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TRANSITION TO RETIREMENT IN ESTONIA: INDIVIDUAL EFFECTS IN A CHANGING INSTITUTIONAL CONTEXT

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Abstract[1]

This analysis of retirement in Estonia during the transition from the socialist system to market economy focuses on individual characteristics and institutional background that shape the country's retirement profile. Estonia exhibits high old-age employment rate against the backdrop of relatively poor health, a trend that has been visible already for several decades. The study contrasts two very different institutional backgrounds – a rigid socialist system with low pensionable age (55 for women and 60 for men) and no unemployment until 1991, and market economy with increasing statutory retirement age and emerging unemployment. The data come from the Estonian Gender and Generations Survey 2004–05, which includes individual demographic, educational, employment, and health histories. Analytical approach includes event history and multi-state analysis. Time-varying health status together with several time-fixed covariates is used to estimate the individual effects on transition to retirement. In the multi-state part, individual activity status at any moment is collapsed into four categories: employed, retired, disabled, or "other" (unemployed, studying, at home, institutionalised, maternity leave, military service). Results of the event history model suggest substantial difference between the retirement behaviour in the socialist system and in market economy. Retirement in the market economy period has been postponed, the effect of health status and educational attainment has become stronger than in the socialist period. Multi-state analysis confirms partly the results of the event history model, but the outcome is less reliable for some variables. While the effect of educational attainment is supported by multi-state approach, health effect on retirement is not consistent with the basic event history analysis. As a modelling exercise, the present research suggests that further research is needed on more appropriate modelling of retirement process in Estonia.

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Contents

1 Introduction

Population ageing has been recognised as one of the great successes of mankind, but also a challenge that modern economies and health care systems face already now or in the near future. Ageing affects many aspects of a society – economy, labour market structure, social security, health care and pension system, etc. Generous retirement schemes and relatively early actual retirement age have produced considerable unused labour capacity in advanced European countries, which contrasts with shrinking working age population. Concerns about employment and social security of the increasing number of older persons is one of the issues related to transformation of society due to ageing. Such problems are not limited to relatively rich welfare countries, but appear also in less developed economies where population ageing is taking place. International organisations have addressed the issue already for some time, e.g. suggestions by International Labour Organisation, OECD, European Commission.[2] The topic of old-age employment and retirement has been the motivation for specialised surveys and numerous studies. The present paper focuses on retirement in Estonia, a country that has gone through a rapid change in socio-economic system, from state socialist[3] planned system to market economy.

Population ageing and transition to retirement in Estonia, both in the socialist period and during recent decades, is well addressed from the demographic perspective (Katus *et al.* 1999; 2003b). Also, studies have been conducted on labour market participation of seniors (Leetmaa *et al.* 2004a) and development of the pension system in Estonia (Leetmaa *et al.* 2004b, Leppik 2006, Leppik and Kruuda 2003). Labour market participation in ages over 45 is very much related to health conditions – long-term illness and injuries are one of the main reasons of inactivity (see Leetmaa *et al.* 2004b). In contrast to comparatively bad health statistics (e.g. Jagger *et al.* 2008, Lai *et al.* 2009), labour market participation rates of older persons in Estonia have been among the highest in Europe. While the reason of this situation is not clear, it may have roots in the socialist period that was characterised by much different old-age employment opportunities than are present today. In the following text the focus will be on some measurable individual characteristics that are likely to have an effect on the timing of retirement, and perhaps help to explain the mentioned health-employment paradox. The individual features are treated in the context of changing socio-economic system – state socialist and market economy will be contrasted by comparing people who are entitled to retirement under the two different periods.

The data for analysis come from the Estonian Gender and Generations Survey 2004–05. As of the methods, the present analysis applies event history and multi-state analysis. Event history analysis uses basic survival modelling with time-dependence. Multi-state analysis will be given as a complement to the event history model, but the two are not directly comparable due to different model specification. The application of multi-state analysis has the purpose of finding a better description of the retirement process. It is able to capture the pathways to retirement that are otherwise ignored in the event history model (e.g. retirement through unemployment or after disability episode).

The present text has the following structure. First, a short description of theoretical approaches to old-age employment and retirement is given. As there is a great number of studies from several fields of social sciences that relate to the problem (starting from economics and ending with psychology), the idea is not to review all possible theories of retirement. However, it is important to distinguish at least two dimensions that define the process under study – institutional and individual. Thus some economic and sociological theories are shortly introduced. Since this paper is a country study, a brief overview of the Estonian setting is given in terms of employment of older people and development of

[2] See for example European Commission (2003), International Labour Organization (1980), OECD (1998).

[3] The term state socialist is used to underline the idiosyncratic type of socialist (communist) system in the former Soviet Union and the satellite countries. In the following text, when referring to state socialist period in Estonia, for the sake of brevity the term "state socialist" is sometimes used interchangeably with just "socialist".

the pension system. Next, some research questions are put forward that will be used for constructing statistical models of retirement in Estonia. Then the data and variables are introduced in section 5. The results of modelling exercises are given in section 6, both for event history and multi-state models. Finally, we discuss the results and some possible extensions for future research.

