couples and the effect of social security benefits in the United States.

Lilja (1996) has used a competing risk hazard model when studying the early retirement behaviour of older Finnish private-sector employees and the self-employed. Similarly, competing risk hazard models have been used by Blau and Riphahn (1999) when studying the labour force transitions of older married couples in Germany, by Hernoes *et al.* (2000) when studying early retirement behaviour in Norway, and by Hakola (2002) when studying the effect of changing economic incentives and rules on retirement probability in Finland. In addition, Tietje (2004) has used a competing risk model when studying the timing of considered farm retirement in Northern Germany. Börsch-Supan (2000) has used a semi-nonparametric hazard model for multiple spell data when analysing the incentive effects of social security on labour force participation in Germany.

2.3 Main results

2.3.1 The effects of farm and family characteristics

In earlier studies, the probability and timing of farm transfers has been found to vary by farm and family characteristics (*e.g.* Kimhi, 1994a). There is evidence that the probability of transferring the farm to a new entrant first increases with the farmer's age and then decreases beyond a certain age limit (Kimhi and Bollman, 1999; Stiglbauer and Weiss, 2000; Kimhi and Nachalieli, 2001; Tietje, 2004). This is especially the case in family successions. One reason for this is the possible successor finding employment outside farming in the case of delayed succession.

To the contrary, the probability of other forms of exits is found to increase with farmers' age (Kimhi, 1994a; Stiglbauer and Weiss, 2000; Kimhi and Nachlieli, 2001; Pietola *et al*., 2003). When studying the timing of farm retirement, Kimhi and Lopez (1999) have found that retirement and succession plans in farm families are not separable. The number of children living on a farm has also been found to increase succession probability (Stiglbauer and Weiss, 2000; Glauben *et al.*, 2004a). Glauben *et al.* (2004a) have also found farmers' succession plans to be time inconsistent. Further, succession takes place earlier and is found to be more likely on the farms operated by more experienced farmers (Glauben *et al*., 2004a).

Other characteristics of the farm have been found to have an affect as well. As Gasson *et al.* (1988) point out, "One of the main reasons for children not taking over the farm is that the farm is too small." The bigger the farm land area, the more likely succession is and the less likely farm closure is found to be (Gasson *et al.*, 1988; Kimhi and Lopez, 1999; Stiglbauer and Weiss, 2000; Kimhi and Nachlieli, 2001; Hennessy, 2002; Pietola *et al.*, 2003; Glauben *et al*., 2004a; Tietje, 2004). Moreover, farms located in less favoured areas are less likely transferred to a new entrant (Stiglbauer and Weiss, 2000; Glauben *et al.*, 2004a). Similarly, the type of production line of the farm has been found to matter (Kimhi, 1994a; Kimhi and Bollman, 1999).

Among other farm and family characteristics, the existence of a spouse has been found to have an influence on farmers' retirement decisions. Pietola *et al.* (2003) suggest that a farmer is expected to retire earlier if he has a spouse. On the other hand, farm succession has been found to be postponed if a farmer's spouse also works on the farm (Glauben *et al.,* 2004a).

In general, couples have been found to make their retirement decisions jointly. According to Blau (1998) and Blau and Riphahn (1999), there is a strong propensity among couples to spend leisure time together. When making retirement decisions, it is most important for spouses to be able to spend their time in retirement together, and this is why they co-ordinate their retirement plans accordingly. Having a retired spouse also increases the value of leisure. Therefore, individuals' retirement decisions are found to be strongly influenced by the retirement decision of the spouse (Lilja, 1996; Gustman and Steinmeier, 2000; Huovinen and Piekkola, 2002). As increasing demand for leisure has been found to increase early retirement (Huovinen and Piekkola, 2002), couples are expected to co-ordinate their early retirement.

2.3.2 The effects of economic incentives

When studying individual retirement behaviour, economic incentives are found to have an impact (*e.g*. Stock and Wise, 1990; Hernoes *et al*., 2000; Chan and Stevens, 2004; Karlstrom *et al*., 2004). Samwick (1998) and Asch *et al.* (2005) have found the actual retirement wealth and retirement benefit to be significant determinants of retirement probability. Kerkhofs *et al.* (1999) have found financial incentives to be the most important factors determining an individual's choice to apply for an early retirement scheme. Börsch-Supan (2000) has also found that workers respond consistently and strongly to economic incentives to retire earlier. Moreover, in the retirement decision process, income streams in alternative exit routes are compared, and different alternative exit routes serve as substitutes (Kerkhofs *et al.,* 1999). Hakola (2002) has found that the impact of economic incentives on the timing of retirement differs between different retirement channels. Dahl *et al.* (2000) have also found that explanatory variables have different effects on different exit routes for males as well as for females. When studying the timing of farm retirement, Pietola *et al.* (2003) found that higher retirement benefits increase elastically the probability of both farm succession and farm closure.

Furthermore, the level of and entitlement to various welfare benefits might be affected by whether one or both of the spouses are retired. For example, Blau (1997, 1998) suggests that when modelling retirement decisions, it is important to model the retirement decisions of both spouses because of *e.g*. financial effects.

In addition to that, farm and off-farm income are found to affect farm retirement probability. According to Hennessy (2002), farm income significantly enhances farm succession. It has also been found that on farms with a higher dependency on farm income, farm succession is more likely than on those farms where the share of farm income of total household income is less (Gasson and Errington, 1993). In previous studies, off-farm income has been found to both stabilise the farm household (Kimhi and Bollman, 1999), for example, in cases of agricultural income variability and policy changes (Mishra and Goodwin, 1997), and to accelerate farm exits by reducing transaction costs for those seeking to leave agriculture (Goetz and Debertin, 2001). Off-farm work can also be seen as a stable long-run combination with farming rather than a step in a direction away from agriculture (Kimhi, 2000). Part-time farming has, however, been found to promote the restructuring of the farming sector (Pfeffer, 1989; Weiss, 1999). Part-time farmers have both lower expectations for continuing farming (Pfeffer, 1989) and lower probabilities of survival and growth compared to full-time farmers (Weiss, 1999). Further, on part-time farms, the probability of succession is found to be lower and the probability of other farm exits higher (Stiglbauer and Weiss, 2000; Tietje, 2004). On the other hand, Kimhi (1994a) has found that parents maximising family welfare may transfer a farm to a successor earlier if a farmer has off-farm work.

3 Theoretical framework and model specification

In this chapter, the theoretical and operational frameworks of the study are presented and the methods and data used are described. The choice of methods and variables included in the current analyses is determined by data availability and the findings of earlier studies. The aim of the chapter is to form the basis for the empirical specification for the models estimated and reported in Chapters 4–7. More detailed descriptions of the models and the estimating equations are found in Chapters 4–7.

3.1 Farm family business

According to Castle *et al.* (1987, p. 3), farm management is concerned with the decisions that affect the profitability of the farm business. A general definition for farm management presented by Boehlje and Eidman (1984, p. 14) states that farm management is the allocation of limited resources to maximise the farm family's satisfaction. Farm management includes making decisions and then executing and evaluating them. A decision is a choice, or selection of choices, from among various ways of getting a particular task done or a goal accomplished (Castle *et al.*, 1987, p. 4–5).

According to Giles and Renborg (1990, p. 400–401), four items characterise farm management: 1) the totality of the job, 2) the management of the job as not very different from other businesses, 3) several, often conflicting, objectives which can be difficult to identify and quantify and 4) the need to ensure the continuity of the business. Gasson and Errington (1993, p. 18) define six key elements of a family farm business:

1) Business ownership is combined with managerial control in the hands of business principals.

2) These principals are related by kinship or marriage.

3) Family members (including these business principals) provide capital to the business.

4) Family members including business principals do farm work.

5) Business ownership and managerial control are transferred between the generations with the passage of time.

6) The family lives on the farm.

According to Gasson and Errington (1993, p. 88), objectives are the mainspring of economic behaviour. The manager of a firm normally has a number of potentially conflicting objectives that he is trying to achieve through the business. Typical objectives for a farm business might include the maximisation of profits or returns, control of a larger business, reduction of borrowing needs, ownership of a tidy, well-kept farm, or more time spent with family. However, the prime objective for family businesses is not profit maximisation but value maximisation (*e.g.* Bellman's principle of optimality: $V_t = \max_u \{\pi_T + \beta v_{t+1}\}$ [2]) and the desire to maintain control and to pass on a secure and sound business to the next generation in succession (Pfeffer, 1989; Gasson and Errington, 1993, p. 89, 94). Decisions are taken according to their effects on current costs and returns or utility and their effects on the value of the firm in the next period.

The farmers' objectives depend on the characteristics of the farmer, the situation at the time of the decision, and the condition of the farm. The farmers' objectives are also expected to change at different stages of their life cycle because the relative importance of objectives is reflected by changes in wealth, the family situation, and age (Boehlje and Eidman, 1984, p. 9). Goals may also change in response to events in the outside world (Gasson and Errington, 1993, p. 90).

On family farms, the farm family's labour supply varies alongside the development of the family life cycle. In the late phase, ageing farmers may be willing to reduce their working hours and make their lives easier. Thus, leisure and alternative activities may be given a higher priority. This may be a way to prepare for the farm transfer, as well (Gasson and Errington, 1993). As stated above, one of the prime objectives for a family farm business is succession, and the presence or absence of a successor may have more influence upon business objectives and farm performance than the farmer's age. A farmer with a successor has a constant incentive to plan ahead and expand the farm. Elderly farmers without a successor, on the other hand, have little incentive to expand or even maintain production but tend to reduce their working hours (a shadow effect) (Potter and Lobley, 1992; Gasson and Errington, 1993, p. 96; Sonkkila, 2002, p. 96).

According to Gasson and Errington (1993, p. 25–26), allocating scarce resources within a farm business in order to achieve predefined objectives involves the farmer in three major functions: planning, implementation and control. Planning demands the prior review of alternatives, their evaluation and the identification of the activities required to implement them. Information on the available options comes both from the farmer and from the outside world. Implementation means carrying out the activities that were identified. Finally, control involves monitoring the outcomes and analysing any discrepancies between targets and actual performance (Errington, 1986).

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[2] Where V is the value function, π is the one period profit, β is the discount factor and v is the control.

Similarly, according to Castle *et al*. (1987), farm level decision making consists of goal setting, problem definition, the observation and analysis of information, decision making, implementation, the bearing of responsibility, and the evaluation of the decision made. However, according to Öhlmér *et al*. (1993, 1998), choosing a way of action does not necessarily mean implementation; there is a way back as well. Thus, the decision process consists of problem detection and definition, the collection and processing of information, analysis, the development of intention, implementation, and responsibility bearing. Analysis involves planning actions, estimating consequences, evaluating and choosing action(s). The development of intention is deciding to implement the chosen action(s). The time before a farm manager develops his intention for implementation depends on, among other factors: economic impact, consequences, time limits and support for the choice of actions. At every stage of the decision process, a farmer may receive new information affecting the decision (Öhlmér *et al*., 1993, 1998). For example, a farmer's decision to buy machinery or land is based on a long period of consideration and a short decision phase (Jacobsen, 1994).

Intentions usually change over time. Some intentions change as time passes by, when new information becomes available or when the economic situation changes (Ajzen, 1985). As Horowitz (1992) found, individuals' plans about their future activities are not intertemporally consistent, but consistency in aggregate economic behaviour is seen.

Intentions may also be delayed because of time constraints or because of the dependency of other people (Ajzen, 1985). In the case of farm succession, the implementation of intention strongly depends on the successors' willingness to take over the farm. As Kimhi and Lopez (1999) conclude, retirement and succession decisions in farm families are not separable. As a unique decision with long term effects, farm succession affects the whole family farm.

3.2 Lifetime utility

According to neo-classical economic theory, individuals always aim at maximising utility. Many studies have applied this theory to retirement decisions. Gustman and Steinmeier (1986), Stock and Wise (1990), Hakola (2002) and Chan and Stevens (2004) assume that individuals maximise their expected lifetime utility when making retirement decisions. The behavioural assumption underlying the empirical models is that individuals decide whether to retire or not based on an evaluation of lifetime utility associated with current and future retirement dates (Chan and Stevens, 2004).

Similarly, Kimhi (2000) bases his study on the theory of decision making over a life cycle when analysing the effects of part-time farming on farm exit probability. In the study, the indirect utility of the farmer is expected to differ between the choices of not working off-farm and exiting farming. Also, Kimhi and Bollman (1999) assume the farmer to maximise the present value of future utilities when making exit decisions. In this approach, utility is a function of consumption and leisure. Goetz and Debertin (2001), on the other hand, compare the expected utilities of continuing to farm and of quitting farming. Miljkovic (2000) maximises the expected present value of the net utility of transferring the farm to the succeeding child reduced by the disutility of farm transfer when defining the optimal timing of farm transfer. Kimhi (1994a) assumes farm families to maximise the present value of the farm when defining the optimal timing of farm succession.

In life cycle models, utility consists of consumption and leisure. Because of the lack of data on consumption, empirical studies on retirement usually proxy consumption by income or by exogenous instruments on farm profits, pensions, *etc*. Similarly, a preference for leisure is reflected by an earlier retirement. In these models, the utility function for an elderly individual can be divided into two parts. These are the utility derived before retirement and the utility derived after retirement (Hakola, 2002). When still farming, the farmer's utility can be approximated by farm income. After retirement, utility is approximated by the expected pension benefits. Following Hakola (2002) we have:

$$U_r(r) = \sum_{s=t}^{r-1} \beta^{s-t} u(Y_s) + \sum_{s=r}^{T} \beta^{s-t} u[B_s(r, Y_{r-1})] \quad (1)$$

In the function, U_t is the lifetime utility evaluated at time t, $u(.)$ is the period-specific utility, t is the current period, r is the period of retirement, β is the discount factor, Y is the income and B is the pension benefit (Hakola, 2002, p. 57).

3.3 Theoretical framework

The theoretical framework of the study is illustrated in *Figure* 5. The model is based on the theory presented in Sections 3.1 and 3.2 and the earlier results reviewed in Chapter 2. The model has been formed based on the model of a farmer's decision process by Öhlmér *et al.* (1993, p. 22).

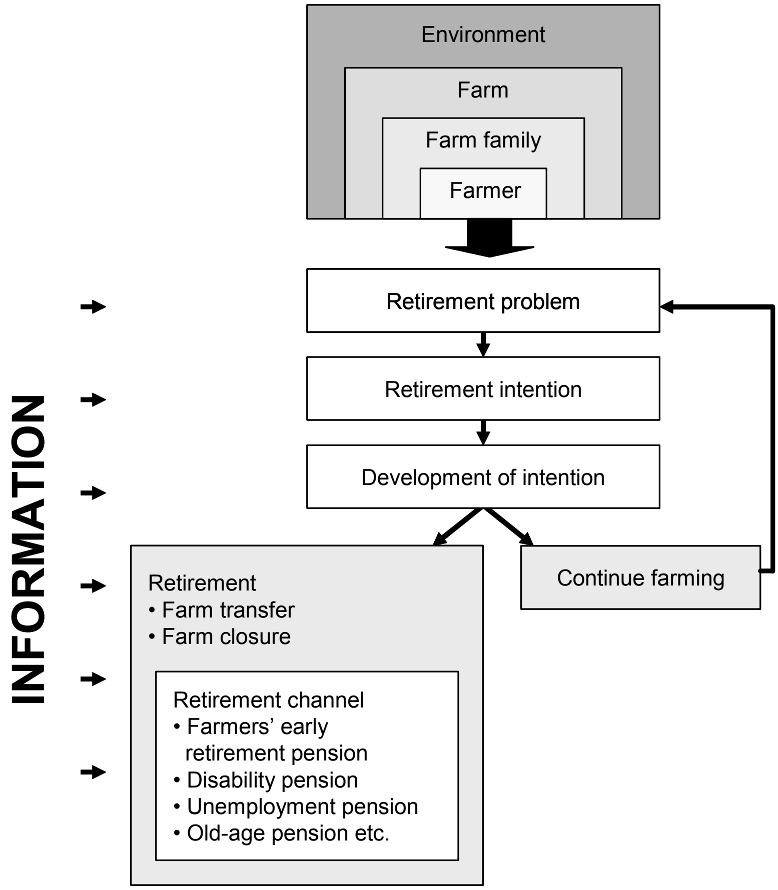

Figure 5. Theoretical framework, formed based on Öhlmér *et al.* (1993).

In the study, the elderly farmers are assumed to maximise their lifetime utilities when making retirement decisions. These decisions were expected to be affected by the farm, the farmer and farm family characteristics, and the environment (Kimhi and Bollman, 1999). In addition, the goals and values of the farmer and the farm family have an influence on farmer retirement decisions. Following Öhlmer *et al.* (1993), farmer's retirement decisions were assumed to proceed from the detection and definition of the problem of retirement through analysing the available options based on the information available for the development of the retirement intention. The development of the retirement intention may lead to retirement (implementation) or the continuation of farming. When continuing farming, an elderly farmer may reconsider retirement later on. When retiring, the elderly farmer may transfer the farm to a new farmer, sell or rent it to another farmer, sign a non-cultivation agreement, or reforest the fields.

The retirement decision is at least partially irreversible, so that once a farmer has retired it is unlikely that he will start farming again. In this study, retirement options were divided into farm transfer and closure, the latter including all other retirement options but farm transfer. The retirement utility between these two options was expected to differ. In addition, these two retirement options may affect the retirement channel chosen. For example, when there is no possible successor available, a farmer cannot consider retirement under a farmers' early retirement pension by farm succession. *Vice versa*, the chosen retirement channel may affect the farm transfer or closure decision.

3.4 Operational framework

The operationalisation of the theoretical model is based on the data available and the study approaches that were chosen. An operational framework on the retirement decision of farmers is presented in Figure 6. The operational framework of the study consists of two parts: part I deals with the development of farmers' retirement and succession intentions, whereas in part II the focus is on farmers' retirement and pension choices and factors affecting these.

Farmers' retirement decisions can be studied either *ex-ante e.g.* by farm surveys or *ex-post* by actual retirement behaviour. As revealed earlier in Section 2.1, most of the earlier studies on farm retirement are based on *ex-ante* considerations of farmers on farm surveys. However, this study is based on two different data sets of farmers' actual retirement behaviour. The first data set is farm accountancy census data complemented by a farm survey (Chapter 4). The second data set is farmers' retirement data collected from the registers of the Farmers' Social Insurance Institution (Mela) (Chapters 5, 6 and 7). Because of the multiple study questions, the study is divided into four different approaches using different data and different methods.

The intention, or stated plan in the case of the farm survey, does not necessarily lead to action (part I of the operational framework). However, these farmers' *ex-ante* considerations have not been compared to their real retirement behaviour, as for example in Chan *et al.* (2004). According to Chan *et al.* (2004), individual retirement expectations are the stronger predictors of individual retirement behaviour the closer to the relevant retirement age the individuals are. In this study (Chapter 4), it was analysed how farmers' succession considerations and actual succession behaviour correspond to each other. In the analysis, farmers were expected to decide whether or not to realise their stated succession plans based on current utility and future utility expectations. Also, the farm and farmer characteristics were expected to affect the analysis. The method and data used in this analysis are described in the following sections, Sections 3.5 and 3.6.1.

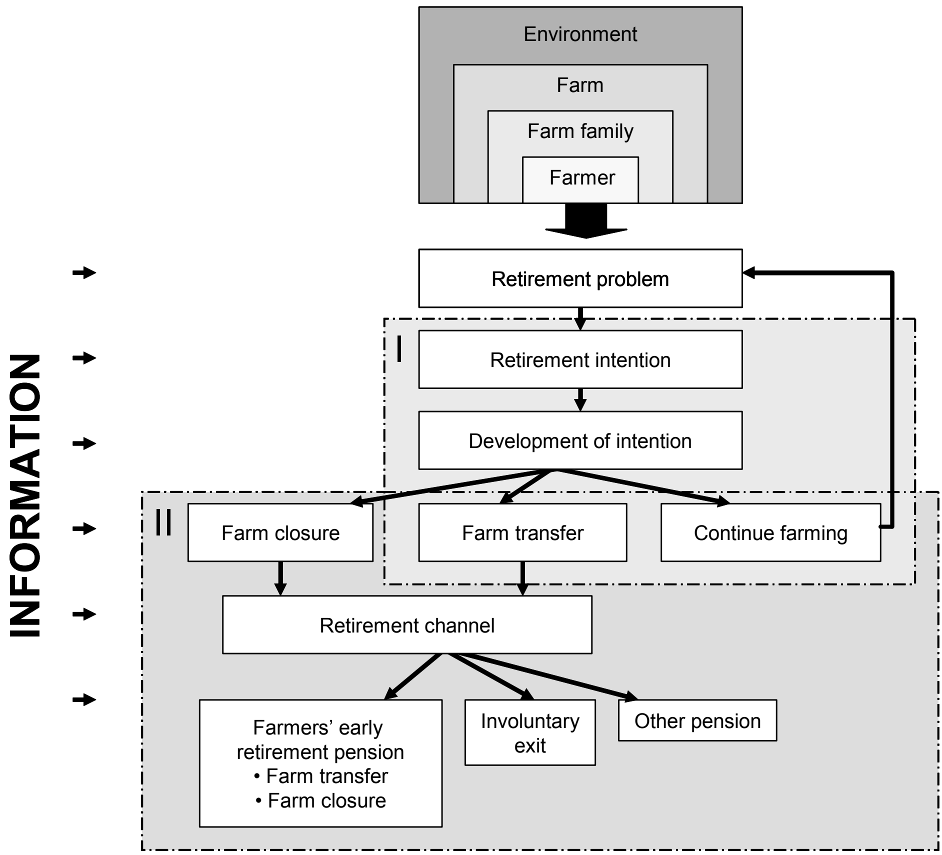

Figure 6. Operational framework.

Because of the data restrictions, there was no information available on the farmer retirement channel in the first analysis (Chapter 4, part I of the operational framework). However, as presented earlier in Section 1.3, farmers have different exit channels to choose from. In the last three analyses (Chapters 5, 6 and 7), these different options were roughly divided into the farmers' early retirement system and other pension schemes. In addition, a farmer may be forced to retire involuntarily. This division is described in part II of the operational framework. In the analyses, retirement cases under the farmers' early retirement system were further divided into farm transfers and closures. Obviously, a farmer's retirement through other pension schemes or involuntarily also includes farm transfer or a farm closure decision, but these were not observed in the data. The latter three analyses (Chapters 5, 6 and 7) deal with the type and timing of farmers' retirement and exit decisions. These approaches were based on *ex-post* farmer retirement data described in section 3.6.2.

Farmers' retirement decisions were expected to be affected by the characteristics of the farm, the farmer and farm family, and the surrounding environment. The characteristics of the farm family included the ages of the farmer and his spouse, the number and ages of the children, spousal retirement status *etc*. Farm characteristics included farm size, location, production line *etc*. The environment included both the production possibilities of the farm and the possibilities and restrictions caused by agricultural policy. Financial incentives to continue farming or to retire were determined by the characteristics of the farm family and the farm (expected pension, farm income, prices, and off-farm income).

In Chapter 5, farmers were assumed to maximise their utilities when choosing a pension scheme. In Chapter 6, spousal retirement was expected to affect the utility related to leisure and thus influence the timing of farmers' retirement decisions. In Chapter 7, farmers' indirect utility was expected to differ between farm closure and transfer. In the analysis, a farmer or farming couple maximised their expected utilities when making a decision on the timing and type of retirement. The methods used in this study are described in Section 3.5 and the economic models are further formalised in Chapters 4–7.

3.5 Methods

In the structural models (*e.g.* Stock and Wise, 1990), it is possible to estimate the parameters of the utility functions conditional on certain parametric specifications for utility (*e.g.* in Equation 1). Because the data available were highly censored, modelling the timing of early retirement quantitatively in structural form was not feasible. When a farmer continued to farm, his farming income, complemented by other income, was observed. But, when the farmer retired, only the pension income was observed. In addition, the farmer and his income data dropped out of agricultural data bases when he retired. We also have data on the opportunity cost for farming before retirement, *i.e.* pension income if the farmer had retired. Similarly, in an ideal case we would like to have had data on the opportunity cost for retirement for those farmers who had already retired (see *e.g.* Maddala, 1983). This opportunity cost is the farming income if the farmer had continued farming. Nevertheless, these data were for the most part unobserved and censored, and we approximated the model in a reduced form. Reduced form applications have been used earlier *e.g.* by Samwick (1998), Kimhi and Bollman (1999), Hakola (2002), Pietola *et al.* (2003), Chan and Stevens (2004), and Asch *et al.* (2005) when studying retirement decisions.

For the reduced form panel data, we can use either discrete choice models or duration models. In this study, probit (Chapters 5 and 7), bivariate probit (Chapters 4 and 5) and duration models (Chapter 6) were used when studying farmers' succession and retirement decisions.

In *discrete regression models*, the dependent variable assumes discrete values. This is because the observations are discrete even though the phenomenon under study is not. In *binary models*, the dependent variable under study receives the values 1 or 0 depending on whether a certain choice is observed or not. There is a variety of binary models available following different distributional assumptions. For example, the logit model assumes a logistic distribution and the probit model a normal distribution of the disturbance term. Both probit and logit models can handle situations with single as well as multiple ordered or non-ordered choices and can be estimated by maximum likelihood methods (Maddala, 1983).

In Chapter 4, farmers' succession planning and actual successions are analysed by a recursive binomial probit model. In this specification, two dependent variables receive the values 1 or 0. This means that there are two separate choice equations that are estimated recursively. Contradicting the simple probit model specification, the error terms are allowed to be correlated with each other. A joint estimation of the two decision rules (probit models) together reveals if there is dependency between them.

In Chapter 5, a univariate probit model is used to analyse the farmers' choice of retirement versus continuation of farming. In addition, simultaneous bivariate probit model is used to analyse the alternatives of choosing an early retirement pension versus some other pension scheme and transferring the farm to a new entrant or closing down the farm.

Chapter 6, which deals with spousal retirement status and the timing of retirement, is based on the *Weibull survival model*. In this approach, the timing of early retirement was measured as the duration between the time a farmer reaches the age of 55 and observed retirement. Both the survival of the farmer and his spouse were taken into account in order to study the spousal effect on farmers' retirement behaviour. In addition, the survival of those farms transferred to the new entrant and those closed down were analysed separately.

In Chapter 7, the timing and type of farmers' retirement decisions are formalised in an optimal stopping framework and simulated as a sequence of interrelated choices. In the model, there are three different occupational choices for each time period (farm transfer, closure and continuation) receiving the values 1 or 0, which are mutually exclusive and sum up to 1. The underlying structural model is derived by dynamic programming. The serial correlation is controlled for through the simulated error terms. This analysis uses the framework of Pietola *et al.* (2003), extending it with the farming couple's off-farm income allowed as endogenous in the estimation.

More detailed descriptions of the methods used and the study approaches are presented in Chapters 4–7, where the models are estimated.

3.6 Data used in this study

3.6.1 Farm Accountancy Data

The farm data on farmers' succession decisions and plans and the realisation of these plans is based on a balanced panel of 97 Finnish farms run by elderly farmers and participating in the Farm Accountancy Data Network (FADN). Farm data from the years 1996–2001 are supplemented by annual surveys on farm operators' (*ex-ante*) succession plans. The data includes detailed information on the farm characteristics and the financial situation of the farm. More detailed descriptions of these data and variable definitions are presented in Chapter 4 with the estimated models.

3.6.2 Farmers' retirement data

Data on farmers' retirement decisions were obtained from the Finnish Farmers' Social Insurance Institution (Mela) and complemented by farmers' income data and information on farmers' children by Statistics Finland. The data described farmers' actual retirement behaviour (*ex-post*). The data are a good representation of the population of elderly farmers in Finland, since the purchasing of pension insurance from Mela is obligatory for all farmers.

The data consists of a sample of 963 farms and includes information on both farm and family characteristics. The sample is a random selection of all farmers born between 1929 and 1943 and was stratified after the farmer's age corresponding to the share of all farmers at every age. All the farmers in the data set were active farmers in 1993. The data set forms a balanced panel prior to retirement and ran from 1993 to 1998. There is no information available on post-retirement income. All farmers in the data set were eligible for the farmers' early retirement scheme during the study period according to age. The oldest farmer in the data was 64 years old in 1993 and the youngest was 55 years old in the final study year 1998.

The share of farms with a spouse (being insured by Mela) is 47%, and there are 456 farms operated by couples (Table 2). Because the eligibility for the early retirement scheme is determined by the age of the older person of the married couple, the older of the spouses is defined as the farmer and the younger as the spouse. The farmer is on average 5 years older than the spouse. In addition, how many years the farmers had been farming is defined. About 82% of the farming couples in the data have children. On average, they have 2.8 children, with the older child being on average 32 years of age and the youngest on average 26 years of age.

Table 2. Descriptive statistics of the farmers' retirement data.

Variable	Mean	Std. Dev.	Min.	Max.
Farmer age (years)	58.9	4.5	43.0	77.0
Share of farmers having a spouse (%)	47.4	-	-	-
Among those households where a spouse exists:				
-Spouse age (years)	53.9	5.24	32.0	68.0
Farming years of farmer	28.6	10.2	1.0	59.0
Share of households having children (%)	81.9	-	-	-
Among the households having children:				
-Number of children	2.84	1.51	1.0	17.0
-Age of the oldest child (years)	31.7	6.23	7.0	49.0
-Age of the youngest child (years)	26.1	7.34	0.0	44.0
Arable land area (hectares)	15.4	14.4	0.0	118.0
Forest area (hectares)	51.2	63.1	0.0	856.0
Livestock (0.1)	0.33	0.5	0.0	1.0
North (0.1)	0.63	0.48	0.0	1.0
Barley subsidy (€/ hectare)	237.9	143.9	77.0	501.0
Farmer's expected pension (€/month)	608.4	141.3	0.0	1,213
Spouse's expected pension (€/month)	273.2	302.2	0.0	1,220
Agricultural income (€/year)	7,185	12,229	0.0	127,365
Share of households having off-farm income (%)	30.6	-	-	-
Share of farmers having off-farm income (%)	22.6	-	-	-
Share of spouses having off-farm income (%)	24.3	-	-	-
Among the households having off-farm income:				
-Farmer off-farm income (€/year)	22,500	42,4	0.0	324,900
-Spouse off-farm income (€/year)	28,700	47,5	0.0	212,700

Farm size is described by hectares of arable land and forest area. In this study, farms are divided according to their production line into livestock farms (dairy, cattle, pig, poultry, sheep, goat and horse farms) and other mainly arable crop farms (crop and other plant production farms). One-third of the sample farms are livestock farms. In addition, farms are divided according to their location into those located in the northern and those located in the southern parts of the country. The division is made according to the EU subsidy areas in Finland so that the northern area included areas classified as C2, C3 and C4. Almost two-thirds of the study farms are located in the northern parts of the country. In addition, the barley subsidy per hectare described the differences in the production environment between subsidy regions caused by agricultural policy.

The agricultural income of the farm describes the profitability of the farm. The expected pension of the sample farmers and spouses if retired under the farmers' early retirement scheme is also defined. The pension level depends on the insurance payments of the farmer and spouse. Like agricultural income, the off-farm income of the farmer and spouse is based on the taxation data of the farmers. Almost one-third of the study farms had off-farm income from either the farmer or the spouse. Almost 23% of all farmers and over 24% of the spouses have off-farm income, with the spouse's income being generally larger than the farmer's off-farm income. However, on farms operated by a couple, it is more often the farmer (28% of farmers) having off-farm income than the spouse (24% of spouses).

More detailed descriptions of the farmers' retirement data and the variables used in estimation are presented in Chapters 5, 6 and 7, where the models are estimated.

In Chapters 5, 6 and 7, farms and farmers are divided into different groups according to their pension channel. In Chapter 5, farms are divided into two groups according to whether the farmers chose to retire or not. The pension choice possibilities are the farmers' early retirement system, involuntary retirement (disability pension *etc.*) or retirement through another pension scheme (old-age pension *etc.*). Exits through the farmers' early retirement system are further characterised by two discrete occupational choices: an exit and the transfer of the farm to a new entrant, or an exit and the closure of the farm. Closing down the farm includes the sale or lease of agricultural resources to neighbouring farms, the reforestation of the land and lay-land agreements. Chapter 6 is concentrated on those farms choosing the farmers' early retirement system. Farmers' and spouses' other "pension choices" are included as independent variables in the analysis. Chapter 7 concentrates on the timing of farmers' early retirement either by transferring the farm to a new entrant or by closing it down. The number of sample farms, farmers and spouses choosing different pension schemes are described in more detail in Chapters 5, 6 and 7.

The correlation between dependent and independent variables is shown in Appendix 2. The dependent variables in the table (Appendix 2) are early retirement pension, farm transfer and no early retirement pension. These variables describe the choice of the pension scheme on the farm level (as in Chapters 5 and 6). As expected, the choice of an early retirement pension is positively correlated (0.708) with transfer of the farm and negatively correlated (-0.412) with the alternative of not choosing a farmers' early retirement pension. None of the dependent and independent variables are highly correlated with each other. Among the explanatory variables, it is found that the agricultural income of the farm is correlated with land (0.447) and that spousal age is correlated with the expected pension of the spouse with a correlation coefficient of 0.943. Nevertheless, endogenous income variables are instrumented in the estimation. With these exceptions, there is no indication of multicollinearity being a major problem.

3.7 Conclusions

In sum, farm management maximises farm family utility. A family farm business has certain characteristics and objectives. Decisions to close down, transfer or continue farming are affected by farm and family characteristics as well as by economic incentives offered to farmers. Different methods are used to analyse empirically the behaviour of farmers. Here a selection of approaches is used to model alternative choices. The choice of models and methods is determined by the data availability and the nature of the problem. The applications are not necessarily nested, but each of them has its benefits and limitations which complement each other. For instance, the use of univariate and bivariate models shed light on the jointness and simultaneity of two decisions. Spousal retirement and economic factors are expected to affect the timing and type of farm retirement.

4 Realisation of farmers' succession plans

4.1 Introduction

As revealed in Section 2.1, most of the earlier studies on farm retirement are based on *ex-ante* farm surveys on the probability and timing of family succession. The difference between planned and real retirement behaviour may, however, be considerable. According to Diamond and Hausmann (1984), the planned timing of retirement may change over time when an individual observes new information. Glauben *et al.* (2004a) have found inconsistency in farm operator's succession plans over time: "The extent to which farm operator's plans materialise might be related to farm and family characteristics, thus introducing bias to farm survey results" (Glauben *et al*., 2004a).

In the case of questionnaires it may be that when the person has devoted only a little time to decision making, the resulting ill-formed intentions are held with low confidence and have a weak impact on behaviour. This might have implications for measuring intention. Individuals might also feel obliged to answer questions about their intentions even though they have not yet formed real intentions (Bagozzi and Yi, 1989).

The goal of this chapter is to find out how farmers' succession considerations and actual succession behaviour correspond to each other. Furthermore, the significance of the information on succession plans, as stated by farmers in questionnaires, in predicting true, revealed successions is estimated. A stated succession plan is defined to exist when a farmer answers in a survey questionnaire that the farm is to be transferred to a new entrant within a five-year period. The succession is revealed when the farm is transferred to a successor. The problem is important because farmer surveys are often used as information sources in designing structural policy measures, such as the terms of farmer retirement programmes. The questionnaires are sent to farmers because in practice it is difficult to have enough information to draw a sample from potential successors. If the information provided by the surveys is consistent with revealed behaviour and makes predictions of true behaviour more accurate, then they are justified. However, if the survey results cannot be consistently linked to observed behaviour, then these surveys cannot be justified as they are an expensive means of attempting to provide information in order to predict behaviour.

The rest of the chapter is organised as follows: Sections 4.2 and 4.3 describe the method and data used in the analysis, in Section 4.4, the results are presented, and finally, Section 4.5 concludes the chapter.

4.2 Method

Stated and revealed behaviour was estimated as a recursive bivariate probit model. The economic model has two choice variables and decision rules to be estimated. The first choice variable (y_1) was the farmer statement of whether he is or he is not planning to transfer the farm to a new successor within five years. This answer or statement was based on a survey that was conducted annually of all farmers in the sample. The second choice variable (y_2) was the realised choice, *i.e.* the transfer of the farm to a new entrant.

The model has a recursive structure; the farmer was hypothesised to have a succession plan first, and then possibly execute the plan. Therefore, the statement on the succession plan (y_1) was entered as an endogenous explanatory variable in the equation for the realised succession (y_2):

$$\begin{aligned} y_1^{i*} &= \beta_1 x_1^i + \varepsilon_1^i \\ y_2^{i*} &= \beta_2 x_2^i + \gamma y_1^i + \varepsilon_2^i \end{aligned} \qquad (2)$$

where the superscript *i* refers to farmer *i* and an asterisk (*) refers to the uncensored latent form, which was unobserved. The matrices X_1 and X_2 included exogenous variables, such as farmer and farm characteristics. Parameters were denoted by β and the error $\varepsilon=(\varepsilon_1, \varepsilon_2)$ was assumed to be normally distributed with mean zero and the variance covariance matrix Σ, that is, $\varepsilon^i \sim N(0,\Sigma)$. The parameter γ indicated the effects of the stated succession plan whether the succession was revealed or not. It was used to test the choice of a univariate or bivariate formulation of the choices. As is the standard in Probit models, the model parameters were identified by normalising the variance of the errors at one. Under this normalisation, the variance covariance matrix takes the form:

$$\Sigma = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$$

where $\rho=Cov(\varepsilon_1, \varepsilon_2)$.

The latent form decision variables were realised as observed binary indicators such that:

$$\begin{aligned} y_1^i &= 1 \ \text{if} \ y_1^{i*} > 0, \ \text{and} \ 0 \ \text{otherwise} \\ y_2^i &= 1 \ \text{if} \ y_2^{i*} > 0, \ \text{and} \ 0 \ \text{otherwise} \end{aligned} \qquad (3)$$

In other words, if the succession plan exists, the binary indicator measuring the stated plan (y_1) equals one, or otherwise, zero. Similarly, if the farm is transferred to a successor, the revealed choice variable (y_2) takes value one, or otherwise, zero. Following Burnett (1997) and Greene (1998), the choice probabilities take the form

$$Prob\left[y_1 = 1, y_2 = 1 \mid x_{1,} x_2\right] = \Phi_1\left(\beta_1 x_1, \beta_2' x_2 + \gamma y_1, \rho\right) \quad (4)$$

The model is a recursive, simultaneous-equations model. The term entering the log-likelihood function is $P(y_1=1, y_2=1) = P(y_1=1|y_2=1)\ P(y_1=1)$. Following Maddala (1983, p. 123), the other three terms in the log-likelihood function are (Greene, 2000):

$$P_{11} = \Phi_1\left(\beta_1' x_1, \beta_2' x_2 + \gamma y_1, \rho\right) \qquad P_{10} = \Phi_1\left(\beta_1' x_1, -\beta_2' x_2 - \gamma y_1, \rho\right)$$
$$P_{01} = \Phi_1\left(-\beta_1' x_1, \beta_2' x_2, -\rho\right) \qquad P_{00} = \Phi_1\left(-\beta_1' x_1, -\beta_2' x_2, -\rho\right)$$

The likelihood function to be maximised is (Maddala, 1983):

$$L\left(\beta_2, \gamma_1, \gamma_2\right) = \prod P_{11}^{y_1 y_2} P_{10}^{y_1(1-y_2)} P_{01}^{(1-y_1)y_2} P_{00}^{(1-y_1)(-1-y_2)} \quad (5)$$

The model accounts for the censoring of the decision variables and controls for a potential correlation between the estimating equations. The parameters in the two choice equations were estimated using the standard maximum likelihood method.

The generic choice equations (2) are linear in the parameters. The set of variables includes field area, forest area, the ages of the farmer and spouse, a dummy variable concerning the production line (arable land, livestock and dairy), a dummy variable concerning the support area (north or south), total assets, farm debt and the farm family's working hours.

4.3 Data

The farm data are taken from the Finnish Farm Accountancy Data Network (FADN) over the years 1996–2001 (Section 3.6.1). These accountancy data are supplemented by a survey about the succession plans of the farmers. The supplementing survey was carried out on FADN farms in 1996 and 1997. The questionnaire included questions about farmers' plans concerning their farm and off-farm activities over the next five years. If the farmer did not intend to continue farming himself, it was asked what would happen to agricultural production. One of the nine response options was that there was to be a succession with a family successor (Appendix 3).

Table 3. Descriptive statistics of the sample farms and those continuing or exiting the Farm Accountancy Data Network during the sampling period of 1996 to 2001.

	Mean	Std. Dev.	Min.	Max.
Farms used for econometric analysis (the number of farms is 97)				
Farmer's age (years)	54.9	4.78	50.0	68.0
Spouse's age (years)	45.8	17.09	-	69.0
Arable land (hectares)	44.5	32.02	6.3	187.0
Forest (hectares)	75.2	63.9	7.1	360.6
Share of livestock and dairy farms (%)	58.9	-	0	1.0
Share of farms located in the north (%)	36.1	-	0	1.0
Total assets (10,000 €)	19.5	13.6	3.9	79.1
Farm debts (10,000 €)	4.4	6.31	0	32.1
Farm family's working hours (100 hours)	35.1	17.5	0.3	81.4
Share of farmers stating succession plan (%)	46.4	-	0	1.0
Continued in the FADN (the number of farms is 108)	Mean	Std. Dev.	Min.	Max.
Farmer's age (years)	55.1	24.8	49.0	84.0
Spouse's age (years)	45.5	38.2	-	69.0
Arable land (hectares)	43.8	24.1	6.3	187.4
Forest (hectares)	73.8	88.5	3.0	360.6
Share of livestock and dairy farms (%)	59.2	-	0	1.0
Share of farms located in the north (%)	36.5	-	0	1.0
Total assets (10,000 €)	18.9	8.0	3.9	79.1
Farm debts (10,000 €)	4.1	10.5	0	32.1
Farm family's working hours (100 hours)	34.4	24.4	0.262	81.4
Share of farmers stating succession plan (%)	41.7	-	0	1.0
Exited from the FADN (the number of farms is 48)	Mean	Std. Dev.	Min.	Max.
Farmer's age (years)	55.2	13.4	50.0	68.0
Spouse's age (years)	47.9	34.7	-	70.0
Arable land (hectares)	29.6	7.93	6.4	66.4
Forest (hectares)	82.6	11.9	1.4	312.3
Share of livestock and dairy farms (%)	60.0	-	0	1.0
Share of farms located in the north (%)	37.2	-	0	1.0
Total assets (10,000 €)	12.9	3.6	2.7	62.3
Farm debts (10,000 €)	3.8	16.7	0	26.7
Farm family's working hours (100 hours)	33.1	18.5	0.4	84.5
Share of farmers stating succession plan (%)	43.4	-	0	1.0

Only the elderly farmers who either had an option to retire immediately or were at the beginning of the study period old enough (50 years) to have a reason to state a plan to transfer the farm to a successor within the five- year period were included in the analysis. The age limit was 50 years in 1996. The FADN data included 156 farms run by a farmer aged over 50 about which the survey data were also available both in 1996 and in 1997. Of these farms, 108 continued farm profitability accountancy to 2001 and 48 gave it up during the years 1998–2001. Those 48 farms which were dropped from the data did not differ substantially from those participating in the farm profitability accountancy for the whole study period 1996–2001 (Table 3). Unfortunately, no specific information was available on the reasons for the farms' exit from the FADN. Those 11 observations where the farm operator reported plans to sell or rent out the farm to a non-family member or reforest the fields, or had some "other plans" for the following five years were further eliminated because the number of these choices was too small to estimate a separate equation for them.

In a 1996–1997 survey, 45 (46%) of the sample farms announced that the farm would be transferred to a successor within the forthcoming five years (Stated succession plan=1). Among these farms that had a plan, succession actually happened on 18 farms (Revealed succession=1), but on 27 farms the succession was delayed (Revealed succession=0). In addition, 9 farms were transferred to a new entrant even though the plan was not announced in the survey (Stated succession plan=0, Revealed succession=1) (Table 4).

The choice of exogenous instruments included in the analysis is determined according to existing literature. The ages of the farmer and spouse are expected to affect succession probability. Farm characteristics are expected to influence both the succession probability and the succession process. This is because they affect the value of the farm for the potential successor (Kimhi and Nachlieli, 2001). Variables related to farm size are arable land and forest area. In addition, total farm assets and farm debt are used to indicate the capital stock and capital structure of the farm. Farm family labour is measured in annual working hours.

Table 4. The number of stated and revealed successions in the sample.

		Revealed Succession (y_2)		
		0 (no)	1 (yes)	Total
Stated Succession Plan (y_1)	0 (no)	43	9	52
	1 (yes)	27	18	45
	Total	70	27	97

The production line is also assumed to affect succession probability and the timing of succession (Stiglbauer and Weiss, 2000; Glauben *et al.*, 2004a; Hennessy, 2002). For example, in the case of a potential successor working on the farm before succession, a successor may be more important on a dairy farm than on other types of farms (Pesquin *et al.*, 1999), and thus also the succession decision is made earlier. Moreover, a dairy farm may be seen as a more stable and reliable source of income than other farms and thus be more likely to be transferred to the next generation. Therefore a dummy variable divided livestock and dairy farms from other farms.