2 Theoretical background

Retirement studies have used a wide range of theoretical approaches. The process of retirement can be viewed as economic, social, health-related, or as a psychological or cultural question. Let us first point out institutional or country-level theoretical aspects. The pressure of ageing on the labour market has given ground to studies of employment rates of older population. From the economic point of view Gruber and Wise (1998) summarise an international comparison of a decline in labour force participation of older persons, pointing out that a striking decrease in employment has connections to retirement schemes, especially the options to have an early exit from work. Regarding the latter, It has also been argued that early retirement schemes were behind falling employment rates in only some countries, but old-age pension system in general encouraged exit from labour market in most countries (Antolin and Scarpetta 1998, Blöndal and Scarpetta 1999, Casey *et al.* 2003). Some arguments for carrying out pension system reforms (Gruber and Wise 2002) characterise the link between theoretical institutional factors and individual retirement decision quite well. Casey *et al.* (2003) suggest that incentive to retire can be evaluated by replacement rate and future pension wealth, where extra pension amount for extra worked year competes with diminishing time to be retired. On the other hand, they point out that labour force participation itself depends on health status, which is correlated with age.

Adding to the economic approach, other institutional factors such as labour market regulations, benefits system, worker retraining practice, etc. have an important effect on retirement. In sociological literature institutional factors are sometimes treated using the typology of different of welfare regimes (Esping-Andersen 1999). As a broad characterisation of institutional approach we could say that retirement is not necessarily regarded as an individual option, but possibly shaped by limitations imposed by non-individual factors, for instance situations of high unemployment. Structure of economy, social and labour market policy, pension system are some of the institutional aspects of retirement. Also, concepts such as life-long learning and re-training of employees, to face the structural changes in economy, count as institutional elements that may have an effect on old-age employment. In recent sociological studies old-age employment and retirement has also been interpreted in the context globalisation, where older population's employment status is not only dependent on national and local setting, but is becoming vulnerable to global economic shocks that bring about increased unemployment hitting particularly hard older population (Blossfeld *et al.* 2006).

In Europe the current state of retirement and old-age employment research relies a lot on Survey of Health, Ageing and Retirement in Europe (Börsch-Supan *et al.* 2005). This survey, as an example of the complexity of retirement analysis, includes a range of measurable characteristics, starting with wealth and ending with physical and mental health indicators. It has been established that a considerable proportion of elderly in Europe are retiring in good health whereas institutional setting provides little incentive to stay in the labour market (Brugiavini *et al.* 2008), thus giving support to the mentioned economic and institutional approach. Further cross-country comparison has shown that variations in employment and labour market exit to retirement depend a lot on the country-level factors (Engelhardt 2011). It has also been argued that a lot of early retirement is due to generous pension schemes in many European countries which do not favour longer working life. Moreover, it has been pointed out that this situation has a possible detrimental effect on diversifying the financial risks of elderly population (Angelini *et al.* 2009). In comparative perspective there is also considerable variation in relative income poverty rates of the elderly (Vignoli and De Santis

2010). Accordingly, some studies suggest that well-being of the elderly is better maintained if they remain longer economically active (Wahrendorf and Siegrist 2010).

At the individual level there is a number of characteristics that presumably have effect on timing of retirement. The economic theory of retirement takes individuals as rational utility-maximisers, who make a conscious choice between financial incentive to stay in the labour market and leisure time of retirement (Gruber and Wise 2004). According to this theory, people leave labour force, given that they prefer leisure over work, at the earliest time if pension income is adequate to substitute for their discontinued wage income. A lot of additional explanation can be derived by introducing individual characteristics. For instance, educational attainment and occupational group are found to be differentiating the retirement age (Blöndal and Scarpetta 1999, Casey *et al.* 2003). Arguments have been put forward that activity status change into retirement is not determined only by needs but also by satisfaction with the current occupation. Job quality has been found to have an important role in decision of retirement (Siegrist *et al.* 2006). On the other hand, person's position that is defined by occupational status should be taken into account, as the socio-economic status has an effect on the age of retirement in many countries (Komp *et al.* 2010). Other aspects relate to job security, i.e. potential unemployment at relatively high age may be the reason for early retirement decision (Schnalzenberger *et al.* 2011), or worries about the retirement income and saving for the old age (Hershey *et al.* 2010), which also associate with the institutional level settings.

Health conditions set clear limitations to the ability to work. Inclusion of health status into analysis of retirement can be complicated as it is not evenly distributed among the population. Some social, occupational or educational groups experience more health problems than others (e.g. Mackenbach *et al.* 2008). Another problem in many cases is measurement of health, as only few surveys apply objective health indicators or bio-markers. Self-reported health may suffer the endogeneity problem due to so-called justification bias – individuals report worse health to justify their exit from labour market (Kapteyn *et al.* 2009). Based on SHARE data analysis, inclusion of objective health indicators along with the self-reported has been suggested as a good solution (Kalwij and Vermeulen 2008). Meijer *et al.* (2008) use health as a latent variable and estimate an individual health index, showing that the index is a good predictor of timing of retirement. On the other hand, Barnay and Debrand (2006) argue that health conditions cannot explain all differences in age at labour market exit. Moreover, much of the difference in retirement age is believed to be determined by institutional factors, whereas health differentials seem to have less importance in this respect (Börsch-Supan *et al.* 2009). In some contexts, health condition or disability state may be an alternative pathway to exit labour market before being entitled to retirement.