Farm location may also affect succession probability (*e.g.* Pietola *et al.*, 2003). The farms are divided according to the EU subsidy region to those located in the southern (coded as A and B subsidy area in the CAP) and the northern parts (C subsidy areas) of the country.

The data give no information about the potential successor or any information stated by the potential successor about whether a potential successor existed or not (however, it is assumed that when the succession plan was stated on the survey, a possible successor existed).

4.4 Estimation and results

4.4.1 Estimation and testing procedures

Parameter estimates of a recursive simultaneous bivariate probit model are shown in Table 5. In order to obtain the identification of the model, correlation coefficient rho (ρ) was restricted to zero (Wooldridge, 2002, p. 227–228). The unrestricted version of the model is presented in Appendix 4. In the unrestricted model, the estimated covariance (ρ) between the errors of the two equations was estimated at 0.998. The Wald test statistics for the null hypothesis of zero correlation between the errors was estimated at 137.19, which is more than the critical value of 10.828. Thus, the null hypothesis of zero correlation (ρ=0) can be rejected at a 0.1% level. This implies that there is dependency between the two decisions and that they are to be estimated jointly. Nevertheless, according to the estimated models, restricting the correlation coefficient to zero has no effect on the main findings of the chapter (the results are discussed in more detail in the next section).

To some extent the estimated bivariate probit model underestimated both the probability of a stated succession plan with actual succession (72.2% of the cases correctly predicted) and revealed succession without a stated plan (55.6% correctly predicted) (Table 6). But the model overestimated the probability of behaving according to the stated survey answers when having no succession plans. Whereas the model predicted 52 cases of neither having a stated succession plan nor being transferred to a new entrant, there were only 43 farms in the sample with these qualities. The predicted number of farms having succession plans without being actually transferred to the next generation corresponded to the number of this kind of farm in the sample.

Table 5. Parameter estimates of the recursive probit model of Equations 2 and 3 (t values in parentheses).

	Stated Plan Equation		**Revealed Succession Equation**	
Explanatory variable	Coefficient	*t* value	Coefficient	*t* value
Intercept	-4.3067**	(-2.470)	-12.4009***	(-3.026)
Farmer's age	0.6469*	(2.197)	1.9032**	(2.948)
Spouse's age	0.1372	(1.235)	-0.0137	(-0.088)
Arable land area	0.0877	(0.097)	0.8225	(0.867)
Forest area	-0.4120	(-1.249)	0.0173	(0.050)
Livestock and dairy farm	0.4120	(1.286)	0.5821	(0.866)
North	0.5669	(1.527)	0.6695	(1.661)
Total assets	0.1129	(0.493)	-	-
Farm debts	0.1404	(0.570)	-	-
Family labour	-0.1291	(-1.114)	-0.0032	(-0.018)
Stated plan	-	-	0.5141	(0.987)
Disturbance correlation ρ	0.0000			
Log likelihood		-100.046		

*** A triple asterisk denotes significance at a two-sided 1% level.
** A double asterisk denotes significance at a two-sided 5% level.
* An asterisk denotes significance at a two-sided 10% level.

Table 6. Predicted and observed probabilities based on the recursive probit model.

	Model	**Revealed succession**		
Cases	Observations	0	1	Total
No stated succession plan	Observed	43	9	52
	Predicted	52	5	57
Stated succession plan	Observed	27	18	45
	Predicted	27	13	40
Total	Observed	70	27	97
	Predicted	79	18	97

4.4.2 Estimation results

The only significant variable explaining the probability of having a stated succession plan was the age of the farmer (at a 10% level). In addition, the dummy variable for northern location was significant at a 12% two-sided risk level (Table 5). These factors were also found to be significant or almost significant when estimating a univariate probit model for a stated succession plan (Appendix 4). The results hold together with earlier findings of *e.g.* Glauben *et al.* (1999) that the probability of succession plans first increases by farmers' age. Similarly, Pietola *et al.* (2003) have found succession to be more likely in northern parts of the country. Based on the estimated univariate models, farm assets and debt were not assumed to have an influence on actual succession probability but on the probability of having a stated succession plan, and were not included in the model.[3]

Similarly to the findings on factors affecting the probability of succession planning, farmer age was found to increase the probability of actual succession significantly (at a 5% level) and northern location almost significantly (Table 5). These factors were also found to be significant in the univariate probit model for succession and in the unrestricted bivariate probit model in which the error correlation between the equations was allowed to differ from zero (Appendix 4). One reason that succession plans are realised more often in northern parts of the country is the fewer alternative employment opportunities for the successor.

According to the results, the endogenous variable stated succession plan was not found to match actual succession behaviour. In the unrestricted model, the probability of actual farm succession was found to decrease when having a stated succession plan (Appendix 4). This unexpected result may either be caused by data that are not informative enough, or it may suggest that farmer statements do not necessarily add information when predicting actual farm successions. In order to obtain identification of the model, a restricted model was estimated. In the restricted model, having a stated succession plan was not found to significantly affect actual succession probability. The result corresponds to earlier findings of Glauben *et al.* (2004a) that farmers' succession considerations are time inconsistent. Restricting the correlation to zero had no effect on the other parameters nor on the significance of the other parameters.

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[3] These are called exclusion restrictions. Farm debt and assets were not found to have a significant affect on the probability of having a stated succession plan nor on the probability of actual succession based on estimated univariate probit models (Appendix 4). Dropping out less significant variables had no effect on the signifi-cance of other parameters.

4.5 Conclusions

This chapter estimated a recursive probit model for farmers' stated succession plans and the revealed farm successions on these farms. The farm data were the Finnish Farm Accountancy Data (FADN) and a questionnaire carried out on those farms in 1996 and 1997. The data consisted of 97 elderly farmers, and 45 of them stated a plan to transfer the farm to a family successor within a five-year period. Nevertheless, only 40% of these plans were realised in that the farm was actually transferred to the next generation during the years 1998–2001 as planned. In addition, farm succession took place on about 17% of the farms which did not state any succession plan on the questionnaire.

According to the results, both the probability of having a stated succession plan and actually transferring the farm to a new entrant increase by farmer age. Also, northern location was found to increase the probability of both planning succession and actual succession, suggesting that the potential successors have fewer occupational options in the north than in the south. The indicated results on the stated succession plans and actual succession are, consistent with earlier literature.

Nevertheless, the stated succession plans are not found to increase the probability of actual succession. The results clearly suggest that the farmer statements, usually collected in farmer surveys, do not add information that is significant in predicting actual, revealed farm successions. A reason for the irrelevance of the information generated by farmer surveys is that the stated plans, as supplied by the elderly farmers, may be inconsistent over time and conflicting with the views, expectations or plans of the potential successors. As Glauben *et al.* (2004a) suggest, farmers' succession considerations are time inconsistent. The observed behaviour may, therefore, be steered more by other circumstances and factors rather than the farmer's stated plans. This is also why it is better to use farmers' actual retirement data than farmers' stated plans when analysing farm retirement.

5 Farmers' retirement decisions and choice of pension system

5.1 Introduction

As farmers' occupational choices determine the characteristics of structural change in agriculture, it is important to find out what the key determinants of farmers' retirement decisions are. In this chapter, the elderly farmers' choice of pension scheme is analysed. Furthermore, it is analysed how farm and family characteristics and economic incentives affect the farmers' retirement decisions and choice of pension schemes. In the analysis, the farming couples are first grouped into those retiring and those continuing to farm. Those retiring choose either the farmers' early retirement scheme or some other pension scheme. Exits by the farmers' early retirement system are further characterised by two discrete occupational choices: an exit and the transfer of the farm to a new entrant, or an exit and the closure of the farm. Exits by other pension schemes are divided into involuntary exits (disability pension, *etc.*) and old age and other pension forms (Figure 7).

The rest of the chapter is organised as follows: the model used in the analysis is outlined in Section 5.2, the data are described in Section 5.3, in Section 5.4, the results are presented and discussed, and Section 5.5 concludes.

5.2 Method

The issues studied in this chapter deal with farmers' exit decisions and their choice of exit channel. For a complete schematic picture of the set of exit choices see Figure 7. First, the farmers' decision to continue or to retire is analysed by a univariate probit model. The method has been presented in Chapter 4 (Appendix 4). Since there are no farms exiting involuntarily, a binary probit model is also used when analysing the choice of a retirement channel among those farmers choosing to retire. The bivariate probit model is formulated to analyse (i) the choice of an early retirement pension and (ii) farm transfer to the next generation. The alternative retirement options of old-age pension and other pension schemes are not further analysed in this study.

The bivariate probit model is estimated to analyse the dependency of two possibly interdependent alternative choices. The system of two equations was described earlier in Section 4.2 (Equation 2). In this chapter, a bivariate probit model is used to evaluate the effects of programme participation to isolate the programme effects. The prior expectation is that the intergenerational transformation of farms might affect the choice of a retirement scheme.

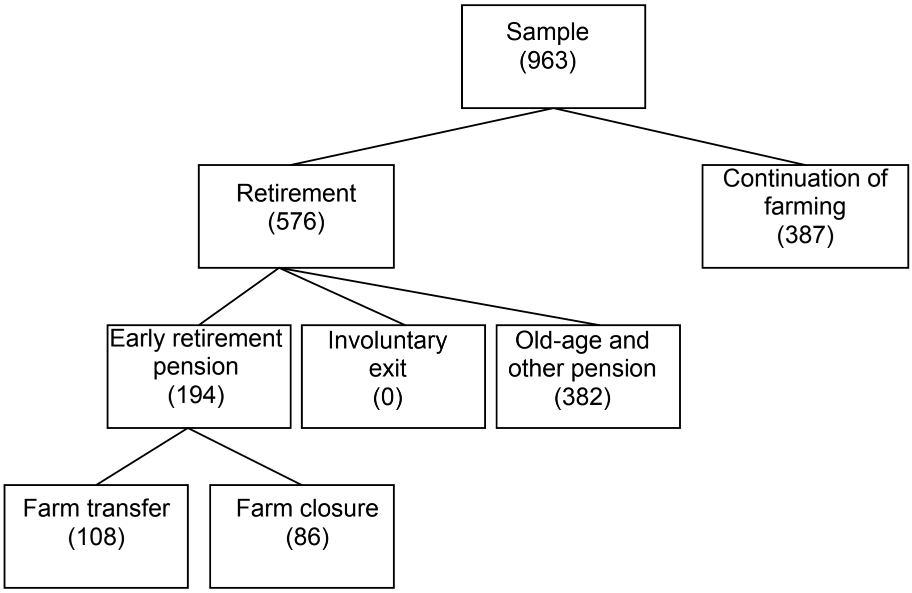

Figure 7. Division of farms and farmers according to their retirement choice, choice of pension scheme and the number of sample farms in each group.

The first choice variable (y_1) is the farmer's choice of a retirement system. The second choice variable (y_2) is the transfer of the farm to a new entrant or its closure. In the model, the retiring farmer is hypothesised to first choose a farmers' early retirement system or not, and then to transfer the farm to a new entrant. Unlike in Chapter 4, the first choice variable (y_1) does not enter as an explanatory variable in the second equation (y_2). The specification for the two-equation model is (Greene, 2000):

$$y_1^{i*} = \beta_1' x_1^i + \varepsilon_1^i \qquad (6)$$
$$y_2^{i*} = \beta_2' x_2^i + \varepsilon_2^i$$

In the model, the binary indicator measuring the choice of the farmers' early retirement system (y_1) equals one if a farmers' early retirement pension is chosen, and the value zero if other pension schemes are chosen (Equation 3). Similarly, if the farm is transferred to a successor, the choice variable (y_2) takes the value one and, if it is closed, it takes the value zero. The bivariate probability is (Greene, 2000):

$$Prob[y_1 = 1, y_2 = 1] = \Phi_2\left(\beta_1' x_1, \beta_2' x_2, \rho\right) \qquad (7)$$

In the data set, farm transfer or closure may only be observed when the early retirement pension is chosen. Similarly, choosing other pension schemes may be observed only when not choosing the early retirement scheme. In other words, y_2 is only observed when y_1=1. This is a type of sample selection model[4] (Greene, 2000). Following Greene (2000) only three terms enter in the log-likelihood function:

$$P_{11} = \Phi_1\left(\beta_1^{'}x_1, \beta_2^{'}x_2, \rho\right)$$
$$P_{10} = \Phi_1\left(\beta_1^{'}x_1, -\beta_2^{'}x_2, -\rho\right)$$
$$P_0 = 1 - \Phi\left(\beta_1^{'}x_1\right)$$

The choice of a retirement system is only analysed for the group of sample farms that are retiring. In order to account for this endogenous retirement choice, an Inverse Mill's Ratio[5] estimated for the univariate probit model for retirement choice is added to the analysis.

5.3 Data

5.3.1 Data description

This chapter is based on the farmers' retirement data described earlier in Section 3.6.2. In the analysis, the farms are divided according to the choice of the pension scheme of the farmer and his spouse into different groups (Figure 7). The choice of the farmers' early retirement scheme and farm transfer are the dependent variables. Out of the 963 sample farms, 387 continued farming whereas 576 retired. One-third of retiring farms (194 farms) chose to retire within the frame of a farmers' early retirement pension (Appendix 5). Out of these farms, 108 were transferred to a new entrant and 86 were closed down. Two-third of retiring farms chose old age or other pension systems (382 farms). There are no farms where both the farmer and spouse exited involuntarily (*e.g.* due to death, disability pension, *etc.*). Descriptive statistics of the data characterising different groups of farms eligible for pension schemes and farm transfers are presented in Table 7.

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4 With the two variables reversed, the model is identical to the Meng and Schmidt (1985) partial observability model where only y1*y2 is observed if y1=0 (Greene, 2002).

5 The Inverse Mill's Ratio variable is computed as $\lambda = \phi/\Phi$ if z=1, $\lambda = -\phi/(1-\Phi)$ if z=0.

Table 7. Descriptive statistics of the farmers' retirement data, 1993–1998.

Model variable	Mean	Std. Dev.	Min.	Max.
All sample farms NT=5,778[a)]				
Farmer age (years)	58.9	4.5	43.0	77.0
Spouse age (years)	53.9	5.2	32.0	68.0
Spouse (0,1)	0.47	0.5	0.0	1.0
Farming years of farmer	28.6	10.2	1.0	59.0
Number of children	2.3	1.7	0.0	17.0
Age of the oldest child (years)	25.7	13.3	0.0	49.0
Land area (hectares)	15.4	14.4	0.0	118.0
Forest area (hectares)	51.2	63.1	0.0	856.0
Livestock and dairy farm (0,1)	0.33	0.51	0.0	1.0
North (0,1)	0.63	0.48	0.0	1.0
Trend (1993=1)	3.5	1.7	1.0	6.0
Income loss of early ret., (€) year [b)]	2,749	8,065	0.0	109,353
Agricultural income per farm, (€) year	7,185	12,229	0.0	127,365
Off-farm income per farm, (€) month	3,106	8,247	0.0	111,424
Share of subsidy[c)]	0.9	14.6	0.0	962.4
Retirement, NT=3,456				
Farmer age (year)	60.3	4.3	43.0	70.0
Spouse age (years)	55.6	5.7	46.0	68.0
Spouse (0,1)	0.31	0.46	0.0	1.0
Farming years of farmer	30.3	10.1	2.0	59.0
Number of children	2.3	1.8	0.0	17.0
Age of the oldest child (year)	26.5	14.4	0.0	49.0
Land area, (hectares)	14.6	14.1	0.0	111.0
Forest area, (hectares)	49.9	62.5	0.0	856.0
Livestock and dairy farm (0,1)	0.31	0.46	0.0	1.0
North (0,1)	0.63	0.34	0.0	1.0
Trend (1993=1)	3.5	1.7	1.0	6.0
Income loss of early ret., (€) year [b)]	4,019	10,622	0.0	109,353
Agricultural income per farm, (€) year	5,507	11,486	0.0	127,3665
Off-farm income per farm, (€) month	1,556	5,308	0.0	62,471
Share of subsidy [c)]	0.4	8.3	0.0	95.2
Early retirement pension, NT=1,164				
Farmer age (years)	59.4	3.9	50.0	70.0
Spouse age (year)	55.8	3.9	43.0	66.0
Spouse (0,1)	0.71	0.46	0.0	1.0
Farming years of farmer	30.5	8.4	4.0	53.0
Number of children	2.6	1.9	0.0	17.0
Age of the oldest child (year)	29.1	11.1	0.0	47.0
Land area (hectares)	21.3	14.3	0.0	97.0
Forest area (hectares)	52.5	48.8	1.0	338.0
Livestock and dairy farm (0,1)	0.28	0.45	0.0	1.0
North (0,1)	0.64	0.48	0.0	1.0
Trend (1993=1)	3.5	1.7	1.0	6.0
Income loss of early ret., (€) year [b)]	3,789	11,261	0.0	109,353
Agricultural income per farm, (€) year	8,592	15,795	0.0	127,365
Off-farm income per farm, (€) month	1,372	5,411	0.0	48,648
Share of subsidy [c)]	0.3	2.2	0.0	60.3

a) The number of farms, periods and observations is 963, 6 and 5,778, respectively.
b) Agricultural income minus expected early retirement pension (per farm).
c) (Subsidy for barley per hectare * land size)/agricultural income per farm.

When comparing the differences between groups, the farmers choosing the farmers' early retirement system were older and the spouses slightly younger than those choosing other retirement schemes. They also had a smaller dispersion in the couple's ages. The same applies to the years of farming. Farms choosing the early retirement system were more often operated by a couple. The share of couples choosing a farmers' early retirement pension is 71%, which is higher than average in the sample. Farmers choosing the early retirement system also had more children. On average, the oldest child is older for the retiring farms than for all sample farms, especially for the farms choosing early retirement. Farms choosing an early retirement pension were to some extent larger than other retiring farms or other farms in the sample measured by the size of arable land and forest area. Farms choosing the early retirement system are also more often specialised in other production activities than in livestock. Because livestock production has a higher agricultural income than all other types of farms, the income loss is also greater (as well as its dispersion among farms) when retiring by choosing the farmers' early retirement system. These farms have lower off-farm income than other farms in the sample.

5.3.2 Variable definitions

The *explanatory variables* included in the analysis are selected with reference to the practice in the existing literature, according to data availability and the *a priori* expectations of the factor influences. The variables included in the analysis explaining farm family characteristics are the ages of the farmer and spouse, the number of years a farmer had been farming, the existence and number of children and the age of the oldest child.

In the analysis, the economic incentive to retire is measured as an income loss of the farmer and spouse when retiring using the farmers' early retirement schemes. The income loss is measured as the difference between agricultural and forestry incomes before retirement and the expected pension benefit when retired. Income loss was measured annually in the aggregate for the farming couple. In pension studies, replacement ratios (the ratio between the expected pension and income before retiring) are often used when modelling withdrawal from the labour market because it is believed that it is the ratio of the expected pension benefit and expected wages that matters rather than the income levels (Hakola, 2003). In this chapter, however, income loss when retiring is used. The income loss is on average 38.2% of agricultural income with a very large dispersion.

Off-farm income is used as an explanatory variable in the analysis to reflect a higher propensity to exit farming. The sample average is 43% of agricultural income with a large dispersion.

To capture the effects of size, the size of the farm is measured by the size of the farmland and forestland, both measured in hectares. The farm's regional location and production line may also significantly influence the timing of a farmer's retirement. In this study, the dummy variable livestock describes the production line and the dummy variable north the northern location of the farm.

In addition, in order to capture the effect of subsidies, a variable defining the share of the subsidy is formed by multiplying the area subsidy for barley per hectare by the farm's land area and dividing the sum by agricultural income per farm. The new variable is included in the analysis simply because farms in northern southern parts of the country differ from each other by land and forest area. The interaction variables south-land and north-forest are obtained by multiplying land area and forest area by dummy variables indicating north and south. The variable trend is defined so that for 1993 it receives the value 1 and for the final year 1998 it receives the value 6.

5.4 Estimation and results

5.4.1 Model specification, estimation and performance

An analysis of farmers' decisions in response to proposed pre-retirement pension plans, as described previously, is made by a bivariate probit model of early retirement and farm transfer. Parameter estimates for the bivariate sample selection model are shown in Table 8 and the predicted probabilities of the model are reported in Table 9. The univariate probit model for the farmers' retirement decision is presented in Appendix 6.

The data were a balanced panel data set. The estimated bivariate probit model was mainly based on cross-sectional information in the choice variable, but year-to-year changes in the variables explaining the choices were accounted for. This means that no attention was paid in the estimation to which year the farming couple retired, but to whether they retired in the first place and in what way. Farms in the data set differed from each other by land and forest area, location and production line. Thus, they formed a heterogeneous group. The heterogeneity was accounted for by using relevant covariates.

The results suggest that the estimated probit model coefficients are jointly statistically significant at any conventional level of significance, as measured by the likelihood ratio test. Here the test was based on log likelihood obtained from the unrestricted models specified as reported in Table 8 and those restricted where all or subsets of the slope coefficients are assumed to be zero. The test results rejected the restricted models in favour of the unrestricted model specifications.

Table 9 shows that 33.7% of the retiring farmers chose a pre-retirement pension. Given that the early retirement pension is chosen, a total of 55.7% selected intergenerational transfer, whereas 44.3% of these farms were closed down.

The estimated bivariate model underestimated both the probability of transferring the farm to a new entrant and closing the farm down when choosing early retirement (Table 9). It also overestimated the probability of choosing other pension schemes. The observed and predicted probabilities of different stages are given in Table 9.

Table 8. Parameter estimates for the bivariate probit sample selection model.

	Early retirement Equation		**Farm transfer Equation**	
	Coefficient	*t* value	Coefficient	*t* value
Constant	3.0481**	(2.761)	-9.4073***	(-3.263)
Farmer age /10	-0.7893***	(-4.357)	1.5136***	(3.250)
Spouse age /10	0.2604***	(8.846)	-0.3295***	(-4.028)
Farming years /10	0.1259***	(3.381)	0.1555	(1.690)
Number of children	0.0512**	(2.702)	0.1555***	(3.634)
Age of the oldest child /10	-	-	0.4264***	(6.366)
Land area /10	0.8462***	(6.345)	0.5748*	(1.866)
Forest area/10	-0.0035	(-0.441)	0.0726***	(5.052)
Livestock and dairy farm	-0.2532***	(-3.858)	-0.0965	(-0.808)
Northern location	-0.7218***	(-3.041)	-0.9629	(-1.291)
Trend	-0.0159	(-0.525)	-0.4153***	(-5.098)
Income loss of early ret., ln	9.0432***	(4.199)	-	-
Agricultural income, ln	-0.0932***	(-8.021)	-0.1697***	(-6.685)
Off-farm income, ln	-0.0168	(-1.528)	-0.0161	(-0.681)
Share of subsidy	-	-	-1.6782***	(-2.992)
South-land	-0.6263***	(-4.698)	-0.2652	(-0.920)
North-forest	0.0049	(0.347)	-0.0164	(-0.581)
Inverse Mill's Ratio Retirement	0.7804**	(2.761)	1.8683**	(2.819)
Disturbance correlation	-0.3625	(-1.456)		
Log likelihood	-1907.503			
Number of 0/1 obs.	2,293/1,164		516/648	
Total number of obs.	3,456		1,164	

*** A triple asterisk denotes significance at a two-sided 1% level.
** A double asterisk denotes significance at a two-sided 5% level.
* An asterisk denotes significance at a two-sided 10% level.