3 Country background

3.1 Old-age employment patterns

This section introduces the Estonian setting regarding old-age employment. The earliest systematic knowledge about employment in older ages in Estonia is based on 1922 and 1934 population censuses. The figures from these decades refer mostly to the population active in agriculture and are less applicable to service sector and industry. It appears that more than half of male population over 70 years old was still economically active during the interwar period. High activity rate at that time is understandable since social security system was still in the starting phase (Katus *et al.* 2003b). Since the 1940s, following the incorporation of Estonia into the Soviet Union, Sovietisation shaped the Estonian economy according to the state socialist model. This brought about the full-scale nationalisation of businesses, collectivisation of agriculture and extensive development of heavy industry. The Soviet authorities used far-reaching centralisation and introduced uniform models in virtually all sectors of administration. (e.g. Kahk and Tarvel 1997, Mertelsmann 2003;

2006). Sovietisation also brought high levels of labour force participation, particularly among women. The proportion of women employed outside the home doubled by the time of the 1959 census compared to the period before the World War II. In later decades the highest level of female labour force participation was observed in the 1970s. Interestingly, at that time female work-life expectancy at birth exceeded that of males (as did the life expectancy as such). As a result of the socialist labour policy, both male and female activity rates were higher than those observed in industrialised market economies (Puur 1995).

As a contrast to general employment pattern, old-age work participation decreased considerably compared to the interwar period, partly due to elimination of private forms of production, partly due to 1956 Pension Act. While the Pension Act initiated the increase of the number of pension beneficiaries, it also did not allow reception of old-age pension benefit and work income simultaneously. This restriction was later relaxed, due to shortage of workforce (see also Jones and Moskoff 1987). By the 1959 census the activity rate of 60+ male population in Estonia was around 60% (Katus *et al.* 2003b). However, economic activity of the 60+ population decreased throughout the 1960s–1970s (median employment exit age in 1970 was 62.6 for men and 57.8 for women). An increase in old-age employment began again in the end of the 1970s, caused at least partly by falling real value of pension income. The former policy towards working retirees was changed and in the 1980s incentives were offered to motivate persons entering retirement age to continue employment (Katus *et al.* 1999; 2003b). As a result, the actual retirement age increased in the second half of the socialist period. Interestingly, this extension of old-age employment occurred in a macro-economic situation which was characterised by much lower growth rates than seen in the immediate post-World War II decades (for Estonia, see Klesment *et al.* 2010).

A feature related to employment patterns is educational development. Until the late 1960s there was a notable expansion of upper secondary and tertiary education. The previously existing gender gap in tertiary education was closed in the cohorts born at the beginning of the 1940s. In secondary education, a reversed gender gap can be traced back to the birth cohorts of the 1930s. In subsequent generations the proportion of university graduates appeared systematically higher among women, with female advantage expanding towards younger generations (Katus *et al.* 2000b).

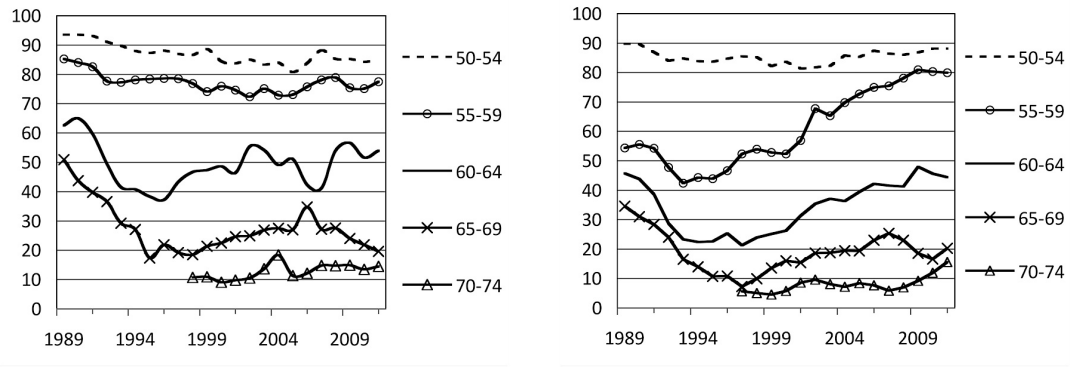
Individual or household income, which is an important element in the analysis of retirement, is relatively under-studied for the entire USSR. Research carried out in the West has provided some insights into living standards and incomes in the Soviet Union (e.g. Bergson 1984, McAuley 1979, Ofer 1981, Ofer and Vinokur 1992, Vinokur and Ofer 1987). Some studies addressed differentials by gender, educational attainment, and other socio-demographic characteristics (Echols 1980, Ofer and Vinokur 2008, Pugh and Lewin 1990, Schwartz 1979, Yanowitch and Dodge 1968; 1969). The Estonian incomes during the socialist period have been analysed using micro-data from income surveys and the tabulations show considerable income loss due to retirement in the 1970–1980s (Klesment and Sakkeus 2010). Thus, from the side of household income there was a lot of motivation for people to continue working after statutory retirement age (see also Figure 2 in the Appendix).

Employment rates during the state socialist period in Estonia have been estimated based on censuses and income surveys (Klesment and Sakkeus 2010). See Figure 1 in the Appendix for certain years for which age-specific data is available. The increase in female employment since the 1950s is quite prominent. It is also evident that survey samples overestimate the employment rate of 60+ population, compared to census results. However, even the 1979 census data indicate that of 60–65 population about 40% of males and 30% of females were still active.

A great deal of information on retirement at the end of the state socialist period comes from the 1989 census data. At that time, 80% of working population was employed at the age of statutory retirement, which means that there was considerable early retirement (exits due to health, hazardous occupations, or 5+ children mothers). Around statutory retirement age there was about 20% drop in activity rates, but at subsequent ages the exit rate slowed down. The median age at retirement was 66.2 years for men (male life expectancy at birth

was 66.15 in 1989) and 62.1 years for women (life expectancy at birth 74.97). Compared to 1979 census, retirement age had been increased by more than 1.5 years and it was spread over a longer age interval. The interval between the first and third quartile of retirement age was 17.3 years among males and 16.8 years among females. In 1989, economically active life expectancy at the age of 60 was 6.1 years for men and 7 years for women (Katus *et al.* 2003b).

During the transition to market economy employment in older age groups dropped considerably. The proportion in 55–59 age group dropped approximately 20% compared to 1989 situation. The decrease, which happened mostly in 1992, was about 40% for those aged 60–64 and about 60% for those aged 65–69. The greatest problem was faced by those in pre-retirement age, who experienced layoffs due to restructuring of the economy, in a situation where the pension system did not support early retirement. The median age at labour market exit declined by about 4 years for both sexes (Katus *et al.* 2003b).



(a) Men (b) Women

Source: Statistics Estonia.

Figure 1: Labour force participation rate 1989–2011 by age group

The transition to market economy witnessed the emergence and expansion of unemployment, a phenomenon practically unknown under central planning. In Estonia, unemployment rates among the working-age population approached 10% in 1993, but declined after that (Puur 1997). People at, or older than, retirement age were able to avoid unemployment pressure by exiting labour market to old-age retirement. For pre-retirement age groups one of the pathways out of unemployment was exit through disability scheme (more on this in the next section). Labour market participation trends during the transition and in the recent years are presented in Figure 1.

The transition to new labour market system had different effects on social groups. Saar *et al.* (2011) point out that economic restructuring, especially reduction of agricultural sector, reduced the number of blue-collar workers by 36% between 1989 and 2008, whereas white-collar numbers declined by 6%. Because the age groups between 50 and 75 were over-represented in lower-skilled occupations, restructuring of economy had more detrimental effect on their activity status. The authors point out that mean age at retirement had increased from 60.1 in the 1980s to 62.9 in the beginning of the 2000s for men, and from 57.1 to 61.3 for women. Also the variation in retirement age had increased. They also observed that foreign origin population retired earlier, which the authors attribute to their more vulnerable position in the labour market. In terms of educational pattern, people with specialised secondary education (vocational) had longer employment career than highly educated, but those with primary education had the lowest retirement age (Saar *et al.* 2011).

3.2 Pension system development

The state pension system in Estonia was established in the 1920s and covered government employees, teachers, workers in state enterprises, military personnel and war invalids. Additionally, private pension schemes were applied by some enterprises and old-age population not entitled to pensions could apply for assistance under the system of public relief since 1925 (Pullerits 1927). Pension expenditure was covered by the Pension Fund, formed by state budget allocations and employers' and employees' contributions. The incorporation of the country into the Soviet Union introduced the Soviet pension system, which lasted until 1991. A large proportion of the beneficiaries under the former scheme lost their right for pension benefits (Katus *et al.* 2003b).

The Soviet pension system was very much shaped by the 1956 Pension Act. According to this, coverage extended only to workers, excluding collective farmers and the self-employed. State pension for collective farmers was established in 1965. Only since 1971, the workers' and collective farmers' schemes converged regarding the amount of benefit received. Some economic activities were considered non-productive, resulting in many people left without an employment record. Thus the number of old-age retirees was initially rather low (in 1960 retirement pension beneficiaries accounted for one quarter of the urban population of post-retirement age), but by the 1980s, almost complete coverage was achieved due to the extension to the rural population and the replacement of older generations who did not have the right for Soviet pension (Leppik 1998). Some occupational groups were entitled to lower statutory retirement age (also, for mothers of 5 or more children the age was 5 years lower). Pension income was dependent on the former wage income, but the differentiated replacement rate equalised the wage differences (about 100% replacement for low-income earners, but 50% for higher-income earners). All pensions were financed from the state budget without individual contributions (Leppik 2006).