Table 9. Predicted and observed probabilities based on the bivariate probit sample selection model.

	Model	**Farm transfer**					
Cases	Observations	0	%	1	%	Total	%
No early retirement pension	Observed	0	0	0	0	0	0
	Predicted	108	9.3	267	22.9	375	32.2
Early retirement pension	Observed	516	44.3	648	55.7	1,164	100
	Predicted	298	25.6	491	42.2	758	67.8
Total	Observed	516	44.3	648	55.7	1,164	100
	Predicted	406	34.9	758	65.1	1,164	100

5.4.2 Results

The likelihood of transferring the farm to the next generation was higher than the likelihood of closing down the farm in those farms choosing a farmers' early retirement pension. The estimated correlation coefficient (ρ=-0.3625) was negative and significantly different from zero only at a 14.6% level, indicating that there is no dependency between these two decisions (Table 8). This implies that the two successive decisions are not to be estimated jointly.

Most of the parameter estimates reported in Table 8 were significantly different from zero at a less than 1% level of significance. Forest area, trend, off-farm income and the dummy variable north-forest were insignificant at a less than 10% level when modelling the choice of the farmers' early retirement system, and age of the oldest child, northern location, livestock farm, off-farm income and south-land and north-forest when modelling farm transfer.

Among other most significant factors influencing the probability of choosing a farmer's early retirement pension were the ages of the farmer and the spouse. Contradictory to each other, the age of the farmer is found to significantly decrease the probability of early retirement but to increase the probability of farm succession. Earlier studies have found that the probability of transferring the farm to a new entrant first increases with the farmers' age, but the effect reverses after a certain age (e.g. Kimhi and Bollman, 1999; Stiglbauer and Weiss, 2000; Kimhi and Nachlieli, 2001 and Pietola *et al.*, 2003). The older the spouse, the higher the probability of early retirement and the smaller the probability of farm transfer to a successor is. However, the number of years the farmer has been farming is found to significantly increase the probability of choosing the farmers' early retirement system.

The more children the farming couple has, the more likely early retirement and farm succession are. Also, Stiglbauer and Weiss (2000) and Glauben *et al.* (2004) have found that the number of children living on a farm increases the probability of succession. Similarly, the older the oldest child is the more likely succession is to take place.

Among other factors increasing the probability of choosing early retirement and farm transfer is the size of the farm. This result is in agreement with earlier findings, among others, Gasson *et al.* (1988), Stiglbauer and Weiss (2000), and Kimhi and Nachlieli (2001), who found that the larger the farm, the more likely succession and the less likely farm closure is. The existence of forest area is also found to increase farm succession probability.

The probability of early retirement decreases if a farm is a livestock farm. The same is true of the farms located in northern parts of the country. Farms in the north are smaller than in the south and have limited potential for development. However, the interaction term between southern location and land area is unexpectedly negative.

The parameter loss of income realised at retirement was unexpectedly positive. This might be due to the fact that farmers owning productive and profitable farms who selected early retirement had a higher probability of taking advantage of the retirement offers as a measure towards an advanced intergenerational transfer of the farm. In line with earlier research, we expected a negative relationship. As a matter of sensitivity analysis, we estimated the same model specification by excluding the income loss variable. The exclusion of income loss did not have any significant effect on the performance of the model in terms of correctly predicted probabilities and did not affect the remaining coefficients concerning changed signs.[6]

Overall farm income decreased the probability of early retirement and farm succession. Also, the larger the share of the subsidy of farm income was, the less likely was the transfer of the farm to a new entrant. Off-farm income was not found to significantly affect retirement and farm succession probability. Earlier it has been suggested *e.g.* by Stiglbauer and Weiss (2000) that part-time farming decreases the succession probability and increases the probability of other types of farm exits. Farm income also has an influence on the level of the farmer's pension when retiring. The trend in the frequency of farm succession was negative, reflecting a positive response by farmers at the early stage of its introduction when transferring their farms to a new entrant.

[6] These results are not reported here due to limitations of space. Results not reported here can, however, be ob-tained from the author upon request.

The Inverse Mill's Ratio estimated in the univariate probit model for retirement was positive and significant at a less than 5% level for both choosing the farmers' early retirement pension and transferring the farm to a new entrant.

5.5 Conclusions

This chapter analysed the effects of farm and farm family characteristics, economic incentives and off-farm income on farming couples' retirement decisions and their choices of pension system. The existing pension systems available were broadly divided into the farmers' early retirement system and all other forms of normal retirement. In addition to retirement, the farming couple could continue farming.

The choice of the farmers' early retirement system was further divided into farm transfers to a new entrant and farm closures. This analysis was distinguished from earlier similar studies by focusing on farms as units, rather than on farmers, as is the case in many earlier studies. This is partly because of the restrictions involved with farmers' early retirement systems, according to which a decision to transfer or close down the farm concerns all farming activities. Also important to consider is that one of the spouses may continue farming, although the other one retires involuntarily or under another pension scheme. The analysis presented here was based on a bivariate probit model.

The results of the bivariate probit model where two successive decisions are jointly estimated suggests that the choice of the farmers' early retirement system and the transfer of the farm to a new entrant are not dependent on each other and are not necessarily to be estimated jointly rather than separately.

The results in general suggest that the probability of retiring by means of the farmers' early retirement scheme decreases and transferring the farm to a new entrant increases according to the farmer's age. The effect is reverse to the spouse's age. Moreover, the longer a farmer had been farming, the more likely early retirement was. Choosing a farmers' early retirement pension and transferring the farm to a new entrant were more likely on those farms having more children. Farm transfer was an increasing function of the age of the oldest child. Both these findings are consistent with earlier results.

The probability of choosing the farmers' early retirement system was less likely in northern parts of the country and on livestock farms. However, the bigger the farm, the more likely early retirement and farm transfer were and the less likely farm closure was.

In sum, the analysis presented in this chapter results in the identification of important factors in the decision of choosing to retire early and the subsequent decision regarding the transfer or the cessation of farm operations. Despite some variations in significance and the effects of each factor, the ages of the farmer and the spouse, the ages and number of potential successors, farm size, income loss when retiring, and the location of the farm together with its production line were found to be the most important determinants of early retirement and the transfer or closure of farms.

6 Spousal effect and timing of retirement

6.1 Introduction

In earlier studies, couples have been found to co-ordinate their retirement decisions out of the desire to spend their leisure time together. Financial factors have also been found to have an effect (*e.g.* Blau, 1997, 1998; Gustman and Steinmeier, 2000). Glauben *et al.* (2004a), on the other hand, found farm succession to be postponed if the farmer's spouse works on the farm. The reason for this might be financial or quite simply, the non-ability of the one spouse alone to take care of all farming activities. In the case of early retirement, the joint retirement of a farming couple may be strongly affected by regulations according to which all entrepreneurs must give up farming activity when one of them applies for the farmers' early retirement scheme. However, as the dependency of farming households on farm income has diminished (Figure 1), the effect of these regulations may have also decreased.

Increasing off-farm labour participation and off-farm income may have increased the economic independence of farming couples. The increased economic independence of the spouse may further contribute to the farmer's exit and retirement decisions. Farm income is found to encourage farm successions (Hennessy, 2002), but when dependency on farm income decreases, the probability of farm succession is expected to decrease and the probability of farm exits and closing down the farm to increase (*e.g.* Gasson and Errington, 1993; Weiss, 1999).

This chapter analyses the impact of expected pension, off-farm income and spousal retirement status on the timing and type of farming couples' early retirement decisions. In addition, it is analysed how the farming couples co-ordinate their exit decisions and under what conditions individual retirement decisions result in farm level changes, *e.g.* farm successions or farm closures. Analyses are based on a duration model. The rest of the chapter is organised as follows: Sections 6.2 and 6.3 describe the method and data used in the analysis, the results are presented in Section 6.4, and Section 6.5 concludes.

6.2 Method

6.2.1 Duration model

Farm transfer and closure are farm level decisions. Since the farmer or the spouse may continue farming even though one of them has retired by through a disability pension or old-age pension, the timing of farm transfer or closure depends on the retirement decision of both spouses. When analysing the survival of the farming couple before early retirement, the duration spell is defined as the number of years that a farmer or spouse, or both of them, continued farming after the farmer reached the age of pension eligibility at 55 years. The duration spell is defined by the ages of the farmer and the older of the spouses is defined as the farmer in the data. Both the eligibility and the ages of the farmer and spouse were taken into account. This means that the duration spell varies among farms between a minimum of one year and a maximum of 20 years. A spell with a duration of one year was assigned if the farmer or spouse retired in the same year that the farmer reached the age of 55. The maximum duration of 20 years was assigned if both the farmer and a spouse 10 years younger than the farmer were eligible for the early retirement scheme but neither of them applied for it before the age of 65. This would mean that the farmer and then the spouse, who was 10 years younger, both had a duration spell of 10 years. The presentation of the duration model below follows Kiefer (1988), Greene (2000) and Wooldridge (2002).

In the analysis, T was the length of time before the farmer (or spouse) retired. The duration spell $T \geq 0$ varied in the population, and t denoted a particular value of T. The cumulative distribution function (CDF) of T is defined as (Kiefer, 1988)

$$F(t) = P(T \leq t) \quad , t \geq 0 \tag{8}$$

where P denotes probability. The probability of surviving past time t was given by the *survival function*

$$S(t) \equiv 1 - F(t) = P(T > t) \tag{9}$$

Given that the spell lasted until time t, the probability of it ending in the next interval of time $[t, t+h]$ is

$$P(t \leq T < t + h \mid T \geq t) \tag{10}$$

A function for characterising this aspect of the distribution is the *hazard rate*

$$\lambda(t) = \lim_{h \downarrow 0} \frac{P(t \leq T < t + h \mid T \geq t)}{h} = \frac{f(t)}{S(t)} \tag{11}$$

where $f(t)$ denotes the density of T, and for each t, $\lambda(t)$ is the instantaneous rate of leaving per unit of time (Wooldridge, 2002). Applied to the early retirement of farming couples, the hazard function gave the probability of early retirement, given that the farmer or the spouse had not retired before.

Duration analysis has a variety of distributions from which to choose for modelling. For example, for the Weibull distribution, the hazard function is either monotonically increasing or decreasing depending on the value of parameter p, and for the exponential distribution, the hazard function is constant (Kiefer, 1988; Wooldridge, 2002). In this study, based on the expected shape of the distribution hazard function with positive duration dependence, the Weibull distribution was chosen.[7] Positive duration dependence in this case means that the hazard rate of retirement is increasing in *t*. Thus, a farmer or spouse was more likely to retire at time *t* given he/she had not retired until time *t*. The density function of the Weibull-distributed random variable is

$$f(t) = \lambda p(\lambda t)^{p-1} \exp(-(\lambda t)^{p}) \tag{12}$$

The corresponding survival function is

$$S(t) = \exp(-(\lambda t)^{p}) \tag{13}$$

And the hazard function is

$$\lambda(t) = \lambda p(\lambda t)^{p-1} \tag{14}$$

The parameters λ and p can be estimated by the method of maximum likelihood. In this study, the sample period ran from 1993 to 1998. If neither the farmer nor the spouse chose early retirement during the study period (retirement time was not observed) or they both chose other pension schemes, the observation is censored (right censoring). This is because according to the restrictions, farmers are no longer eligible for the farmers' early retirement scheme after utilising other pension schemes. Censored observations are incorporated in the log likelihood function as

$$\ln L = \sum_{\text{uncensored observations}} \ln f(t \mid \theta) + \sum_{\text{censored observations}} \ln S(t \mid \theta) \tag{15}$$

where $\theta = (\lambda,p)$ (Greene, 2000). Since the timing of early retirement was expected to be affected by farm and family characteristics *etc*., a parametric approach was chosen. In the Weibull model, let

$$\lambda_i = \exp(-\beta' x_i) \tag{16}$$

where i indexes individuals, x_i includes a constant term and a set of variables which do not change from time $T = 0$ to $T = t$, and β is a parameter vector. Making λ_i a function of a set of regressors is the same as changing the units of measurement in the time axis. The regressors have no affect on the duration dependence, which is a function of p. Let $\sigma = 1/p$ and

[7] The results based on other distributions commonly used in empirical analysis, such as exponential, log-normal and logistic, can be obtained from the author upon request.

$$\delta_i = \begin{cases} 1, \text{if the spell is completed} \\ 0, \text{if the spell is censored} \end{cases} \tag{17}$$

Finally, let

$$w_i = p \ln(\lambda_i t_i) = \frac{\ln t_i - \beta' x_i}{\sigma} \tag{18}$$

and the log likelihood is

$$\ln L = \sum_i \left[\delta_i \left(w_i - \ln(\sigma) - \exp(w_i)\right)\right] \tag{19}$$

The estimates of β and p can be obtained by maximising (12) with respect to β and p (Greene, 2000).

6.2.2 Time-varying covariates

It has been assumed thus far that the covariates are constant from the beginning of the measurement period, $T = 0$, to the time of the measurement, $T = t_i$. However, factors such as the labour status of the spouse or farm income may change over the course of the spells. Incorporating these time-varying covariates into the duration model is based on Greene (2002), who draws heavily on Petersen (1986a, 1986b).

Let the interval between 0 and t_i be divided as k exhaustive, non-overlapping intervals, $t_0 < t_1 < \ldots < t_{k-1} < t_k$, where $t_0 = 0$ and $t_k = t_i$. The covariates in x are assumed to stay constant within each of the k intervals, but may change from one interval to next. Let

$$h(t \mid x_j) = \text{the hazard function from time } t_{j-1} \text{ to } t_j, \tag{20}$$

since within that interval, the covariates are constant. Then, from the relationship between the hazard function and the survival rate,

$$h_j = -d \ln S(t) / dt \tag{21}$$

and

$$P\left[T \le t_j \mid T \ge t_{j-1}\right] = \exp - \int_{t_{j-1}}^{t_j} h\left(s \mid x_j\right) ds \tag{22}$$

The survival function for the duration of t_k can be written

$$S(t_k \mid x_k) = \prod_{j=1}^{k} P[T \geq t_j \mid T \geq t_{j-1}] \tag{23}$$

Finally, the density at t_k is

$$f(t_k \mid x_k) = h(t_k)S(t_k) \tag{24}$$

The log likelihood function for one observation is

$$\ln L_i = \delta_i \ln h(t_k \mid x_k) + \ln S(t_k) \tag{25}$$

Thus, each observation contributes the survivor function to the log likelihood function. For uncensored observations, density evaluated at the terminal point was added. For the observations:

$$\ln L_i = \delta_i \ln h(t_k \mid x_k) - \sum_{j=1}^{k} \int_{t_{j-1}}^{t_j} h(s \mid x_j) ds \tag{26}$$

6.2.3 Unobserved heterogeneity

In duration models, the *heterogeneity* problem may result from an incomplete specification. The most common reason for unobserved heterogeneity is an omitted variable. Heterogeneity can be taken into account in estimating duration models (Kiefer, 1988). A direct approach is to model heterogeneity in the parametric model with a survival function conditioned on the individual specific effect v_i. In this approach, the survival function is treated as $S(t_i|v_i)$. When a model for the unobserved heterogeneity $f(v_i)$ is added, we get:

$$S(t_i) = E_v[S(t_i \mid v_i)] = \int_v S(t_i \mid v_i) f(v_i) dv_i \tag{27}$$

The gamma distribution is often used for this purpose. In the Weibull model, assuming that v_i has a gamma distribution with mean 1 and variance $\theta = 1/k$ and parameters k and R, then

$$f(v_i) = \frac{k^R}{\Gamma(R)} e_i^{-kv} v_i^{R-1} \tag{28}$$

and

$$S(t_i \mid v_i) = e_i^{-(v\lambda t)^p} \tag{29}$$

If the model contains a constant, no generality is lost by assuming that the mean of v_i is 1. Thus, $E[v_i] = k/R = 1$ or $k = R$. Now, the unconditional distribution is

$$S(t_i) = \int_{o}^{\infty} S(t_i \mid v_i) f(v_i) dv_i = \left[1 + \theta(\lambda t)^p\right]^{-1/\theta} \qquad (30)$$

The variance of v is $1/k$, so $\theta=0$ corresponds to the Weibull model (Greene, 2002). The further the parameter θ deviates from zero, the greater the effect of heterogeneity.

6.3 Data

6.3.1 Data description

This chapter is based on the farmers' retirement data described earlier in Section 3.6.2. Descriptive statistics of the data for all sample farms and those choosing the farmers' early retirement system are presented in Table 7 in Section 5.3.1 and in Table 10.

6.3.2 Variable definitions

The analysis concentrates on those farms utilising the farmers' early retirement system. This farm level decision depends on the retirement decisions of the farming couple. A *farming couple* is defined as choosing the farmers' early retirement scheme if either the farmer or the spouse retire or both retire under the farmers' early retirement scheme.[8] Exits under the farmers' early retirement system are further characterised by two discrete occupational choices: (i) an exit and the transfer of the farm to a new entrant or (ii) an exit and the closure of the farm (Figure 8). Closing down the farm includes selling or leasing agricultural resources to neighbouring farms, reforestation of the land, and lay-land agreements.

Farmers' and spouses' other pension choices are included as independent dummy variables in the analysis in order to capture the effect of spousal retirement on farm level early retirement decisions (transfer or closure). Other pension choice possibilities are involuntary retirement (disability pension *etc.*), retirement under another pension scheme (old-age pension *etc.*), or the continuation of farming (Figure 8). Since all entrepreneurs must give up farming when one of a couple applies for an early retirement scheme, there are no farmers or spouses continuing farming among those farms choosing the farmers' early retirement system (Table 10).

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[8] An alternative to modelling this occupational choice would have been to use a competing risk framework, as for example Tietje (2004).

Table 10. Descriptive statistics of the farmers' retirement data.

Variable	Mean	Std.Dev.	Min.	Max.
All sample farms, NT=963				
Farmer's expected pension, (€) month [a)]	608.4	141.3	0.0	1,213
Spouse's expected pension, (€) month [a)]	273.2	302.2	0.0	1,220
Farmer's off-farm income. (€) month	1,396	5,007	0.0	88,487
Spouse's off-farm income, (€) month	1,709	5,410	0.0	58,070
Farmer early retirement pension (0.1)	0.17	0.37	0.0	1.0
Spouse early retirement pension (0.1)	0.09	0.29	0.0	1.0
Farmer continued (0.1)	0.28	0.45	0.0	1.0
Spouse continued (0.1)	0.26	0.44	0.0	1.0
Farmer involuntary retirement (0.1)	0.15	0.36	0.0	1.0
Spouse involuntary retirement (0.1)	0.19	0.14	0.0	1.0
Farmer old-age pension (0.1)	0.39	0.49	0.0	1.0
Spouse old-age pension (0.1)	0.69	0.25	0.0	1.0
Farms choosing early retirement system, NT=194				
Farmer's expected pension, (€) month [a)]	648.9	130.6	0.0	1,213
Spouse's expected pension, (€) month [a)]	433.7	302.3	0.0	1,220
Farmer's off-farm income, (€) month	491.6	2,997	0.0	36,446
Spouse's off-farm income, (€) month	880.5	4,215	0.0	44,306
Farmer early retirement pension (0.1)	0.83	0.38	0.0	1.0
Spouse early retirement pension (0.1)	0.49	0.50	0.0	1.0
Spouse involuntary retirement (0.1)	0.03	0.16	0.0	1.0
Farmer other pension (0.1)	0.10	0.30	0.0	1.0
Spouse other pension (0.1)	0.05	0.22	0.0	1.0

[a)] Expected pension if retired under the farmers' early retirement schemes.

Out of the 963 sample farms, on 194 farms (20%) the farmer or the spouse chose to retire within the framework of a farmers' early retirement pension (Appendix 5). More than one-half of these farms were transferred to a new entrant (108 farms). Amongst the 456 farms operated by a couple, 137 (30%) applied for the early retirement scheme. Out of these farms, in one-third (42) of the cases only a farmer and in one-fourth (33) of the cases only a spouse applied for the scheme. In 45% of the cases, early retirement was a joint decision made by the farming couple. In total, 17% of the farmers and 21% of the spouses in the sample retired under the farmers' early retirement scheme. A large majority of the spouses (61%) and almost one-third (28%) of the farmers continued farming. Also, 15% of the farmers but only 4% of the spouses retired involuntarily. Old age or another pension scheme was chosen by 40% of the farmers and by 14% of the spouses.

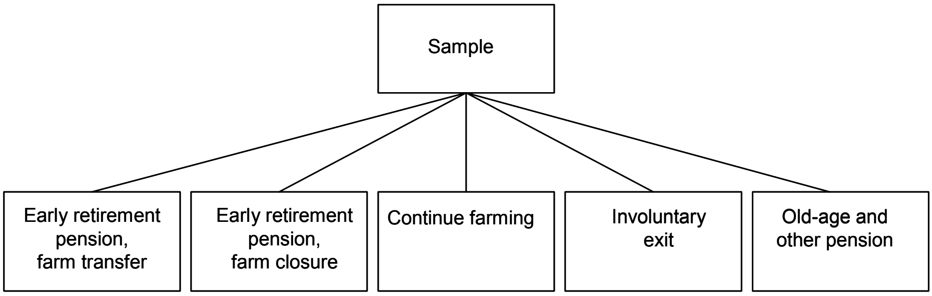

Figure 8. Choice of the pension scheme in the analysis.

The variables included in the analysis were selected according to the availability of data and *a priori* expectations on the important factors explaining the timing of retirement. The economic incentive to retire or to continue farming is measured as the expected pension of the farmer and of the spouse if retired under the farmers' early retirement scheme, and by agricultural *income* (Table 2). Similarly, the off-farm income of a farmer and a spouse are used as explanatory variables in the analysis to reflect a higher propensity to exit farming.

The variables concerning the farm family are the ages of the farmer and spouse, the existence of a spouse, the number of children and the age of the oldest child (Table 2). In addition, it is defined how many years a farmer has been farming. The farm size is measured in hectares of arable land and forest area.

Other farm characteristics included in the analysis are variables defining farm location (the dummy variable north) and production line (the dummy variable livestock). In addition, the variable share of subsidy describes the effect of subsidies. Definitions of these variables are presented earlier in Sections 3.6.2 and 5.3.2.