The re-establishment of independent republic brought also the change in pension system. Reforms during the years 1990–1993 were mostly triggered by financial separation from the Soviet system. After some (failed) experimentation, a flat rate pension system was established in 1992 as a temporary measure. Pension benefits were linked to minimum wage, but heavy inflation drove down the real value of pension benefit. As a result, replacement rate declined from 36% to 16% in 1992. A major change was introduces in 1993, when State Allowance Act established a new pension system with flat-rate base amount to which the worked years component was added. In the next year pension amounts were disconnected from the minimum wage and pension calculation started to be on the basis of a fixed rate that was updated by the Parliament for each fiscal year. An important feature of the pension system since 1996 was that full old-age pension benefit could be received together with work income. The government policy in the following years, regarding the lifting of pension income, was mostly directed towards increasing the worked years component coefficient of the total receivable pension income. The pension system became more generous towards people with longer work career (Leppik 2006). The present pension system in Estonia is a three-pillar system (state-managed, compulsory private, and voluntary private), gradually implemented since the end of the 1990s (see Paas *et al.* 2004). Since 1998 there is a possibility for early retirement, up to 3 years before the statutory age, which results in somewhat lower pension benefit. Postponement of retirement, on the other hand, could increase the pension benefit (Leppik and Kruuda 2003).

Finally, we have to describe the system of disability pensions. In the state socialist system the term for disability was "invalidity". Both the workers' pension scheme from 1956 and farmers' scheme from 1965 offered benefits in case of old-age retirement, disability, and loss of breadwinner. Disability pension assumed that a person went through medical expertise, but the disability status could be granted at any age. Nevertheless, a person still needed a certain number of years worked to be eligible for disability pension. In case of no worked years, minimum rate of pension was granted. Disabled people were not required to work (as it was the requirement for all abled people in the Soviet Union), but they had the right to participate in the labour market. This allowed them to retain disability pension

benefit in parallel with the wage income (in full or only partly, depending on severity of disability). The share of disability pensioners among all pensioners was around 14% in 1980, and this declined to approximately 11% in 1990. Since 1990, the number started to increase again (due to increase of statutory pensionable age and thus declining number of old-age pensioners, but also other factors). About two thirds of all disability pensioners were of working age at the turn of the century (Leppik 2002).

4 Research questions and hypotheses

In contemporary Estonian context relatively high employment rate of older population is combined with relatively bad health status. It is quite possible that old-age employment is directly determined by relatively low replacement rate, i.e. it is a necessity for many seniors. However, replacement rate was also low in the end of the state socialist period, so we could argue that working at old ages is at least partly a "behaviour of survival" inherited from the previous socio-economic system. While our data does not allow to account for income size, comparison of market economy period with the socialist one offers some possibilities to observe continuation or discontinuation of retirement patterns. The first question is about the direction in which the risk of retirement has changed from the socialist period to the present era. While pensionable age has been increasing for both sexes, since the mid-1990s the activity rates have moderately gone up also for ages beyond statutory retirement age, suggesting later retirement. On the other side, increasing unemployment rate should be suppressing employment at old ages and speed up early exit from labour force.

Next the focus is on the effect of health status on retirement risk, especially how it has changed from one societal regime to the other. On one hand, it is expected that health problems have less effect on retirement in the post-1994 period, since the use of alternative exit to disability pension has increased and fewer persons are moving from labour force directly to old-age retirement. Yet, since the pensionable age has increased, exits to retirement due to health reasons should be more pronounced in the market economy period. It is also likely that tighter labour market conditions make long-term disease episodes much more critical in terms of preserving the job at old ages. Consequently, the hypothesis tends to be on the side that long-term disease episodes will have a positive effect on retirement hazard in the post-1994 period. It is expected that also in the state socialist period health problems lead to quicker withdrawal from the labour market.

We would also like to know what is the role of individual characteristics in defining the retirement risk. The effect of educational attainment is usually with a clear gradient, higher educated staying longer in the labour market. We hypothesise that this is also the case in Estonia, but with certain differences between the socialist and market economy period. The importance of education (in terms of income and occupational status) in the socialist period was much weaker than in the market system, which suggests that difference in retirement age should also be less pronounced. As a result, individuals with higher education are likely to exhibit lower retirement risk since 1994 compared to the previous period. If there is an educational gradient in retirement in Estonia, we expect it to be very weak for the socialist period and strong for the market period.

Regarding other variables, it is expected that foreign origin population has higher retirement risk than the natives. However, we would like to test the argument, put forward in recent literature, that this is due to less favourable conditions for the immigrant population in the labour market (Saar *et al.* 2011). If the latter holds, foreign origin population will exhibit higher risk of retirement in the post-1994 period, but be indifferent from the native population in the pre-1994 period (since state socialist system applied equal, or even privileged, conditions for immigrant population in Estonia).

An important question is also the relevance of one or the other analytical method that is used for retirement study. The present study applies two different analytical approaches and we are interested in how consistent are the results obtained. Event history analysis

and multi-state approach are not in this case directly comparable, but we should be able to indicate in which respect more discrepancy occurs.