6.4 Estimation and results

6.4.1 Estimation and testing procedures

The survival of farming couples after their eligibility under the farmers' early retirement scheme and before their actual retirement varied between one and 16 years. Out of those 194 couples choosing the farmers' early retirement pension, 108 retired by transferring the farm to a new entrant and 86 closed down their farm. The survival time of farming couples when transferring the farm to a new entrant varied between one and 15 years and the survival of those closing down their farm varied between one and 16 years. The average survival time was shorter on farm transfers (4.41 years) than on farm closures (5.67 years) (Table 11).

Table 11. Results from the duration analysis for the farming couple's survival before early retirement (t values in parentheses).

	Farm transfer		Farm closure	
	Basic Weibull	Latent heterog.	Basic Weibull	Latent heterog.
	Coefficient	Coefficient	Coefficient	Coefficient
Constant	-0.3304	-1.0833	-7.2744***	-8.7891***
	(-0.294)	(-0.883)	(-12.716)	(-14.273)
Farmer age	0.1849***	0.1848***	0.1667***	0.1835***
	(25.421)	(24.982)	(21.078)	(22.297)
Spouse age	-0.0585***	-0.0557***	-0.0578***	-0.0642***
	(-6.694)	(-6.045)	(-7.698)	(-6.891)
Spouse	8.6474***	10.1487***	3.2499***	4.1612***
	(8.625)	(8.466)	(3.104)	(2.884)
Farming years	-0.0043	-0.0058*	-0.0049*	-0.0015
	(-1.347)	(-1.757)	(-1.888)	(-0.528)
Number of children	-0.0543***	-0.0616***	0.0847***	0.0597**
	(-4.663)	(-4.576)	(3.782)	(2.618)
Age of the oldest child	-0.0301***	-0.0253***	-0.0033	-0.0007
	(-8.148)	(- 7.168)	(-1.389)	(-0.259)
Land area	-0.0124***	-0.0143***	0.00009	0.0005
	(-7.221)	(-7.192)	(0.052)	(0.255)
Forest area	0.0011**	0.0008*	0.0012**	0.0014**
	(2.775)	(1.943)	(2.450)	(2.662)
Livestock farm	0.0579	0.0553	0.1879***	0.1984***
	(1.316)	(1.137)	(4.058)	(4.187)
North	-0.2326***	-0.1925***	-0.1006**	-0.0934*
	(-4.520)	(-3.560)	(-2.265)	(-.1.849)
Farmer exp. pension, ln	-1.0383***	-0.9879***	0.0316	0.0119
	(-6.626)	(-6.025)	(0.791)	(0.273)
Spouse exp. pension, ln	-0.9286***	-1.176***	-0.0808	-0.1592
	(-7.585)	(-7.384)	(-0.528)	(-0.740)
Agricultural income, ln	0.1110***	0.1106***	0.0183***	0.0191***
	(16.384)	(16.477)	(3.788)	(3.331)
Farmer off-farm income, ln	0.0098	0.0119	0.0431***	0.0511***
	(0.936)	(1.226)	(4.980)	(5.945)
Spouse off-farm income, ln	0.0296***	0.0131	0.0034	-0.0013
	(3.043)	(1.390)	(0.506)	(-0.171)
Share of subsidy	0.1027***	0.1191***	0.0005	0.0009
	(3.076)	(4.022)	(0.113)	(0.155)
Spouse involuntary ret.	0.0524	0.1015	-0.0491	0.0575
	(0.234)	(0.488)	(-0.311)	(0.266)
Farmer old-age pension	0.7095***	0.6353***	0.3728***	0.2723**
	(6.455)	(5.371)	(3.585)	(2.664)
Spouse old-age pension	0.4287**	0.5121**	0.0474	0.2132
	(2.234)	(2.617)	(0.431)	(1.486)
Sigma (σ)	0.5368***	0.4104***	0.4189***	0.2844***
	(24.993)	(15.681)	(22.331)	(12.550)
Theta (θ)	-	1.6705***	-	4.9893***
		(4.568)		(4.846)
Mean survival	4.407	4.407	5.674	5.674
Log likelihood	-1535.80	-1517.17	-1278.960	-1257.645
Lambda (λ)	0.035	0.0513	0.057	0.0929
Weibull p	1.863***	2.437***	2.386***	3.517***
	(24.992)	(15.681)	(22.332)	(12.549)

***A triple asterisk denotes significance at a two-sided 1% level.
**A double asterisk denotes significance at a two-sided 5% level.
*An asterisk denotes significance at a two-sided 10% level.

The Weibull *p* parameters for the farming couple survival model before a farm transfer to a new entrant or closure were statistically significant and $p>1$, indicating an increasing hazard function and an increasing probability of early retirement over time (Table 11). The parameter estimates for θ in the Weibull survival model with gamma heterogeneity were statistically significant and differed from zero. The likelihood ratio test,[9] however, showed that the Weibull distribution models including unobserved heterogeneity did not significantly differ from the basic Weibull models. The signs of the remaining parameter estimates are robust and do not vary between models because of the inclusion of the heterogeneity parameter in the case of the farm transfer model. Therefore, it seems that the model with unobserved heterogeneity did not result in a significant improvement on the basic Weibull model when modelling early retirement. Nevertheless, heterogeneity is suggested to be a significant determinant and is seen in the case of the farm closure model in the following parameters: off-farm income of the spouse and the involuntary retirement of the spouse. Neither of these variables was found to be statistically significant so in fact, heterogeneity does not make a difference here either.

6.4.2 Results

When comparing parameter estimates, it was found that the predicted effects of different factors differed between farm transfer and closure only in the case of certain variables.

The age of the spouse was found to advance and the age of farmer was found to delay the timing of early retirement for both retirement alternatives (Table 11). This is in agreement with earlier findings that after first increasing, retirement and especially succession probability starts to decrease with the farmer's age (Kimhi and Bollman, 1999; Stiglbauer and Weiss, 2000; Kimhi and Nachlieli, 2001; Pietola *et al*., 2003). The existence of a spouse was found to delay both farm transfers and closures. The result of postponing retirement on farms where the spouse was also working on the farm tallies with the earlier findings of Glauben *et al.* (2004a). But the longer the farmer had been farming, the sooner the farm closed down.

It was found that the number of children advanced farm transfers but delayed farm closures. This result also corresponds with the earlier findings of Glauben *et al.* (2004a), who found that the number of family members reduces the planned time until farm succession. Further, the age of the oldest child was found to significantly advance farm transfers. This is very understandable: the older the possible successor is, the more likely succession is to take place.

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[9] That is, $\chi 2$ on the probability that the unobserved variance between individuals is zero, $\theta = 0$.

The bigger the farm land area, the earlier it was transferred to a successor. This result is consistent with earlier findings of *e.g.* Pietola *et al.* (2003) and Tietje (2004). Forest area and agricultural income delayed both farm succession and closure decisions. On the other hand, the share of the farm income subsidy delayed farm transfers. Moreover, livestock farms were found to be closed down later than other types of farms. A northern location was found to advance both farm transfers and closures. In Chapter 5 both early retirement and farm transfer were found to be less likely in the northern parts of the country. The results indicate that despite being less likely, in northern parts of the country both farm transfers and closures took place earlier than in the south. This was the case especially on bigger farms.

In earlier studies, pension benefits have been found to be significant determinants of retirement probability (*e.g.* Asch *et al.*, 2005). Here, the expected pension of the farmer and spouse was found to advance farm succession but had no effect on the timing of farm closure.

The off-farm income of the farmer has previously been found to both encourage farm successions (Kimhi, 1994) and to accelerate farm exits (*e.g.* Goetz and Debertin, 2001). Here, the results suggest that farmer and spouse off-farm income have qualitatively different effects. The off-farm income of the farmer was predicted to delay farm closures, whereas the off-farm income of the spouse was predicted to delay farm transfers. Thus, the off-farm income of elderly farmers was not found to promote but to slow down the development of the structure of farming. This result is also consistent with earlier findings of Stiglbauer and Weiss (2000) that the probability of farm succession is lower on part-time farms.

Unlike what was expected, the involuntary retirement of a spouse was not found to affect the timing of a farmer's early retirement. The old-age or other pension of the farmer was found to delay the spouse's retirement in the case of both farm transfer and closure. In addition, an old-age or other pension taken by the spouse was found to delay the farmer's early retirement in farm transfers. Thus, farmers and spouses were not found to co-ordinate their early retirement decisions with their spouse's retirement under other pension schemes.[10] One reason for this might be that even though the older of the spouses retires under an old-age or other pension scheme, the younger spouse continues farming as long as s/he is eligible for the EU subsidy schemes which keep farming financially viable. Another explanation might be that when in good health, the retiring spouse continues working on the farm, thus enabling the continuation of farming.

[10] I have also estimated the farmer survival model including the dummy variable spouse's retirement un-der the farmers' early retirement scheme, which was statistically significant, received a negative sign and did not alter the remaining effects. However, due to the endogenous nature of the farming couple's early retirement decision, the analysis presented here is based on a model excluding the dummy variable.

6.5 Conclusions

In this chapter, the effect of a spousal retirement decision, economic incentives, and farm and family characteristics on the timing of farmers' early retirement decisions were analysed with a duration model. The timing of retirement was measured as the duration between the farmer's eligibility for the early retirement scheme and the actual retirement of the farmer or spouse. Farmers' early retirement choices were divided into the transferring of their farm to a new entrant and the closure of their farm.

Farm transfers, in general, were found to take place somewhat earlier than farm closures. One reason for the difference between these two retirement options is the availability and willingness of a potential successor. One should also notice that when studying farm retirement, it is important to analyse the retirement decisions of both the spouses, not just those of the farmer. In this study, in 17% of the cases, only the spouse applied for the farmers' early retirement scheme. Ignoring the cases where the spouse chooses the farmers' early retirement scheme would bias the results due to missing observations in the analysis. Further, farm retirement would be predicted to take place earlier than it actually does if spousal retirement choices are not included in the analyses.

When comparing farms operated by couples to all sample farms, it was found that applying for an early retirement scheme and especially farm succession was more likely on the farms with two entrepreneurs. The same applied to the farmers' early retirement choices. In 45% of the farms operated by a couple and utilising the farmers' early retirement scheme, both the farmer and spouse applied simultaneously for the early retirement pension.

On those farms where the farmer had a spouse, early retirement took place later. But the older the spouse, the earlier the farm was transferred to a new entrant or, alternatively, closed down. Contradicting that, an increasing farmer age delayed both farm transfers and closures. This tallies with earlier findings that after first increasing, the probability of farm succession starts to decrease beyond a certain age.

Besides the farming couple, farm and family characteristics and financial factors were also found to matter. The existence of a possible successor significantly affected the timing of early retirement. The number of children advanced farm successions, but at the same time, delayed farm closures. In addition, the older the oldest child was, the sooner the farm was transferred to a new entrant. Farm size was also found to affect the timing of farmers' early retirement. The bigger the farm, the sooner the farm was transferred to a new entrant.

A high level of farm income delayed farmers' early retirement. Depending on the farm income and pension payments paid by the farming couple during their active farming years, a high expected pension of the farmer and spouse was found to advance farm transfers. This result corresponds to earlier findings and prior expectations on pension benefits enhancing retirement probability.

The off-farm income of the spouse delayed the transfer of the farm to a new entrant and the off-farm income of the farmer delayed closing down the farm. Postponing retirement resulted in a delay in the transferring of resources to a new entrant or to those farmers expanding their activities. Thus, off-farm income may slow down structural development in the farming sector.

In earlier studies, spousal retirement has been found to strongly influence an individual's retirement decisions. The results of this chapter support this view with the findings on the farming couple's joint early retirement decision. Unlike prior expectations, farmers were not found to co-ordinate their early retirement according to spousal retirement under other pension schemes.

7 Modelling exit choices as sequences

7.1 Introduction

Although the number of farms has been gradually decreasing and farm size has been increasing, agriculture is still in most European countries characterised as family farming. Nevertheless, a large share of family farms has adjusted into market policy movements through starting and expanding their off-farm activities. As a result, the share of off-farm income from farmers' and farming households' total income has been increasing (Figure 1). As farmers' early retirement programmes have been important policy tools for steering structural development in European agriculture, an important policy question which then emerges is to what extent does the gradually increasing off-farm activity and off-farm income affect, in addition to other financial factors, farmers' exit behaviour and the response of farmers to the terms of early retirement programmes. It may be hypothesised that off-farm labour income alters decisions particularly to exit and close down farms, which, in turn, may affect the transfer of resources from the exiting farms to farms aiming to expand their production. In earlier studies, part-time farming has been found both to stabilise farm household income (Mishra and Goodwin, 1997) and to accelerate farm exits (*e.g.* Goetz and Debertin, 2001).

This chapter analyses the effect of off-farm income and economic incentives on the timing and type of farmers' early retirement choices. This analysis uses the framework of Pietola *et al.* (2003), extending this with the farming couple's off-farm income, information on their children and a more general error structure. The results provide new insights into the effect of the farmer's and the spouse's off-farm income on the timing and type of exit decisions, while controlling for family and farm characteristics, the agricultural market and policy environment, and the terms of retirement.

The rest of the chapter is organised as follows: Section 7.2 describes the formal optimisation model and its estimation, the data are presented in Section 7.3, followed by a description and discussion of the results in Section 7.4. Section 7.5 concludes.

7.2 Method

Farmers' early retirement decisions are categorised as farm transfers and the closing down of the farm (*i.e.* selling, renting and reforesting the land). Farmer occupational choices, with regards to exit decisions, are denoted by a binary indicator d_k for k=1,…,3, such that $d_k=1$ if the occupation k with the current period indirect utility U_k is chosen and $d_k=0$ otherwise. The value $k=1$ refers to exiting and closing down the farm operation, the value $k=2$ refers to exiting and transferring the farm to a new entrant, while the value $k=3$ refers to continued 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, and one of them is redundant. Each of these mutually exclusive occupational choices may involve off-farm activities.

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, transferring the farm to a new entrant may, in practice, make a significant contribution to the utility of the retiring farmer compared to the utility of closing down the farming operation. Second, these two exit types have diverse contributions to structural development in agriculture and are characterised by different terms in early retirement programmes. Current indirect utility from farming and farm income (U_3) is a function of current prices, subsidies, fixed inputs, farm characteristics, farmer characteristics, off-farm income,[11] and other return shifters.

In the continuation region, the optimal value function, *V,* for this decision problem then solves[12]

$$V(Z(t),t)=\max_{d_k(t)} E\left[\sum_{\tau=t}^{T}\delta^{\tau-t}\sum_{k=1}^{3}U_k(\tau)d_k(\tau)\middle|Z(t)\right] \qquad (31)$$

where $\delta>0$ is the discount factor, $E(\cdot)$ is the 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 and level of pension). Equation (30) is maximised choosing the sequence of control variables ($d_k(t)$) over the finite horizon of $t=0,..,T$.

The optimal value function is rewritten as in Keane and Wolpin (1994):

$$V(Z(t),t)=\max_{d_k(t)}\{V_k(Z(t),t)\} \qquad (32)$$

[11] Early retirement systems include income limits on retiring farmers' off-farm income. After consideration, these restrictions were not taken into account in the analysis, and the analysis was simplified in this way.

[12] Only the continuation region was considered because the decision to exit is at least partially irreversible.

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

$$V_k(Z(t),t)=U_k(Z(t),t)+\delta E\left[V(Z(t+1),t+1)\middle|Z(t),d_k(t)=1\right],\ t\leq T-1 \qquad (33)$$

subject to a certain set of transition equations for the current state $Z(t)$. Augmenting V_{kt} by an error term v_{kt}, occupation k is chosen and $d_k(t)=1$ if

$$V_{kt}+v_{kt}>V_{jt}+v_{jt},\quad \forall j\neq k \qquad (34)$$

which implies

$$v_{kt}-v_{jt}>V_{jt}-V_{kt},\quad \forall j\neq k \qquad (35)$$

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

The structural-form estimation of (32), (33) and (35) would require a solution for the occupation-specific value functions by, for example, numerically iterating the Bellman equation (33) conditional on some functional specification for the one period indirect utility $U_k(\beta)$ and the trial values for parameters β. The parameter values could then be updated by estimating the behavioural equations given by (34) (*e.g.* Rust, 1987). The structural-form estimation requires a numerical simulation of the expected values for the next period's optimal value functions, *i.e.* for expected maxima for future revenue streams that are stochastic and dependent on the exit choices (Keane and Wolpin, 1994).

Equation (34) highlights that the choices are based on the differences between the occupation specific indirect utility streams (not on the level of each utility stream). Therefore, the boundaries of the error distributions can be normalised by the value of one choice, and the differences between the choice specific value functions are approximated by a reduced form representation (*e.g.* Dorfman, 1996).

Many of the earlier studies on retirement probability have been based on estimating structural models (*e.g.* Stock and Wise, 1990; Gustman and Steinmeier, 1986, 2000). Approximation errors between the structural optimal stopping model and the reduced form models are, however, found to be negligible (Provencher, 1997). A reduced form specification has also been the standard in earlier studies on discrete choices (*e.g.* Green *et al.*, 1996; Pietola *et al.*, 2003; Asch *et al.,* 2005). Therefore, the reduced form specification is also used in this study.

The differences in the value functions were approximated so that at time *t*, firm *i* choose $d_k^i(t)=1$ if

$$\varepsilon_{kj,t}^i > X_t^i \beta_{kj}, \forall j \neq k \tag{36}$$

where, $\varepsilon_{kj,t}^i = v_{kt}^i - v_{jt}^i$, X is a vector of explanatory variables, 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 $j \neq k$.

Off-farm labour participation represents an occupational choice which can be either a substitute for or a complement to farm labour activity, and therefore, it is important to control for it as an endogenous determinant of exiting from farming. The off-farm income of the farmer and spouse are both endogenous among the explanatory variables in *X*, all other variables being exogenous or predetermined. Therefore, the off-farm income variables are replaced by their fitted values. A recursive structure is imposed when estimating the model such that the endogenous off-farm income variables in the exit equations are instrumented. The fitted value is obtained by an Ordinary Least Squares (OLS) regression.[13] The set of instruments in these regressions is denoted by $Z_t^1 \in Z_t$ and it includes household characteristics, farm characteristics, and the wage rate (wage and salary index).

The timing of the farmer's exit is modelled in an optimal stopping framework as a sequence of interrelated choices.[14] Because the farmers' retirement data were highly censored and the error terms of the model are unobserved, farmer specific effects, past revenue shocks and serial correlation are controlled for through a numerical simulation. This is done following Eckstein and Wolpin (1989) by simulating the sequence of interrelated choice probabilities and using the Geweke-Hajivassiliou-Keane (GHK) simulation technique. The parameters in β are then estimated by simulated maximum likelihood (SML) (McFadden, 1989; Pakes and Pollard, 1989; Keane, 1993). The main steps of the simulation technique are described below.

For given *k* and *j*, the two boundaries (inequalities) in Equation (36) are stacked as (Keane, 1993)

$$(2d_{k,t}^i - 1)\varepsilon_{kj,t}^i > (1 - 2d_{k,t}^i) X_t^i \beta_{kj} \tag{37}$$

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[13] The simple two-stage estimation provides consistent but not necessarily the most efficient estimates in the overall empirical model.

[14] Recently, new methods have been developed to study a sequence of decisions made using multilevel probit models (e.g. Renard et al., 2004). In comparison with a traditional unilevel probit model, the multilevel model has the advantage that it accounts for the interrelationship between sequences of decisions by conditioning on earlier stages. However, in the latter case, gains are achieved at the cost of the complexity of the model structure, estimation procedures, diagnosis and, not least, the interpretation of the results.

Next, to simplify the notation, the *kj* subscripts are dropped when stacking the farmer specific errors over time into sequences of errors $\varepsilon^i = \{\varepsilon_1^i, \varepsilon_2^i, ..., \varepsilon_T^i\}'$ for *t=1,2…,T*. Now we have $\varepsilon^i = A\eta^i$ where $\eta^i = \{\eta_1^i, \eta_2^i, ..., \eta_T^i\}'$ with $\eta_t^i \sim N(0,1)$. Matrix *A* is a parameter and a lower-triangular matrix of the Cholesky decomposition of the covariance matrix Σ so that $\Sigma = AA' = E[\varepsilon^i \varepsilon^{i}{}']$. Using these definitions, (37) can be written in its general form as (Keane, 1993):

$$(2d_t^i - 1)\eta_t^i > [(1 - 2d_t^i)X_t^i\beta \ - (2d_t^i - 1)(A_{t,1}\eta_1^i + ... + A_{t,t-1}\eta_{t-1}^i)] / A_{t,t} \qquad (38)$$

where the parameters in *A'* matrices and the normalised errors (η_t^i) link the original errors (ε_t^i) across the full time span of the sample *t=1,2, … ,T*. If no zero restrictions are imposed in *A'*s, the model controls for a time-varying serial correlation that has as long a memory as the length of the farmer specific time series. In this most general specification, farmer specific individual effects are also accounted for since the choice in the final period depends on the error term of the first period.

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* (38) given above holds for each draw. The simulation goes through each farmer *i* specific time series in the data. It 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 $\tilde{\eta}_1^i$, for η_1^i in (38). The second error η_2^i is drawn using the updated truncation point

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

and substituting this new draw $\tilde{\eta}_2^i$, for η_2^i in (38). This procedure is continued until *t=T*. The sequence of these *T* draws is repeated *S* times for each firm *i*. 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 in only a negligible simulation bias even when the simulated choice probabilities are small (Börsch-Supan and Hajivassiliou, 1993).

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).

As described above, the application has three options. 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 exiting and closing down the farm is chosen

0, otherwise

$d_2(t) =$ *1*, if exiting and transferring the farm to a new entrant is chosen

0, otherwise

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

The log likelihood function, $l_t^i(\beta)$, for a single observation has the form (Keane, 1993)

$$\begin{aligned} l_t^i(\beta) = {} & d_{t,1}^i(\ln P(d_{t,1}^i = 1 \mid J_{t-1}^i, X_t^i, \hat{\beta}, \hat{A}) + \ln P(d_{t,2}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta}, \hat{A})) \\ & + d_{t,2}^i(\ln P(d_{t,1}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta}, \hat{A}) + \ln P(d_{t,2}^i = 1 \mid J_{t-1}^i, X_t^i, \hat{\beta}, \hat{A})) \\ & + (1 - d_{t,1}^i - d_{t,2}^i)(\ln P(d_{t,1}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta}, \hat{A}) + \ln P(d_{t,2}^i = 0 \mid J_{t-1}^i, X_t^i, \hat{\beta}, \hat{A})) \end{aligned} \quad (39)$$

where $P(\cdot)$ are the simulated probabilities, conditional on all choices made before time t (J_{t-1}), a set of explanatory variables (X_t) and trial parameters ($\hat{\beta}, \hat{A}$). The set of explanatory variables X includes the variables age, land area, forest area, output price index, subsidy rate, expected pension, number of children, and the off-farm income of farmer and spouse. Also, dummy variables identifying the northern location and the existence of a spouse were included in the analysis.

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. Both A_1 and A_2 are defined generally enough to control for farmer specific individual effects as well as serial correlation in the errors. But to decrease the parameter space and to identify the parameters in the model, the diagonal elements are imposed equally and each off-diagonal array is imposed equally in A_1 and A_2. In addition to the diagonal arrays, both A matrices have four off-diagonal arrays and in total five parameters to be estimated. Thus, the total number of variance covariance parameters to be estimated in the choice equations is 10, and the A matrices have the structure:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ A_{12} & A_{22} & 0 & 0 & 0 \\ A_{13} & A_{12} & A_{22} & 0 & 0 \\ A_{14} & A_{13} & A_{12} & A_{22} & 0 \\ A_{15} & A_{14} & A_{13} & A_{12} & A_{22} \end{bmatrix}$$

The parameter restrictions in *A'*s are to some extent ad hoc. An alternative approach to impose zero restrictions to identify other parameters in *A'*s would be to follow a sequential procedure of Diewert and Wales (1987). In the model used here it would be, nevertheless, computationally very intensive since it would start from the most general specification and then sequentially decrease the number of parameters through imposing zero restrictions.

7.3 Data

The analysis is based on the farmers' retirement data described earlier in Section 3.6.2. About 17% (161) of the farmers in the sample exited farming through the farmers' early retirement scheme during the study period (Appendices 5 and 7). More than every second farmer (58%) choosing the early retirement system transferred their farm to a new entrant, whereas a smaller share (42%) closed down their farms. A large share of the group of farmers transferring their farm to a new entrant retired immediately upon reaching the age of 55. The group of farmers closing down their farm are more equally distributed across age groups. About 15% of the sample of farmers (147 cases) exited farming involuntary because of an accident, health problems or death. These exogenous exit cases are excluded from the data set in the year of exit (see Appendix 7).

The variables characterising a farming family are the age of the farmer, the existence of a spouse, the number of children and the ages of the youngest and the oldest child (Table 2, Section 3.6.2 and Table 12).

The economic incentive for a farmer to retire is measured by the expected pension after retiring from farming. Both the off-farm income of the farmer and spouse are included in the analysis. The common *index of wage and salary earnings* represents the development of wage rates earned by farmers and their spouses in their off-farm labour activities.

Farm size was represented by the number of hectares of land and forest area. Differences in the agricultural production environment in the northern and southern parts of the country were described by the dummy variable north. The subsidy rates are summarised in a single index of subsidy per hectare of coarse grains, which is exogenous for farmers; it varies over the years and by production region. In addition, the index of agricultural output prices is included in the analysis to control for annual movements in agricultural commodity prices. Similarly to the subsidy rate, it is an exogenous instrument for farmers' agricultural income.

The dummy variable final year controls for possible uncertainty over the continuation of the early retirement programme. It identifies the years in which an early retirement programme expired and was replaced by a new, possibly revised one. The dummy variable for the final year controls for the potential change in farmers' decisions upon the expiration of the terms of the current retirement programme. This is because the value of the option of a postponed exit may differ from other years because farmers either have uncertainty over the continuation of the early retirement programme, or they have new information about newer retirement programmes.

Table 12. Descriptive statistics of the data (units of measurement in parentheses).

Model variable	Mean	Standard deviation	Min.	Max.
Output price index (1993=1)	0.753	0.16	0.621	1.0
Farm subsidy [a)]	0.27	0.15	0.08	0.50
Index of wage and salary earnings (1993=1)	1.86	0.12	1.0	1.174
Final year of retirement system (0.1)	0.17	0.37	0.0	1.0

[a)] The farm subsidy is an exogenous index, normalised per hectare of coarse grains (€100/ha).

7.4 Results

7.4.1 Parameter estimates

Parameter estimates were obtained for the system of two occupational choice equations and the two equations for off-farm income using a GAUSS package. Predicted values of the endogenous off-farm income variables were used in the estimation of the occupational choice equations. Estimation results of the off-farm income equations are found in Table 13. Table 14 reports the results of the estimation of the occupational choice equations (Equation 39).

Off-farm income

Farmer age and household characteristics were predicted as the most important determinants for off-farm activities both for the farmer and his spouse (Table 13). The off-farm income of the farmer decreased as the farmer and spouse aged. In other words, in farming households where the farmer and spouse were young, the farmer was more eager than average to have off-farm earnings. This holds together with earlier findings (Kimhi, 1994b, 1994c; Ahituv and Kimhi, 2002; Kimhi, 2004). The age pattern is also supported by general and broader statistics on taxable income than was available in this analysis (Figure 2). According to the results, the off-farm income of the spouse decreased as the farmer aged, but the spouse participated in off-farm activities and had off-farm earnings more independently of her age. Unfortunately, in this study it was not possible to distinguish between the farmers' off-farm income by the gender of farmer and spouse, unlike in Kimhi (1994c), where women's off-farm participation was found to decrease with their husbands' age.

The number and age distribution of children was an important factor in off-farm earnings. The off-farm income decreased with the number of children in the family but increased as the oldest child matured. In earlier studies, younger children and the number of children have been found to decrease especially the probability of the spouse to work off-farm (Mishra and Goodwin, 1997; Kimhi, 1994c). Since most studies on farmers' off-farm labour have studied all farmers, whereas this study concentrated on ageing farmers, earlier results cannot be utilised or compared to the results of this study.

Arable land area did not affect off-farm earnings, but forest area and income from forestry substituted for off-farm activities and off-farm income. The wage rate did not have a significant effect on off-farm activities and off-farm income. The insignificant wage rate (wage and salary index) effect gave signals that the labour market may have constraints in rural areas such that the off-farm labour

Table 13. Parameter estimates in the off-farm income equations[15].

Variable (Z_1)	**Farmer income** parameter	**Farmer income** *t* value	**Spouse income** parameter	**Spouse income** *t* value
Intercept	2.10	1.77	2.32**	2.94
Farmer age	-0.143***	-9.70	-0.144***	-10.1
North	-0.124	-1.49	-0.123	-1.44
Land area	$-3.18*10^{-5}$	-0.621	-3.20	-0.608
Forest area	-0.00151*	-2.31	-0.00151*	-2.24
Dummy variable for spouse	0.205	0.239	-	-
Spouse age	-0.00132	-0.0850	0.00238	1.49
Index of wage and salary	-0.657	-0.938	-0.662	-0.919
Number of children	-0.0811**	-2.53	-0.0809**	-2.45
Age of the youngest child	-0.0291***	-3.80	-0.0292***	-3.70
Age of the oldest child	0.0358***	4.47	0.0357***	4.33

*A triple asterisk denotes significance at a two-sided 1% level.
**A double asterisk denotes significance at a two-sided 5% level.
*An asterisk denotes significance at a two-sided 10% level.

participation of farming households does not respond to wage rates. These market imperfections were also supported by the parameter estimate of the variable north, which suggests that off-farm income is smaller in the central and northern parts of the country, where options for off-farm labour participation are even rarer than in the southern parts of the country.

[15] Even though the predicted off-farm incomes of farmer and spouse had very similar parameter estimates, they were not found to be correlated (coefficient: 0.095761). This is why the multicollinearity problem was not ex-pected to arise when estimating choice equations for farm transfer and closure.

Choice equations

The results suggest that the likelihood for farm succession decreases with the farmer's age (Table 14). The probability of farm succession *ceteris paribus* increased significantly with the farms' land area, producer prices and farm subsidies. Further, the parameter associated with pension benefits was statistically significant. The expected pension benefit varied more by farm than by year. The expected pension benefit did not differ between the two farm retirement options either. Expected pension was found to increase farm transfer probability. When comparing these results with those of Pietola *et al.* (2003), it can be seen that the extension of the framework of the earlier study with a more general error structure, endogenous off-farm income and family characteristics decreased the overall significance of the other parameters in the choice equations, but the results remain unchanged in qualitative terms with a few exceptions.

Table 14. Parameter estimates in the choice equations (t values in parentheses) estimated in Equation 39.

	Exit and transfer		Exit and closure	
Variable	GHK	t value	GHK	t value
Constant	-5.53**	(n.a.)[a)]	-3.07**	(n.a)[a)]
Farmer age	-0.100**	(-2.13)	0.039	(0.682)
North	0.0542	(0.324)	0.112	(0.677)
Land area	0.0144**	(4.62)	-0.0001	(-0.027)
Forest area	-0.0005	(-0.531)	-0.0021(*)	(-1.42)
Output price	2.77**	(3.50)	-0.258	(-0.316)
Subsidy rate	0.221*	(1.70)	0.0389	(0.245)
Expected pension	0.0856(*)	(1.56)	-0.0471	(-0.626)
Spouse	0.475*	(1.72)	0.770	(0.310)
Number of children	0.0505	(1.05)	-0.0882**	(-2.08)
Age of the youngest child [b)]	0.0140	(0.949)	-	-
Age of the oldest child [b)]	0.0123	(0.807)	-	-
Farmer off-farm income	-0.110	(-0.277)	0.848**	(2.11)
Spouse off-farm income	-0.139	(-0.559)	-0.492*	(-1.79)
Final year	-0.136	(-0.775)	0.439**	(2.87)

[a)] Fixed at the initial value of the previous GHK specification.
[b)] Could not be identified in the equation for exit and farm closure.
[**] A double asterisk denotes significance at a two-sided 5% level.
[*] An asterisk denotes significance at a two-sided 10% level.
[(*)] An asterisk in the parenthesis denotes significance at a one-sided 10% level.

In the equation for exiting with farm closures, the term indicating the expiration of the pension programmes (*final year*) was positive and significant. When the pension programme was close to expiry and there was a large degree of uncertainty over the terms of a new programme, the probability of farm closures increased significantly. This result suggests that the option value of a postponed exit is an important determinant in these choices when the exit implies closing down the farming operation. Uncertainty over the terms in a new retirement programme decreases the option value for postponed exiting and provides an incentive for farmers to exit immediately.

The results in Table 14 suggest that the off-farm income of the farmer and the spouse was an important determinant in the timing of decisions to exit and close down the farm, whereas it did not play a significant role in the decision to transfer the farm. The off-farm incomes of the farmer and spouse had opposite effects. The spouse's off-farm income increased the likelihood of continuing the farm operation, whereas the farmer's off-farm income increased the likelihood of exiting and closing down the farm. The effect of farmer off-farm income corresponds to the earlier findings of Stiglbauer and Weiss (2000) and Tietje (2004) that farms operated by part-time farmers are, *ceteris paribus*, more likely to be closed down than farms operated by full-time farmers. Farmer off-farm income may, on the other hand, increase the opportunity cost of farming or at least provide a feasible occupational alternative to farming and reduce transaction costs for leaving agriculture, as Goetz and Debertin (2001) suggest.

In contrast, the spouse's off-farm income was predicted to encourage the continuation of farming. Therefore, the spouse's off-farm income, unlike the farmer's off-farm income, may be seen more as a complement of farm income and may decrease the probability of exiting from farming. This result is in line with the results of Kimhi and Bollman (1999).

Off-farm income was weakly predicted to decrease the probability of farm succession, as suggested by Stiglbauer and Weiss (2000), but these effects were not found to be significant.

When the number of children increased, the likelihood for exit and farm closure decreased and the likelihood of farm succession increased. However, the effect of the number of children on the probability of farm transfer was not found to be significant, unlike in earlier studies (Stiglbauer and Weiss, 2000; Glauben *et al*., 2004a). Similar to an earlier study of Pietola *et al*. (2003), having a spouse increased the probability of farm succession. The increasing age of the farmer was found to decrease farm succession probability. The ages of the oldest and youngest children were not found to increase succession probability.

An increase in land area increased the probability of farm transfer. An increase in forest area, on the other hand, decreased the probability of farm closure. An increase in output prices and in subsidy rates increased farm succession probability. The results suggest that economic policy and the market environment, such as prices and farm subsidies, significantly affect farm successions. For example, the trend towards decoupling agricultural subsidies may affect farm development opportunities and thus increase the probability of succession.

Error structure

The joint effects of past revenue shocks and farmer-specific individual effects were predicted to have significant effects on the timing of both types of exit decisions (Tables 15 and 16). Nevertheless, the panel data used in the estimation were unbalanced, and therefore, the serial correlation and farmer specific individual effects cannot be distinguished separately in the off-diagonal elements of the covariance matrices. For example, if a farmer exits during his second year in the sample, a first off-diagonal element in the covariance matrix controls for the first order serial correlation and for the farmer specific individual effect.[16] Nevertheless, since most of the parameters in *A'* matrices differ significantly from zero, the results suggest that either farmer specific individual effects or the serial correlation with memory of at least four years or both are significant determinants of the decision to exit and close or transfer the farm.

Table 15. Error parameters.

	Exit and transfer	Exit and closure
Variable	GHK	GHK
Covariance a)	-	-
A11=A22… =A55 b)	0.827*	0.833**
	(7.71)	(4.14)
A21=A32… =A54	0.566**	0.856**
	(2.22)	(3.30)
A31=A42… =A53	-0.111	-0.111
	(-0.254)	(-0.254)
A41=A52	-0.530(*)	-0.530 (*)
	(-1.41)	(-1.41)
A51	-0.0765	-0.0765
	(-0.264)	(-0.264)

a) Instantaneous covariance between the errors of two choice equations.
b) Lower case A_{kj} refers to the kjth element in the corresponding *A* matrix.
** A double asterisk denotes significance at a two-sided 5% level.
* An asterisk denotes significance at a two-sided 10% level.
(*) An asterisk in parenthesis denotes significance at a one-sided 10% level.

16 Please note that each farm was dropped out of the sample after an exit, because exiting is at least partially irre-versible and the decision rule no longer holds after the exit.

Table 16. The covariance matrices. [a)]

$$\text{Exit and closure: } \hat{\Sigma}_1 = \hat{A}_1\hat{A}_1' = \begin{bmatrix} 0.694 & & & & \\ 0.713 & 1.43 & & & \\ -0.215 & 0.493 & 1.49 & & \\ -0.541 & -0.771 & 0.660 & 1.91 & \\ 0.385 & -0.146 & -0.889 & 0.360 & 2.13 \end{bmatrix}$$

$$\text{Exit and transfer: } \hat{\Sigma}_2 = \hat{A}_2\hat{A}_2' = \begin{bmatrix} 0.684 & & & & \\ 0.468 & 1.00 & & & \\ -0.0919 & 0.406 & 1.02 & & \\ -0.438 & -0.392 & 0.464 & 1.30 & \\ -0.0633 & -0.482 & -0.383 & 0.505 & 1.30 \end{bmatrix}$$

[a)] The covariance matrices are of size 5x5 even though we have six years of data, because the data were not informative enough to identify the covariance between the errors in the first sampling year (1993) and the choices in the final sampling year (1998). In 1998, the data had two endogenous farm successions and nine endogenous farm closures.

7.4.2 Elasticity estimates

Table 17 gives estimates of the elasticity of the probabilities of exiting and transferring or closing down the farm to changes in the levels of different variables. The relative changes in the response probabilities were evaluated at the sample averages for continuous model variables. The baseline values for dummy variables were: north=0, final year =0, and spouse=1. That is, the base farm is located in the south, the pension programme is not about to expire, and the farmer has a spouse. Elastic response means that the relative change in the response probability is greater than the relative change in the model variable. If, for example, a 1% change in the model variable results in a 1.5% change in the response probability, the effect is elastic (note that the base probabilities are within the range of 0.5%–4.5%).

The probabilities reacted elastically to changes in the farmer's age, output prices, number of children and off-farm income levels. The level of pension benefits had a smaller elasticity estimate than in the analysis of Pietola *et al.* (2003), although the decision to transfer the farm still responds almost elastically to changes in this variable (0.65). In years in which an early retirement programme was about to expire, the likelihood of exiting and farm closure, on average, increased by 150% compared to other years. This result suggests that the option values of a delayed exit are critical determinants in the timing of decisions

Table 17. Elasticity estimates: Percentage change, *ceteris paribus*, of the response probabilities with respect to a change in the model variable.

Model variable (description of the change in the parentheses)	Exit and transfer GHK	Exit and closure GHK
Farmer age (+ 1 year)	-19**	11
Land area (+1%)	1.0**	-0.10
Forest area (+1%)	-0.050	-0.29(*)
Output price (+1%)	4.5**	-0.52
Subsidy rate (+1%)	0.72*	0.16
Pension (+1%)	0.65(*)	-0.45
Number of children (from two children to none)	-88	58**
Off-farm income, farmer	-0.20	2.0**
Off-farm income, spouse	-0.26	-1.1*
North (north compared with south)	12	34
Spouse (a couple compared to a single person)	67*	90
Final year	-22	150**

** A double asterisk denotes significance at a two-sided 5% level.
* An asterisk denotes significance at a two-sided 10% level.
(*) An asterisk in parenthesis denotes significance at a one-sided 10% level.

to close down the farm. The elasticity of the dummy variable spouse suggests that exiting reacts very elastically to the presence of a spouse. This implies that farmers with a spouse, *ceteris paribus*, are much more likely to exit than farmers without a spouse. Similarly, the probability of farm transfer increased by land area and subsidy rate.

An increase in farmer age decreased farm transfer probability and increased farm closure probability. Simulation results of the impact of the farmer's age on farm transfer and closure probabilities are demonstrated in Figure 9. The probability of transferring the farm to a new entrant decreased faster than the probability of closing down the farm increased with a one year increase in the farmer's age.

A 1% increase in the farmer's off-farm income had a larger impact on the probability of exiting and closing down the farm than a 1% increase in the off-farm income of the spouse. This is also illustrated in Figure 10, which demonstrates the results of a simulation of the impact of the farmer's and spouse's income on the probability of exiting and closing down the farm. Figure 10 shows that the probability of closing down the farm increased more rapidly with the farmer's off-farm income than it decreased with the same percentage increase of the spouse's off-farm income.

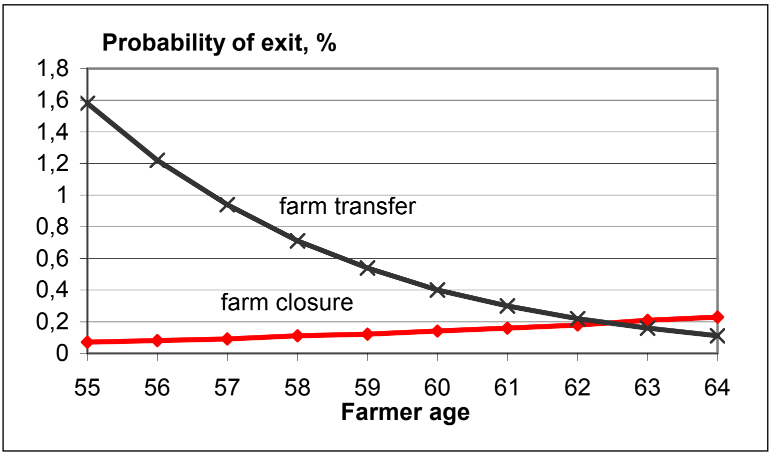

Figure 9. The effects of an increase in farmer's age on exiting and farm transfer or farm closure probability.

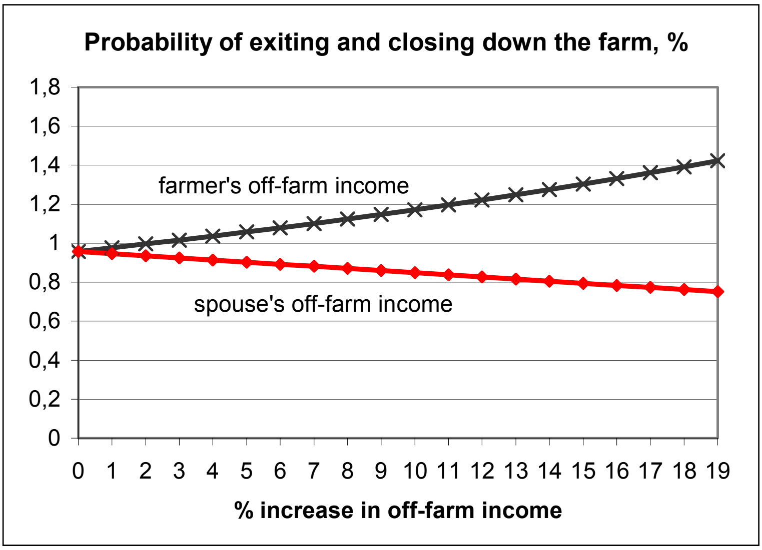

Figure 10. The effects of an increase in farmer's and spouse's off-farm income on exiting and farm closure probability.

7.5 Conclusions

This chapter analysed the effects of the farmers' and spouses' off-farm incomes on the decision to exit farming either through closing down the farm or transferring the farm to a new entrant. The model extended the empirical specification of the optimal stopping model in Pietola *et al.* (2003).

The results suggest that farmers' off-farm income, *ceteris paribus*, encourages farmers to exit farming and close down the farm operation. The off-farm income of the spouse, on the other hand, encouraged the farmer to continue the farm operation and to delay the exit decision. The farmer's and his spouse's off-farm income did not have a significant impact on the decision to transfer the farm to a new entrant (*e.g.* succession).

According to the results, the common trend of gradually increasing off-farm income amongst elderly farmers and their spouses did not have significant implications for the continuation of family farming in the long run because it did not significantly alter the timing of farm successions. However, increasing off-farm incomes significantly affected the timing of farm closures and the transfer of fixed resources, such as land and production rights to other farmers.

The farmers' and spouses' off-farm income had different impacts on the decision to exit and close down the farm. The increasing off-farm income of the spouse delayed the decision to close down the farm and slowed down the transfer of resources from farms without sound economic perspectives to expand. However, increasing the off-farm income of the farmer himself increased the likelihood of exiting and closing down the farm. Thus, the farmer's off-farm income is likely an indication that a farmer has feasible and attractive occupational alternatives to farming. The farmer's off-farm income increased the opportunity cost of farming.

The results found in this chapter are mainly in line with earlier results found by Pietola *et al.* (2003), who used a less advanced method and lacked data on off-farm incomes. Furthermore, results of this analysis suggest that if the exit decision is delayed and the farmer becomes older, the likelihood for farm succession decreases even faster than predicted in the earlier analysis of Pietola *et al.* (2003). Therefore, the early retirement programmes crucially steer long-term structural development by promoting farm succession and the continuation of family farming.