5 Data and methods

5.1 Data and variables

The data come from the Estonian Gender and Generations Survey 2004–2005. The survey was conducted in the framework of Gender and Generations Programme (see Vikat *et al.* 2008), but was designed to include all life history modules already in the first wave. As a result the survey includes, among other modules, retrospective information on education, activity status, and health, which allows reconstruction of the respective individual trajectories for event history analysis. In the present context we are interested in activity, health, and partnership status. These are the personal characteristics that are likely to vary around retirement age.

Most of the life events are recorded with monthly precision in the survey. Activity status module recorded up to 18 employment episodes and all episodes between the employment episodes (such as studies, maternity leave, unemployment, home-making etc.). In the case of basic event history model, the focus is only on transition from work to retirement, alternative pathways are ignored at this state. For multi-state analysis the other possible transitions are included, which requires a construction of a variable that captures moves between employment, disability, retirement, and the remaining state (including unemployment and other forms of inactivity).

Health status variables can be derived from two sub-sections of the questionnaire. The first asks for injuries that had limiting effect on person's activities (study, work, daily living). The second records long-term (3 months or longer) health problems that have effect on activities. Both in case of injuries and long-term diseases there are up to four episodes. For modelling purposes a dichotomous time-varying health covariate is derived from the section of long-term diseases (injuries will be not dealt with at this stage). In the event history model disease status is applied as a continuous time variable, resulting in exact timing of beginning and ending of the respective health-status episodes. For multi-state application the health status variable is simplified as a transition-specific covariate, indicating whether the disease condition is present at the time of transition to another state or censoring.

There is an obvious overlap between the health status and activity status variable, because the latter includes disability status. The difference, however, is that injury and health problem episodes do not necessarily mean that a person is away from labour market. Disability as activity status category excludes the possibility of being employed at the same time. As activity status changes and disease events are recorded in separate modules, there is probably less reason to be concerned about the justification bias. Nevertheless, it cannot be argued that health status variable is going to be free of bias, because a) there is selection by mortality, which is closely correlated to health status, and b) events closer to interview time are more likely to be remembered by respondents. Thus interpretation of modelled health parameters has to be done with some reservations.

Partnership history can be reconstructed from specific questions about the beginning and ending of partnership episodes. It must be remembered that activity status, as well as other individual histories, are self-reported, which leaves some room for personal interpretation of less clear life episodes. However, during the quality control the data has been checked for general consistency of life-course events to correct more obvious errors that may be due to mis-remembering.

Background variables in this case are those that in most cases remain fixed over the older ages. Education is one of the important ones, because it can also be taken as a proxy for occupational class (employment history includes occupation for each episode, but it is

currently not included in the analysis). Educational attainment is taken as the highest level obtained and grouped into four categories – basic, secondary, vocational, and tertiary. Separation of vocational from others is needed, because despite the similarity with other respective levels, vocational education was likely to have a different meaning in the state socialist system. Basic means compulsory general education at the levels which are inferior to upper secondary education. Since the late 1980s, the duration of basic education has been nine years, earlier in the postwar period it was seven or eight years. Secondary is general education at the upper secondary level (high-school, gymnasium). The duration of such education is currently 12 years, earlier it was 11 years. Vocational is education that followed the graduation from lower levels of general education (primary or basic) or from upper secondary general education (high-school, gymnasium). With reference to the period before 1990s, the so-called specialised secondary education (technical schools, medical schools, music and arts schools, etc.) are also included in this category (duration currently ranges between 10-15 years). Tertiary means academic education that followed upper secondary education. All are holders of an academic degree in this category, as are graduates from non-academic higher education programmes which have emerged in the 1990s (minimum duration about 15 years). Programs of lifelong learning are a relatively new feature in Estonia, so we do not consider changes in education after age 40 to have a significant effect.

It is important to include a nativity variable since immigrant population follows quite different path in many aspects of life-history (Katus *et al.* 2000a; 2003a, Sakkeus 2000). Moreover, there was a considerable employment segregation by origin during the state socialist period. Immigrant population was concentrated in heavy industry and mining, which may also have an impact on their retirement trajectories. The dichotomous nativity variable is constructed using the origin of a respondent (person or person's both parents born in or out of the country).

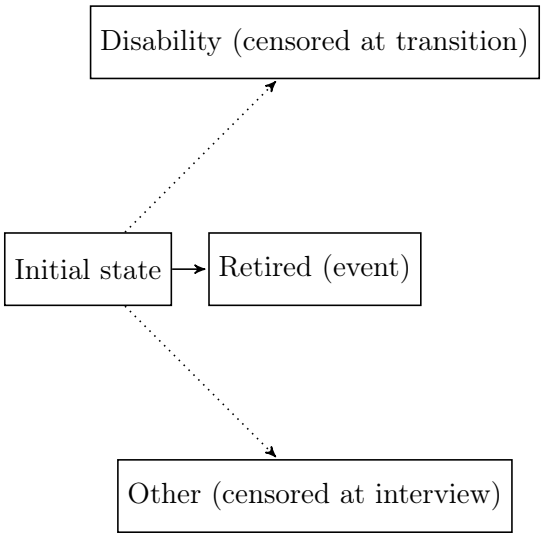
Other covariates of interest are number of children and number of jobs held, both of which are inserted into models as continuous variables. Place of residence is a covariate that must capture the difference between urban or rural environment, thus it is also a simple dummy variable. From the individual point of view, the Estonian GGS has questions that allow construction of the locus of control variable. Locus of control is coded as a three-level variable ("internal", "external", and "middle") and will be used to capture individual behavioural characteristics that are likely to shape the decision of retirement.