In addition, the current analysis suggests that economic policy and the market environment, such as prices and farm subsidies, significantly affect farm successions. Either farmer-specific fixed effects or past revenue shocks or both were found to have significant effects on the timing and type of farmer exits. The policy implications of the results in this chapter were evaluated in terms of the trend towards decoupling subsidies. Contradictory to the traditional market based subsidies, direct income subsidies are not dependent on the production level. If decoupled farm payments result in large revenue shocks and affect the level of coupled subsidies and output prices, then reform is expected to significantly alter farmers' exit behaviour and their response to early retirement programmes.

8 Conclusions

8.1 Summary

During the last decade, the number of farms has decreased, the average farm size has increased, and the number of farm transfers has decreased. In addition, the share and amount of off-farm income of the farm family's total income has increased. As the type and timing of occupational choices among elderly farmers play a crucial role in determining the characteristics of structural change in agriculture, it is important to establish what factors determine the type and timing of an exit from farming among elderly farmers. In earlier studies on farm retirement, farm and family characteristics, economic incentives and institutional differences and constraints have been found to matter.

One of the policy tools aiming at improving the farming structure is the farmers' early retirement system. In Finland, farmers' early retirement programmes were first introduced in 1974. Since then, there have been several different programmes enhancing the continuity of family farming. Since the large generation born in the 1940-50s is now approaching retirement age, new information is needed about the factors affecting farming couples' retirement behaviour.

The main objective of the present study was to produce new information on farm retirement and the factors affecting it. The main research questions addressed were how farm and farm family characteristics and economic incentives affect farmers' retirement choices and the type and timing of these decisions. In addition, farmers' succession considerations and actual succession behaviour were compared in order to find out how well farm surveys predict future farm successions.

In the study, farmers' were expected to maximise their lifetime utility when making retirement decisions. According to the earlier studies reviewed in Chapter 2, different farm and family characteristics and economic incentives were expected to affect these decisions. In addition, the farmer's utility was expected to differ between farm transfer and farm closure.

As described in Chapter 2, most of the earlier studies on farm retirement are based on the *ex-ante* considerations of farmers on farm surveys. This study, however, was based on two data sets on farmers' actual retirement behaviour (*ex-post*). Farm accountancy data complemented by farm surveys were utilised in order to study the time consistency of farmers' succession considerations (Chapter 4). Farmers' retirement data collected from the registers of the Farmers' Social Insurance Institution (Mela) were utilised in studying the type and timing of farmers' retirement and exit decisions (Chapters 5, 6 and 7). The choice of study approaches was based on earlier studies on farm retirement and individual retirement probability.

In Chapter 4, a recursive probit model for farmers' stated succession plans on the farm surveys and the observed farm succession on these farms was estimated. The results clearly suggest that the farmer statements usually collected in farmer surveys do not add significant information in predicting actual, revealed farm successions. A reason for the irrelevance of the information generated by farmer surveys is that the stated plans, as set by the elderly farmers, may be inconsistent over time and may conflict with the views, expectations or plans of the potential successors. The farmers' observed succession behaviour may, therefore, be steered more by other circumstances and factors rather than the farmer's stated plans. In earlier studies, farmers' succession considerations have been found to be time inconsistent. This is why one should use actual retirement data when analysing farm retirement.

In Chapter 5, the effects of farm and family characteristics and economic incentives on farming couple's retirement decisions were analysed. The choice of the farmers' early retirement system was further divided into farm transfers to new entrants and farm closures. The analysis was based on a bivariate probit model. The results in general suggest that farmers' early retirement was a decreasing function and farm transfer an increasing function of the age of the farmer. For the spouse's age, the opposite effect was found. Choosing the farmers' early retirement system was less likely in the northern parts of the country and on livestock farms. However, the bigger the farm, the more likely early retirement and farm transfer were and the less likely farm closure was. The result is in agreement with earlier findings of farm transfer being more likely on bigger farms. Choosing a farmers' early retirement pension and transferring the farm to a new entrant were more likely on those farms having more children, and farm transfer was an increasing function of the age of the oldest child. The increase in farm income decreased the early retirement and farm transfer probability as well.

Recently, the joint retirement of couples has received great attention, and an individual's retirement decisions have been found to be strongly influenced by the retirement decisions of the spouse. Not only because of the restrictions of the farmers' early retirement system, but also because of the incapability of the other spouse to take care of the farm work alone, joint retirement is expected to involve farming couples especially. In Chapter 6, the effect of spousal retirement and economic incentives on the timing of farmers' early retirement decisions was analysed. The analysis was based on a commonly used Weibull survival model. In the model, the survival of a farming couple is defined as years after the eligibility of the farmer for the farmers' early retirement scheme at the age of 55 and before the actual early retirement of the farmer and/or the spouse. According to the results, farm transfers in general took place somewhat earlier than farm closures. It was found that applying for the early retirement scheme and especially farm succession was more likely to take place on farms with two entrepreneurs. The existence of a spouse was, however, found to delay early retirement. The result of postponing retirement holds together with earlier findings of Glauben *et al.* (2004a), who suggest that farm succession is postponed when the spouse is also working on the farm. A high level of expected pension of the farmer and spouse was found to advance farm transfers in particular. The off-farm income of the spouse delayed the transfer of the farm to a new entrant and the off-farm income of the farmer delayed closing down the farm. Postponing retirement delayed the transfer of resources to new entrants or to those farmers expanding their activities. The results suggest that off-farm income may slow down structural development in the farming sector. In earlier studies, spousal retirement is found to strongly influence an individual's retirement decisions. The results of this study support this view with the findings about the farming couple's joint early retirement decision. Unlike prior expectations, another pension received by either the farmer or the spouse delayed the timing of the early retirement of the other spouse.

Chapter 7 analysed farmers' exit decisions as sequences of interrelated choices such that unexpected changes in revenues and farmer specific effects were controlled for. Special attention was paid to the effect of off-farm income and economic incentives on the timing of retirement decisions. The results suggest that farmers' off-farm income encourages farmers to exit farming and close down the farm operation. This result corresponds to earlier findings (*e.g.* Stiglbauer and Weiss, 2000) of part-time farms being more likely to be closed down than full-time farms. The off-farm income of the spouse, on the other hand, encouraged the farmer to continue the farm operation and delay the exit decision. This result was qualitatively different from the results of Chapter 6. The difference may be explained by the fact that farmer retirement decisions are merely affected by unexpected changes in production, whereas those of farming couples are mainly affected by their income. The results suggest that the common trend of gradually increasing off-farm income amongst elderly farming couples does not have significant implications for the continuation of family farming in the long-run. However, increasing off-farm incomes significantly affected the timing of farm closures and the transfer of fixed resources, such as land and production rights to existing or new farms.

8.2 Main findings

Family farms are a combination of family life and farm business, both run by a farm family. Because of this close connection, they cannot be separated from each other. Taking care of the business not only has effects on family life, but the characteristics, values and goals of the farm family also affect farm management and business decisions. One of the main objectives of the farmers has been found to be to pass on the farm to the next generation. As retirement and succession decisions affect the whole farm and family, they usually are preceded by a (long) planning period. However, a person's intentions and plans tend to change, e.g. because of new information. In this study, it was found that farmers' succession plans may be time inconsistent. This is why an analysis of farm retirement should not only be based on farmers' succession considerations collected in surveys etc. but on actual farm retirement data, too.

Both the probability of having a stated succession plan as reported on a farm survey and actually transferring the farm to a new entrant were found to increase with farmer age. However, corresponding to earlier findings, it was found that after first increasing, beyond a certain age the probability of farm transfer starts to decrease. This is why a farm succession should not be delayed. Even though farm succession is not restricted to family members, it was found to be more likely when the farmer had more children. And the older the possible successors were, the sooner the farm succession was expected to take place after the farmer reaches the lower age limit of the farmers' early retirement system.

Couples have been found to tend to co-ordinate their retirement decisions. In this study, applying for the early retirement scheme and especially farm succession were also more likely on farms with two entrepreneurs. One reason for this is that all entrepreneurs must give up farming activities when one of them applies for the early retirement pension. However, having a younger spouse working on a farm postponed a farmer's early retirement decision. Further, the older the spouse, the sooner the farm was transferred to a new entrant or closed down. Moreover, the longer the farmer had been farming, the more likely retirement became. Unlike the expected result, farmers were not found to co-ordinate their early retirement decisions according to spousal retirement by other pension schemes.

Besides the farm family, the farm's characteristics and economic incentives were found to matter. The bigger the farm, the more likely farm succession was and the earlier it took place. The result is in agreement with earlier findings. The bigger the farm income is, the bigger the dependency of the farm family on farming as a source of living is expected to be. According to the results, early retirement is less likely and takes place later on farms with a larger farm income. However, the expected pension when retiring depends on the level of farm income. It is found that the bigger the expected pension is, the more likely farm succession is and the earlier the farm is transferred to a new entrant. In earlier studies, part-time farming has been suggested to enhance farm closure. The results of the present study also confirm this finding. However, farmers' and spouses' off-farm earnings are not found to affect farm transfers and thus do not endanger the continuation of family farming in the long run.

8.3 Policy implications

Because the farmers' early retirement system carries out the targets of agricultural structural policy, it greatly differs from other early retirement channels. Its farm level nature is also unique; when one of the entrepreneurs decides to retire under the farmers' early retirement scheme, the others also have to stop their farming activities. During the last 30 years, over 68,000 Finnish farms have benefited from the farmers' early retirement system. Even though the number of farms applying for the farmers' early retirement programme annually has been decreasing, it is still of great importance in securing the continuation of family farming in Finland. The early retirement programmes also crucially steer the long-term structural development of the farming sector.

According to the results, pension benefits and the farmer's age significantly affect the probability of succession and the timing of retirement. In order to encourage young entrants to farm, an attractive early retirement system is needed. This implies both keeping the lower age limit low enough and having a pension benefit encouraging enough for retiring farmers. This is necessary for securing a living for retiring farmers. The result is likely to be generalised from farming to other small scale family businesses, as well.

In addition, the analysis suggests that economic policy and the market environment, such as prices and farm subsidies, significantly affect farm successions. The policy implication of this is that the producer price fall after Finland's entry into the EU in 1995 significantly decreased the number of new entrants. Similarly, higher direct income subsidies enhanced farm successions but not as strongly as high price supports. The policy implications of the results were evaluated in terms of the trend towards decoupling subsidies. If decoupled farm payments result in large revenue shocks and affect the level of coupled subsidies and output prices, then reform is expected to significantly alter farmers' exit behaviour and their response to early retirement programmes. Decoupled farm payments may also significantly affect farm development opportunities and the attractiveness of farming to possible successors and thus increase the probability of succession.

8.4 Suggestions for further research

In the present study, elderly farmers' succession and retirement decisions were analysed using four different approaches. The study object was the retiring, elderly farmer or farming couple, whereas the possible successor and new entrants taking over the farming activities were not further studied. However, as the maintenance of family-based farming and the future development of the farming sector heavily depend on the number of farm successions taking place, further research on farm succession and the factors affecting it is needed. In earlier studies, both demographic and economic factors have been found to matter. Besides farm and family characteristics, the possible farm successor is also expected to have a major influence on the probability of farm succession. It is especially important to find out how education, employment status, and the income of a possible successor and his spouse affect the probability of farm succession. Furthermore, it should be investigated how the financial situation of the farm develops after the succession and what factors enhance the survival of farms transferred to new entrants.

Selostus: Viljelijöiden luopumiseen ja sukupolvenvaihdoksiin vaikuttavat tekijät Suomessa

Suomalaisen maatalouden rakenne on muuttunut nopeasti viimeisen vuosikymmenen aikana; maatilojen määrä on vähentynyt ja keskikoko kasvanut. Samaan aikaan myös tehtyjen sukupolvenvaihdosten määrä on vähentynyt. Lisäksi tilan ulkopuoliset tulot ja niiden osuus viljelijäperheen kokonaistuloista ovat kasvaneet. Koska ikääntyvien viljelijöiden luopumispäätökset vaikuttavat ratkaisevasti maatalouden rakennekehitykseen, on tärkeää selvittää, mitkä tekijät vaikuttavat viljelijöiden sukupolvenvaihdos- ja luopumispäätöksiin sekä näiden päätösten ajoitukseen. Erityisen tärkeää viljelijöiden luopumispäätösten tarkastelu on nyt, kun suuret ikäluokat ovat lähestymässä eläkeikää ja sukupolvenvaihdos tai tilanpidon lopettamispäätös on ajankohtainen monella tilalla lähivuosina. Sekä viljelijän ja tilan ominaisuudet, taloudelliset kannustimet että erilaiset politiikkatoimenpiteet vaikuttavat viljelijöiden luopumispäätöksiin.

Suomessa on ollut vuodesta 1974 lähtien käytössä erilaisia viljelijöiden luopumistukijärjestelmiä, joiden tavoitteena on ollut tilarakenteen parantaminen ja sukupolvenvaihdosten kannustaminen. Viimeisen kymmenen vuoden aikana viljelijöiden luopumistukijärjestelmää on toteutettu Euroopan Unionin vastaavan järjestelmän puitteissa. Järjestelmä mahdollistaa luopumisen tilanpidosta ennen varsinaista eläkeikää. Luopumiseläke on viljelijäkohtainen ja sen suuruus riippuu maksetuista eläkevakuutusmaksuista.

Tämän tutkimuksen tavoitteena on tarkastella viljelijöiden sukupolvenvaihdos- ja luopumispäätöksiä. Tutkimuksessa analysoidaan viljelijän ja tilan ominaisuuksien sekä taloudellisten kannustimien vaikutusta viljelijöiden luopumisvalintoihin sekä näiden päätösten ajoitukseen. Lisäksi verrataan viljelijöiden sukupolvenvaihdosaikomuksia koskevia kyselyvastauksia ja toteutunutta kehitystä toisiinsa. Tarkastelun tavoitteena on selvittää, voidaanko viljelijäkyselyjen perusteella ylipäätään tuottaa tilastoista ja viljelijöiden ikäjakaumista saatavan tiedon lisäksi sellaista tietoa, joka auttaisi ennustamaan sukupolvenvaihdosten määrää ja maatalouden rakennekehityksen nopeutta yhä tarkemmin. Kysymys on ajankohtainen, sillä viljelijäkyselyjä on viime aikoina usein käytetty erilaisten rakennekehitysennusteiden tekemiseen. Aikaisempien tutkimusten perusteella viljelijöiden sukupolvenvaihdossuunnitelmat muuttuvat kuitenkin ajan myötä.

Tutkimus muodostuu neljästä osasta ja se perustuu kahteen eri tila-aineistoon. Ensimmäisessä osiossa tutkimusaineistona käytetään kirjanpitotila-aineistoa vuosilta 1996–2001 sekä näille tiloille vuosina 1996–1997 tehtyä kyselyä. Kyselyssä selvitettiin, aiottiinko tilalla tehdä sukupolvenvaihdos seuraavan viiden vuoden aikana. Tarkastelussa oli mukana 97 tilaa, jotka vastasivat kyselyyn 1996–1997 ja jotka olivat mukana kirjanpitotila-aineistossa vuoteen 2001 asti. Tarkastelu perustui rekursiiviseen probit-analyysiin. Tulosten perusteella viljelijäkyselyjen vastausten perusteella ei voida ennustaa toteutuneita sukupolvenvaihdoksia. Yhtenä syynä tähän on, että sukupolvenvaihdossuunnitelmat muuttuvat ajan myötä. Lisäksi viljelijäkyselyt on yleensä suunnattu ikääntyville viljelijöille eikä niissä oteta huomioon mahdollisen jatkajan odotuksia tai mielipiteitä. Lisäksi viljelijöiden sukupolvenvaihdos- ja luopumispäätöksiä koskevien tutkimusten tulisi perustua toteutuneeseen kehitykseen perustuvaan aineistoon tulevaisuudensuunnitelmia koskevien kyselyjen sijasta.

Tutkimuksen muissa osioissa aineistona käytetään Maatalousyrittäjien eläkelaitoksen rekistereistä poimittua tilakohtaista aineistoa, jota on täydennetty Tilastokeskuksessa viljelijöiden henkilöverotuksen tiedoilla, IACS-tukirekisterin tiedoilla sekä viljelijöiden lapsia koskevilla tiedoilla. Tutkimusaineisto sisältää 963 tilan tiedot vuosilta 1993–1998. Otoksen viljelijät olivat vuonna 1993 korkeintaan 64-vuotiaita ja vuonna 1998 vähintään 55-vuotiaita. Siten heidän kaikkien olisi ollut iän puolesta mahdollista luopua viljelystä tutkimusajanjakson aikana. Tutkimusaineisto sisältää myös viljelijän puolison tiedot. Aineisto sisältää mm. seuraavat tiedot: viljelijän ja puolison ikä, eläkkeelle jäämisen ajankohta ja eläkekanava, luopumistuen kyseessä ollen myös luopumistavan (sukupolvenvaihdos, myynti, vuokraus, metsitys tms.), tilan koko, sijainti, tuotantosuunta, lasten ikä, maa- ja metsätalouden tulot sekä tilan ulkopuoliset tulot.

Tutkimuksessa tilat ja viljelijät jaetaan viljelijän ja puolison eläkevalintojen mukaan luopumistukijärjestelmän valinneisiin sekä niihin, jotka eivät valinneet luopumistukieläkettä. Luopumistukieläkkeen valinneet jaetaan edelleen sukupolvenvaihdoksen tehneisiin sekä tilanpidon lopettaviin. Muut kuin luopumistukieläkkeen valinneet jaetaan tilanpidon ei-vapaaehtoisesti lopettaneisiin (esim. kuolema, sairaseläke yms.) ja muun eläkejärjestelmän (vanhuuseläke ym.) valinneisiin.

Toisessa osiossa tarkastellaan viljelijöiden eläkevalintoja. Tarkastelussa käytetään apuna bivariate probit-mallia. Tutkimustulosten perusteella sukupolvenvaihdosten ja luopumistukijärjestelmän valinnan todennäköisyys pienenee viljelijän ikääntyessä ja kasvaa puolison iän myötä. Luopumiseläkkeen todennäköisyys on pienempi maan pohjoisosissa sekä kotieläintiloilla, mutta mitä isompi tila, sitä todennäköisempi sukupolvenvaihdos on. Lasten lukumäärä ja vanhimman lapsen ikä lisäävät myös sukupolvenvaihdosten todennäköisyyttä.

Aikaisemmissa tutkimuksissa puolison eläkepäätösten on todettu vaikuttavan merkittävästi henkilöiden eläkepäätöksiin. Luopumistukijärjestelmän ehtojen mukaan kaikkien tilan maatalousyrittäjien on luovuttava tilanpidosta, mikäli yksi heistä jää luopumiseläkkeelle. Lisäksi tilan töistä huolehtimisen takia erityisesti viljelijäpariskuntien oletetaan hakeutuvan eläkkeelle samaan aikaan. Tutkimuksen kolmannessa osiossa tarkastellaan puolison eläkevalintojen sekä taloudellisten kannustimien vaikutusta viljelijöiden luopumispäätöksiin. Tarkastelu perustuu duraatioanalyysiin. Tarkastelussa mallinnetaan sitä, kuinka kauan tilanpitoa jatketaan sen jälkeen, kun luopumiseläkkeelle jääminen olisi mahdollista vanhemman viljelijäpuolisoista täyttäessä 55 vuotta. Tulosten perusteella sukupolvenvaihdokset tehdään aikaisemmin kuin tilan lopettamispäätökset. Tiloilla, joilla on kaksi yrittäjää, luopumiseläkkeen valinta on todennäköisempää, mutta sukupolvenvaihdokset tehdään myöhemmin kuin tiloilla, joilla on vain yksi yrittäjä. Odotettavissa olevan eläkkeen kasvun havaitaan aikaistavan erityisesti sukupolvenvaihdoksia. Tulosten perusteella viljelijäpariskunnat hakeutuvat erityisesti luopumistukieläkkeelle yhdessä. Sen sijaan puolison jääminen muulle eläkkeelle ei vaikuta viljelijöiden luopumispäätöksiin.

Tutkimuksen viimeisessä osiossa tarkastellaan viljelijäpariskunnan tilan ulkopuolisten tulojen vaikutusta viljelijöiden luopumispäätöksiin ja näiden päätösten ajoitukseen. Tarkastelu perustuu Pietolan *et al.* (2003) käyttämään menetelmään, jossa käytetään hyväksi sekä probit –mallia että suurimman todennäköisyyden menetelmään perustuvaa simulointia. Tulosten perusteella viljelijän ja puolison tilan ulkopuolisilla tiloilla on erilainen vaikutus viljelijän luopumispäätöksiin. Viljelijän tilan ulkopuolelta hankkimat tulot edesauttavat viljelijän päätöstä jäädä eläkkeelle ja lopettaa tilanpito. Puolison tilan ulkopuoliset tulot sen sijaan kannustavat jatkamaan tilanpitoa. Tulosten perusteella viljelijöiden lisääntyvät tilan ulkopuoliset tulot eivät merkittävästi vaikuta perheviljelmämuotoisen maatalouden jatkuvuuteen pitkällä aikavälillä. Sen sijaan tilan ulkopuoliset tulot vaikuttavat tilanpidon lopettamispäätösten ajoitukseen sekä tuotantoresurssien siirtymiseen tuotantoa jatkaville viljelijöille.

Johtopäätöksenä todetaan, että viljelijöiden luopumistukijärjestelmät ovat ensiarvoisen tärkeitä perheviljelmämuotoisen maatalouden säilyttämiseksi Suomessa. Järjestelmät mahdollistavat oikein ajoitetun sukupolvenvaihdoksen ja ylläpitävät maatalouden työpaikkoja pitkällä aikavälillä. Lyhyellä aikavälillä järjestelmät edesauttavat resurssien siirtymisen tilanpidon lopettavilta viljelijöiltä tuotantoaan jatkaville ja kehittäville tiloille. Houkutteleva luopumistukijärjestelmä on tarpeen nuorten viljelijöiden saamiseksi alalle. Tämä edellyttää eläkkeen alaikärajan pitämistä tarpeeksi matalana sekä riittävän korkeaa luopumistukieläkettä.

Tulosten mukaan myös talouspolitiikalla sekä maatalouden toimintaympäristöllä, kuten tuottajahinnoilla ja maataloustuilla, on merkittävä vaikutus sukupolvenvaihdosten toteutumiseen. Tuottajahintojen laskiessa Suomen liityttyä Euroopan Unionin jäseneksi myös tehtyjen sukupolvenvaihdosten määrä väheni huomattavasti. Samoin tulotuet lisäävät sukupolvenvaihdoksia, mutta eivät yhtä paljon kuin hintatuet. Jos ennakoidut muutokset ja tuotannosta irrotetut tilatuet aiheuttavat suuria tuottoshokkeja ja muuttavat tuki- ja tuottajahintatasoa, vaikuttaa politiikan uudistus myös viljelijöiden luopumispäätöksiin sekä tilanpidon aloittamisen houkuttelevuuteen.

Tässä tutkimuksessa tarkastellaan ikääntyvien viljelijöiden luopumispäätöksiä. Koska perheviljelmämuotoisen maatalouden jatkuvuus riippuu ennen kaikkea tehtyjen sukupolvenvaihdosten määristä, jatkotutkimuksissa tulisi keskittyä mahdollisen jatkajan näkökulmaan. Aikaisempien tutkimusten perusteella sekä tilan, että mahdollisen jatkajan ominaisuuksilla on merkittävä vaikutus sukupolvenvaihdosten toteutumiseen. Lisäksi tulisi selvittää kuinka jatkajan ja hänen puolisonsa tulot sekä työllistyminen vaikuttavat tilanpidon jatkamiseen. Edelleen olisi tärkeää tarkastella tilan talouden ja elinvoimaisuuden kehitystä sukupolvenvaihdoksen jälkeen.

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Appendix 1 (1/5). Farmers' early retirement system.

Farmers' early retirement arrangements and their restrictions in 1991–2006 (Mela 1991a, 1991b, 1993, 1998, 1999, 2000, 2003).

Farm closure pension 1991–1992

- The age limit is set at 55-64 years.
- The spouse may retire at the age of 45 if the farmer is eligible for the scheme.
- The retiring person must give up all farming activities and farms.
- The farmer must live on the farm before retirement.
- The farmer must have at least a two-hectare field under cultivation.
- Retirement takes place by selling the land to the government or to a neighbouring farmer, reforesting the field or making a lay-land agreement.
- A lay-land agreement lasts six years. After that the agreement may be continued, or the farm and fields may be sold. A farm may also be transferred to a new entrant.
- The income limit for the farmer (and spouse) for off-farm income during the previous five years is 13,960 EUR (83,000 FIM/year). Off-farm income after retirement has no limitations.
- Off-farm income includes income from wage work and other entrepreneurship, property in-come and pensions.
- The farm must have been acquired more than three years ago.
- No restrictions are set for selling wood.
- When selling to another farmer, the farm has to be viable. On the other hand, the farm cre-ated by the sale is not allowed to exceed the size of a family farm.
- The farm may be sold to more than one neighbouring farmer.
- The retiring farmer may keep the farm house and garden.
- The buyer has to be a farmer or the successor to the farm.
- The field may not be located more than 12 kilometres away from the farm.

Change of generation pension 1991–1995

- The age limit is set at 55-64 years.
- A 50-54-year-old spouse has the right to receive pension benefits at the age of 55 years.
- The income limit for the farmer (and spouse) off-farm income during the previous five years is 10,090 EUR (60,000 FIM/year). The income limit for off-farm income after retirement is 340 EUR (2,020 FIM) per month.
- The property of the retiring farmer may not exceed 252,282 EUR (1.5 million FIM) after retirement.
- The farmer must live on the farm and cultivate the land for five years before retirement.
- The farmer himself must cultivate at least one-fourth of the field area.
- The farmer has to own at least one-fourth of the farm.
- The successor may own at most half of the farm before the hand over. The farm has to be viable and profitable.

Appendix 1 (2/5).

- The farm size may not exceed the size of a family farm.
- The whole farm must be sold to the same buyer.
- The other owners must sell their share of the farm.
- The successor must be skilled and capable of farm work.
- The successor may not be over 45 years old.
- The income of the successor and the spouse may not exceed 27,751 EUR (165,000 FIM) (one person 21,864 EUR/130,000 FIM) per year.
- The successor must commit to owning and cultivating the farm for the next five years.
- The successor must live on the farm or at most five kilometres away from it.
- The successor may not lease the fields out.
- The pension ends when the retiring farmer reaches the age of 65 years.
- Since 1994, all farms must prove their ability to have a continuing, profitable production.

Farm closure compensation 1993–1995

- The age limit is set at 55-64 years.
- A 50-54-year-old spouse has the right to receive pension benefits at the age of 55 years.
- The retiring farmer must be a full-time farmer.
- The income limit for the farmer (and spouse) off-farm income during the previous five years is 10,680 EUR (63,498 FIM) per year. Income is not limited after retirement.
- The farm must have been under cultivation for the previous five years
- The farmer himself must have cultivated at least three hectares during the previous five years.
- The farmer must have owned the farm for the previous three years.
- Parts of the farm's land may not be sold or given out during the previous three years.
- The income from plant- and livestock production must be more than 505 EUR (3,000 FIM) per hectare.
- The farmer must give up farming and cattle farming.
- The fields may be reforested.
- Farm closure may not exceed the change of generation pension.
- Income is not limited after retirement
- Compensation ends when the retiring farmer reaches the age of 65 years

Appendix 1 (3/5).

Early retirement aid 1995–1999

- The age limit is set at 55-64 years.
- The 50-54-year-old spouse has the right to receive the pension benefits at the age of 55 years.
- The farmer also has the right to the pension when he has leased a farm.
- No restrictions are set on size or profitability, but one must earn a primary income from the farm.
- The retiring farmer must have been farming for at least the previous ten years. (At most 866 hours of off-farm work are allowed. In addition, farm and forestry income has to form half of the total income)
- The income limit after retirement is 398 EUR (2,368 FIM) per month in addition to earlier off-farm income.
- The farmer may sell or rent the fields in a succession to a new entrant or to another farmer.
- A land lease agreement must be valid for at least ten years.
- The successor has to be under 45 years of age and have either an agricultural education or three years experience and ten study points in agricultural education.
- The successor must expand the farm area by ten per cent or at least by two hectares.
- The successor must live on the farm or at most five kilometres away from it.
- The successor must cultivate the farm for the next five years as a full-time farmer.
- Other farmers buying additional land must be less than 55 years old.
- The pension ends when the retiring farmer reaches the age of 65.
- If there is no successor, fields may be reforested.

Aid for termination of agricultural production 1997–1999

- The age limit is set at 50-64 years.
- The farmer must have practised agriculture for at least the previous ten years.
- Leased farms are ineligible.
- A and B subsidy regions in Southern Finland are eligible.
- The field must be sold to a farmer who already has at least 15 hectares of fields.
- At least two-thirds of the fields must be passed on.
- The farmer must also give up cattle farming.
- A farmer buying the land has to commit to cultivating the land for the next five years.
- No aid is given on the basis of leasing the land.
- The farmer loses the right for the aid if he already receives a disability pension, individual early old-age pension or old-age pension
- The commitment is in force until all eligible persons are 65 years old and for at least 10 years.
- The aid is defined based on the number of hectares and cattle.
- The amount of aid is 3,364-33,640 EUR (20,000-200,000 FIM) (one-time compensation).

Appendix 1 (4/5).

Early retirement aid 2000–2002

- The age limit is 55-64 years.
- The farmer must have practised agriculture for at least the previous ten years and have had MYEL insurance for the previous five years.
- The aid is for arm succession or selling the fields to another farmer (not leasing out the land or making a lay-land agreement).
- The farm must be viable (at least 8,998 EUR/53,500 FIM in income per year).
- The aid is also for reindeer owners when transferring the farm to a new entrant or selling the reindeer to another reindeer owner who has at least 20 reindeer.
- No restrictions are set concerning full-time farming.
- The income limit for off-farm income after retirement is at most 406 EUR/2,412 FIM per month.
- A 50-54-year-old spouse has the right to receive pension benefits at the age of 55 years.
- A spouse under 55 years of age with a dormant right to support may freely have other sources of income.
- The farm must have buildings.
- The successor must be under 40 years of age.
- The successor must have had an agricultural education or three years of experience and have acquired 20 study points of education.
- The successor must cultivate the farm for the next five years.
- In farm succession, the farm has to be financially viable.
- The off-farm income of the successor may not exceed 34,983 EUR (208,000 FIM) per year. (No attention is given to the spouse's income.)
- A successor has to live on the farm or at such a distance that it is possible to handle the farm work.
- Other farmers buying additional land must be less than 55 years old.
- When buying additional land, the farm must be expanded by at least two hectares.
- The buyer must commit to cultivating the land for five years.

Early retirement aid 2003–2006

- The age limit in farm succession was 55-64 years in 2003-2004, 56-64 years in 2005-2006.
- The age limit when selling the land to another farmer is 57-64 years.
- It was also possible to lease out the land from 2004 to 2006. The age limit is 60-64 years.
- A spouse who is five years younger has the right to receive pension benefits when reaching the lower age limit.
- The income limit for off-farm work after retirement is 448 EUR per month.
- The off-farm income of the successor may not exceed 34,000 EUR (208,100 FIM) per year.
- The farm must be financially viable, and the farmer must receive at least 9,000 EUR (53,512 FIM) in income per year from it.

Appendix 1 (5/5).

The number of insured farms and farmers,[a)] total field area, the average farm size of insured farms, and the number of farms on which farmers have exited farming after the farmers' early retirement schemes in 1974 to 2005 in total and the number of farm transfers within the early retirement system (Mela, 2006).

	Number of insured farms	Number of insured farmers	Land million ha	Average size ha/farm	Farms involved in the early ret. system	Farm transfers under the ret. system
1974	193,231	303,761	2.06	10.7	194	16
1975	185,550	286,874	2.02	10.9	2,053	1,297
1976	178,296	274,716	1.99	11.2	1,783	1,119
1977	171,535	261,684	1.98	11.5	5,913	5,657
1978	165,272	252,463	1.97	11.9	1,418	970
1979	160,350	244,017	1.96	12.2	1,431	927
1980	155,563	235,663	1.98	12.7	1,828	1,492
1981	151,590	228,822	1.97	13.0	1,830	1,545
1982	146,461	221,287	1.96	13.4	1,881	1,576
1983	142,276	215,158	1.95	13.7	2,170	1,909
1984	139,615	210,402	1.97	14.1	1,946	1,685
1985	135,436	203,843	1.95	14.4	2,387	2,117
1986	129,865	195,278	1.93	16.0	2,438	2,153
1987	125,262	188,483	1.93	16.7	7,523	1,844
1988	120,986	181,752	1.91	16.9	4,940	2,044
1989	117,296	175,970	1.90	17.3	2,728	1,442
1990	113,109	169,894	1.92	17.7	2,507	1,602
1991	108,649	164,285	1.94	18.9	2,681	989
1992	105,581	159,007	1.90	29.2	4,941	943
1993	102,218	153,358	1.86	19.6	3,586	918
1994	96,205	143,816	1.84	20.2	1,379	1,127
1995	91,374	135,624	1.80	20.8	1,211	516
1996	86,090	126,475	1.77	21.7	1,309	341
1997	82,175	120,372	1.78	22.8	1,086	385
1998	78,172	114,205	1.79	24.2	1,111	376
1999	73,862	107,097	1.79	25.6	1,761	489
2000	70,326	102,244	1.80	27.0	817	345
2001	67,826	98,478	1.82	28.2	745	570
2002	65,746	95,158	1.86	29.6	808	607
2003	63,179	91,191	1.86	31.0	604	487
2004	62,418	89,515	1.88	31.9	688	397
2005	60,924	87,178	1.90	32.9	945	622

[a)] Purchasing pension insurance from the Farmers' Social Insurance Institution (Mela) in practice is obligatory for all farmers. It is also a pre-condition for applying for a farmer's early retirement pension.

Appendix 2 (1/1). Correlation on farmers' retirement data.

Correlation matrix, NT=5,778 observations, on farmers' retirement data.

	Independent variables							
	Farmer age	Spouse age	Farming years	Number of children	Age, oldest child	Age, youngest child	Land area	Forest area
Spouse age	0.009							
Farming years	0.376**	-0.003**						
Number of children	0.019	0.123***	0.061**					
Age of the oldest child	0.219	0.188***	0.135***	0.613**				
Age of the youngest child	0.301	0.524***	0.243***	0.253***	0.625**			
Land area	-0.065***	0.237***	0.114**	0.053 ***	0.039***	0.025**		
Forest area	0.003	0.029 **	0.027**	0.089 ***	0.041**	0.115***	0.030**	
Barley subsidy	0.128	0.035**	0.073***	0.045**	-0.054***	-0.042**	-0.052***	0.094***
Expected pension farmer	-0.199***	-0.052***	0.253***	0.006***	-0.039**	-0.003**	0.573***	0.162***
Expected pension spouse	-0.077**	0.943**	-0.014**	0.127***	0.163**	0.0804***	0.309***	0.032***
Agricultural income	-0.145***	0.259***	0.039***	0.092***	0.088***	0.145**	0.447***	0.068***
Farmer off-farm income	-0.203***	0.028***	-0.165**	0.007	0.000*	0.030**	-0.199***	-0.045***
Spouse off-farm income	-0.205**	0.059***	-0.133***	0.025	0.023**	0.004***	0.042**	-0.065**
Early retirement pension	0.041***	0.256***	0.096**	0.058***	-0.091***	-0.007**	-0.077***	0.010
Farm transfer	0.038***	0.180***	0.097**	0.152***	0.169**	0.253***	0.232***	0.049***
Continue farming	-0.349***	0.362***	-0.205**	-0.005	-0.075**	-0.147***	0.062***	0.026*

	Independent variables						Dependent variables	
	Barley subsidy	Exp. pens. farmer	Exp. pens. spouse	Agric. income	Farmer off-f. income	Spouse off-f. income	Early ret. pension	Farm transfer
Spouse age								
Farming years								
Number of children								
Age of the oldest child								
Age of the youngest child								
Land area								
Forest area								
Barley subsidy								
Expected pension farmer	-0.067***							
Expected pension spouse	0.007***	0.044***						
Agricultural income	-0.086***	0.343***	0.322***					
Farmer off-farm income	-0.054**	-0.072**	-0.072***	0.021***				
Spouse off-farm income	-0.052***	0.041***	0.042**	0.036***	0.252***			
Early retirement pension	0.011**	0.144***	0.267***	0.058***	-0.091***	-0.077***		
Farm transfer	0.002***	0.161***	0.216***	0.006	-0.058**	-0.083***	0.708***	
No early retirement pension	0.037***	-0.013**	0.360***	0.167***	0.167***	0.195***	-0.412***	-0.291***

Note: Significant at less than 1% (***, 1-5% (**), 5-10% (*), and more than 10% () insignificant.

Glossary of variables: The farmer or spouse chose early retirement pension (early retirement pension), the farmer or spouse chose early retirement and transferred the farm to a new entrant (farm transfer), the farmer and spouse have not chosen early retirement and either continued farming or chose an old-age pension or other pension (no early retirement pension).

Appendix 3 (1/1). Farm survey question for Chapter 4.

The questionnaire on Finnish farms participating in the Farm Accountancy Data Network (FADN) since 1996 includes questions about the farmers' plans concerning farming over the next five years. First, it was asked whether the farmer was going to start, continue, expand or give up agricultural production, forestry, small business entrepreneurship and wage work outside the farm in the next five years. Next, it was asked more closely what was going to happen to agricultural production if the farmer was not going to continue it himself. The answer analysed in this study is the first answer option for the follow-up question:

If you are not going to continue farming on your farm yourself, what is going to happen to its agricultural production?

1. The farm is going to be transferred to a family successor.
2. The whole farm will be sold to a non-family-member.
3. The farm, except the house lived in, will be sold.
4. Only the fields will be sold.
5. The whole farm will be rented out.
6. Only the fields will be rented out.
7. The fields will be reforested.
8. Part of the fields will be reforested.
9. Other, what?

Appendix 4 (1/3). Unrestricted model and univariate probit models for Chapter 4.

Parameter estimates of the recursive probit model of Equations 2 and 3 (t values in parentheses) without restricting the covariance coefficient between the errors of the two equations.

	Stated Plan Equation		Revealed Succession Equation	
Explanatory variable	Coefficient	*t* value	Coefficient	*t* value
Intercept	-3.9291**	(-2.302)	-8.8617**	(-3.076)
Farmer's age	0.5936*	(2.031)	1.4525**	(2.996)
Spouse's age	0.1340	(1.185)	0.0863	(0.589)
Arable land area	0.4035	(0.393)	0.7707	(1.413)
Forest area	-0.3315	(-0.976)	-0.2009	(-0.642)
Livestock and dairy farm	0.5211	(1.306)	0.6349	(1.368)
North	0.5851	(1.553)	0.6563*	(2.088)
Total assets	0.0226	(0.091)	-	-
Farm debts	0.1458	(0.583)	-	-
Family labour	-0.1538	(-1.359)	-0.0654	(-0.457)
Stated plan	-	-	-1.2044***	(-3.948)
Disturbance correlation ρ	0.9976***	(10.931)		
Log likelihood		-98.003		

*** A triple asterisk denotes significance at a two-sided 1% level.
** A double asterisk denotes significance at a two-sided 5% level.
** An asterisk denotes significance at a two-sided 1% level.

Predicted and observed probabilities based on bivariate probit models without restricting the covariance coefficient between the errors of the two equations.

	Model	Revealed succession		
Cases	Observations	0	1	Total
No stated succession plan	Observed	43	9	52
	Predicted	61	0	61
Stated succession plan	Observed	27	18	45
	Predicted	8	28	36
Total	Observed	70	27	97
	Predicted	69	28	97

Appendix 4 (2/3).

Univariate probit analysis

In the probit model, a discrete choice between two possibilities is described by the latent dependent variable y. The probit model follows a normal distribution (Maddala 1983):

$$y_i^* = \alpha + \beta' x_i + \varepsilon_i \qquad \text{(A.1)}$$

where the residual term is normally distributed as εi ~ (0, σ2). In the model, observed dependent variable y receives two values:

$$\begin{aligned} y &= 1 \quad \text{if } y_i^* > 0 \\ y &= 0 \quad \text{otherwise} \end{aligned} \qquad \text{(A.2)}$$

In the first case, (i) y received value 1 if there was a stated succession plan and zero if not. In the second case, (ii) y=1 if the farm was transferred to a successor and y=0 if the farm was not. The modelling is done separately for these choices.

The analysis probability of y = 1 depends on a vector of independent variables labelled as x. The probability of P(y=1) increases with β'x. Thus, assuming that σ 2 =1, we get:

$$\begin{aligned} P(y_i = 1) &= \Phi(\beta' x_i) \\ P(y_i = 0) &= 1 - \Phi(\beta' x_i) \end{aligned} \qquad \text{(A.3)}$$

where Φ = the cumulative distribution function of the normal distribution with normalised vari-ance. The likelihood function is (Maddala, 1983):

$$L = \prod_{i=1}^{n} [\Phi(\beta' x_i)]^{y_i} [1 - \Phi(\beta' x_i)]^{1-y_i} \qquad \text{(A.4)}$$

Appendix 4 (3/3).

Parameter estimates of the univariate probit models for stated succession plan and revealed succession (t values in parentheses).

	Stated Plan Equation		Revealed Succession Equation	
Explanatory variable	Coefficient	*t* value	Coefficient	*t* value
Intercept	-4.3068**	(-2.457)	-12.898***	(-4.651)
Farmer's age	0.6469*	(2.201)	2.0189***	(4.550)
Spouse's age	0.1372	(1.516)	0.0249	(0.227)
Arable land area	0.0877	(0.101)	0.8284	(0.792)
Forest area	-0.4120	(-1.542)	-0.0595	(-0.214)
Livestock and dairy farm	0.4390	(1.142)	0.7235	(1.404)
North	0.5669	(1.688)	0.7619*	(2.001)
Total assets	0.1129	(0.550)	0.0356	(0.143)
Farm debts	0.1404	(0.598)	-0.1048	(-0.307)
Family labour	-0.1291	(-1.229)	-0.0380	(-0.307)
Log likelihood	-61.439		-39.653	
Restricted log likelihood	-66.983		-57.365	
Likelihood ratio test	11.086		35.423	
Degrees of freedom	9		9	
Total number of observations	97		97	

*** A triple asterisk denotes significance at a two-sided 1% level.
** A double asterisk denotes significance at a two-sided 5% level.
* An asterisk denotes significance at a two-sided 10% level.

Predicted (column) and observed (row) probabilities based on the univariate probit models for stated succession plan and revealed succession.

	0	1	Total
Stated plan			
0	35	17	52
1	22	23	45
Total	57	40	97
Revealed succession			
0	65	5	70
1	13	14	27
Total	78	19	97

Appendix 5 (1/1). Choice of pension scheme in the farmers' retirement data.

The number of sample farms, farmers and spouses according to the choice of pension scheme on all farms and on farms operated by a couple in the farmers' retirement data.

All farms	Farms	Farmers	Spouses
Continued farming	387	276	277
Retirement	576	687	686
-Early retirement pension	194	161	95
*Farm transfer	108	91	54
*Farm closure	86	70	41
-Involuntary exit	0	147	18
-Other pension	382	378	66
Total	963	963	456
Farms with a spouse	Farms	Farmers	Spouses
Continued farming	178	170	277
Retirement	278	286	179
-Early retirement pension	137	104	95
*Farm transfer	76	59	54
*Farm closure	61	45	41
-Involuntary exit	0	46	18
-Other pension	141	136	66
Total	456	456	456

Appendix 6 (1/1). Probit model for retirement for Chapter 5.

Parameter estimates of the estimated probit model for retirement.

	Retirement	
Independent variable	Coefficient	*t* value
Constant	-5.9949***	(-20.403)
Farmer age	1.2109***	(22.334)
Spouse age	-0.22077***	(-28.105)
Farming years	0.13338***	(6.259)
Number of children	-0.0111	(-0.752)
Age of the oldest child	0.1349***	(6.699)
Land area	0.0804	(1.296)
Forest area	-0.0139***	(-3.458)
Livestock and dairy farm	-0.1596***	(-3.925)
North	0.0588	(0.578)
Trend	-0.1870***	(-14.529)
Income loss of early ret., ln	0.0054	(0.792)
Agricultural income, ln	-0.0484***	(-7.429)
Off-farm income, ln	-0.0355***	(-5.957)
Share of subsidy	-0.0355	(-1.341)
North-forest	0.0081	(1.296)
South-land	0.0122	(0.195)
Log likelihood	-2823.126	
Restricted log likelihood	-3892.998	
Likelihood ratio test	2139.744	
Degrees of freedom	16	
Number of 0/1 observations	2,322/3,456	
Total number of observations	5,778	

*** A triple asterisk denotes significance at a two-sided 1% level.

Predicted (column) and observed (row) probabilities based on the univariate probit model for retirement.

	0	1	Total
0	1,524	798	2,322
1	622	2,834	3,456
Total	2,146	3,632	5,778

Appendix 7 (1/1). Number of farms and exit cases in the farmers' retirement data

The number of farms and exit cases in the farmers’ retirement data by year.

	Year					
	1993	1994	1995	1996	1997	1998
Sample farms	963	884	823	766	717	678
Farm transfers	37	24	8	11	9	2
Farm closures	3	10	21	16	11	9
Exogenous exit	39	27	28	22	19	12

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