Additionally, we need to create a variable that captures the changes over calendar time, thus representing the effect of changing socio-economic system. The purpose is to contrast events that happened before the change in retirement system in 1993–94 and after that. As the first category, people who were eligible to retire until 1993 are considered (depending on year of birth, males and females separated). In the second category are those who were eligible for retirement during the years 1994–2005. The rest, that is people who were not eligible for retirement during the interview, are coded as a third category. This categorisation does not take into account special conditions of early retirement (for instance, certain hazardous occupations). Obviously the three groups are very unbalanced regarding the transition to retirement – there are almost no censored cases in the first category as opposed to the second or, let alone, the third one. In the following the variable will be referred to as "retirement cohort" as it represents three larger groups that are in contrast with respect to calendar time.

5.2 Modelling strategy

Modelling part of the study includes two main approaches. The first one applies basic event history analysis and the second looks at retirement in a multi-state framework. Since the data used come from a survey, both approaches will be limited because of missing mortality. An assumption that old-age mortality has no effect on the transition that will be modelled, or it is equal for all groups, is a strong, but at this stage unavoidable, simplification.

Event history approach considers people at risk of retirement, starting from age 40. In



Solid line accounts for transition, dotted line for censoring.

Figure 2: Event history analysis scheme

the simplest case we would estimate the rate of retirement taking into account those who contribute to the risk set but who do not experience retirement due to censoring. The weakness of this is that it does not account correctly for the risk set – people who become unemployed or disabled at certain point are in this case considered having the same risk with employed persons. Alternatives are a) to consider unemployment and/or disability as a competing risk or b) remove them from the risk set when their state changes from employment to one of the non-risk population states. In the case of the first alternative, the problem appears that hazards of competing risks are not proportional. Consequently, the choice is to differentiate them by censoring – when a person becomes disabled he/she is counted as censored (disability status implies disability pension); in the case of "other" event person remains in the risk set. See Figure 2. One reason for such setting is that we want to estimate the effect of health status on retirement. Having persons in disability status counted in risk set would bias the effect of health status on work-retirement transition. Those who are in the state "other" are still counted as in the risk set for retirement (in the 1990s–2000s, exits to retirement happened through unemployment and we want to include these cases).

We start observing people since age 40 and follow them until retirement or censoring. Removing individuals under age 40 from the data set leaves 1,741 men and 3,362 women for survival modelling (see Table 1 in the Appendix for number of respondents by individual characteristics). Event history modelling experiments with two parametric forms. In the first case we assume that the retirement hazard follows the log-logistic distribution, which allows non-monotonic change in the shape of hazard function (see Bennett 1983). The resulting model is an accelerated failure time model, where the assumption is that covariates have an effect on failure time, not on hazard. Log-logistic hazard function is written as:

$$h(t|X) = \frac{\lambda \frac{1}{\gamma t} \left(\frac{1}{\gamma} - 1 \right)}{\left[1 + (\lambda t)^{\frac{1}{\gamma}} \right]} \tag{1}$$

where $\lambda_i = e^{-(X_i \beta)}$. The estimated γ parameter determines the shape of the function – if it is below 1 then hazard has an inverted U-shape. In regression equation the dependent

variable, which is the logarithm of the time of retirement, is regressed with the covariate vector X:

$$log(T_i) = X_i\beta + \epsilon_i \tag{2}$$

The relationship between covariates on the expected log-time to event is supposed to be linear. We can test whether this assumption is fulfilled by plotting the logit of survival function against log-time. It appears that the fit is not good in younger ages and at the statutory retirement ages, where there is higher hazard of retirement, but in general is relatively good. Comparison of different parametric models gives the best AIC value in the case of log-logistic one.

An important question to be addressed is the problem of unobserved heterogeneity (Vaupel *et al.* 1979, Vaupel and Yashin 1985). It is likely that some people retire earlier for a reason that is not captured in the data, in the sense they are more "frail" to retire. A frailty model is fitted to check for unobserved heterogeneity. Frailty is assumed to be gamma-distributed with mean 1 and variance θ. Individuals with frailty over 1 are then considered more likely to retire for unexplained reasons, whereas those with frailty below 1 are less likely to retire.

As a second option, we use piecewise exponential model. The latter parameterizes the baseline hazard and keeps the hazard of retirement constant over the chosen age intervals. The intervals are after every 5 years until age 70. A strong assumption of this model is that the effect of covariates is assumed to be proportional over the age, which may not always be the case in the retirement process. The piecewise constant model is specified in the common form:

$$h(t|X) = h_0(t) + e^{\beta X} \tag{3}$$

where X is the vector of individual fixed and time-dependent covariates, and β stands for coefficients to be estimated.

The multi-state framework takes into account transitions not only to retirement but also to other possible states. Accordingly, one is able to estimate the probability to move to any other state, given a certain individual covariate profile. To make the estimation more manageable, the states that a person can occupy in the GGS data are collapsed into four – work, disability, "other", and retirement. The "other" state includes unemployment, institutional population, and those staying home. Given a set of states $S = \{W, D, O, R\}$, an individual at time t can be only in one state $S(t)$. In the case of four states, there are 16 possible transitions between the states. Theoretically, individuals may move freely from any of them to any other, because none is a terminal state. For our modelling purposes we may want to treat retirement as an absorbing state, i.e. not to consider anything that happens after the transition to retirement. In this case, there is some similarity with the illness-death models used in epidemiological research (for description of different multi-state models see Hougaard 1999). Further simplification is done to exclude transitions that have a low number of events – from disability to "other" (5 transitions) and from "other" to disability (28 cases). As a result, we are left with 7 different transitions to estimate, which in the form of a life-cycle graph are presented in Figure 3.

The probability to move from one state to another is determined by instantaneous transition intensities (in other words, hazard rates). For instance, transition from work (W) to retirement (R) is the probability that an individual moves from state W to state R within a short time interval, depending on the covariate profile $z(t)$:

$$q_{wr}(t, z(t)) = \lim_{\Delta t \to 0} \frac{P(S(t + \Delta t) = r | S(t) = w)}{\Delta t} \tag{4}$$

Transition intensities are estimated from the data for each transition that we would like to study and for which there is sufficient number of events. The transition intensity matrix

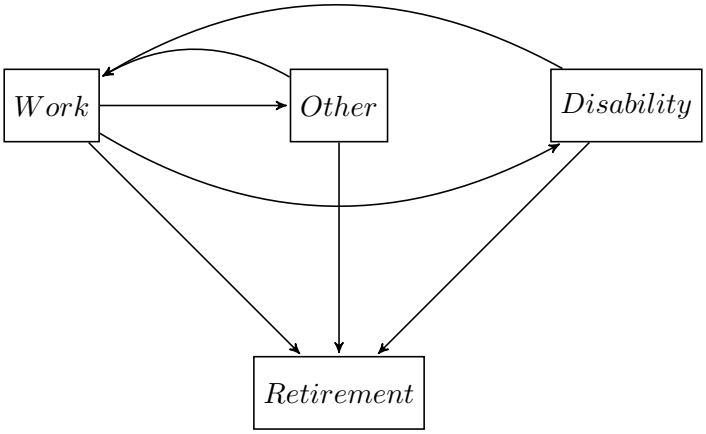


Figure 3: Multi-state analysis scheme

$\mathbf{Q}(t)$ is a matrix with SxS dimensions, S being the number of states (in our case four). The matrix elements are $Q_{gh}(g \neq h)$ and each row must sum up to zero, hence the negative sums in the diagonal: $q_{gg} = -\sum_{g \neq h} Q_{gh}(t)$. The transition intensity matrix for the present retirement analysis looks like this (remind that zeros denote the transition to the same state or one of the transitions that were chosen to be ignored; origin state is by rows and destination state by columns):

$$Q = \begin{pmatrix} -(Q_{wd} + Q_{wo} + Q_{wr}) & Q_{wd} & Q_{wo} & Q_{wr} \\ Q_{dw} & -(Q_{dw} + Q_{dr}) & 0 & Q_{dr} \\ Q_{ow} & 0 & -(Q_{ow} + Q_{or}) & Q_{or} \\ 0 & 0 & 0 & 0 \end{pmatrix} \tag{5}$$

We are interested in estimating the transition intensities from the data in the presence of individual-specific covariates. The estimation must take into account that different transitions do not follow the same baseline hazard. Also, covariates may have different effects on transitions. The R package *mstate* by de Wreede *et al.* (2011) allows modelling separate transition-specific baselines and covariate effects (see also Putter *et al.* 2007). Estimation is done by using Cox model without assumption of proportionality of baseline intensities. The authors of *mstate* specify a transition-specific Cox model as:

$$h_{wr}(t|\mathbf{X}) = h_{wr,0}(t)e^{(\beta^T \mathbf{X}_{wr})} \tag{6}$$

where the hazard rate of transition from work to retirement h_{wr} is determined by the baseline hazard $h_{wr,0}$ and transition-specific covariates $\mathbf{X}_{wr}$.

Multi-state analysis has the advantage of allowing retirement transitions from other states than employment and multiple transitions between states before retirement. Also, the risk set is likely to be more accurate as those who return to employment from disability are again counted being in risk of retirement. On the other hand, we are limited with modelling options that have less control over the form of hazard function and are more likely to suffer from non-proportional effects of covariates on a single transition.

6 Results

6.1 Descriptive results

Before turning to the results of modelling exercises, let us give some descriptive results derived from the GGS data. First, the distribution of sample by state occupancies is given in Figure 4.[4] The y-axis shows the number of cases: there are over 1,700 males and over 3200 females, who are aged 40 or more at the time of interview (obviously each of them has a personal state history record for age 40 but only few have that for very old ages).

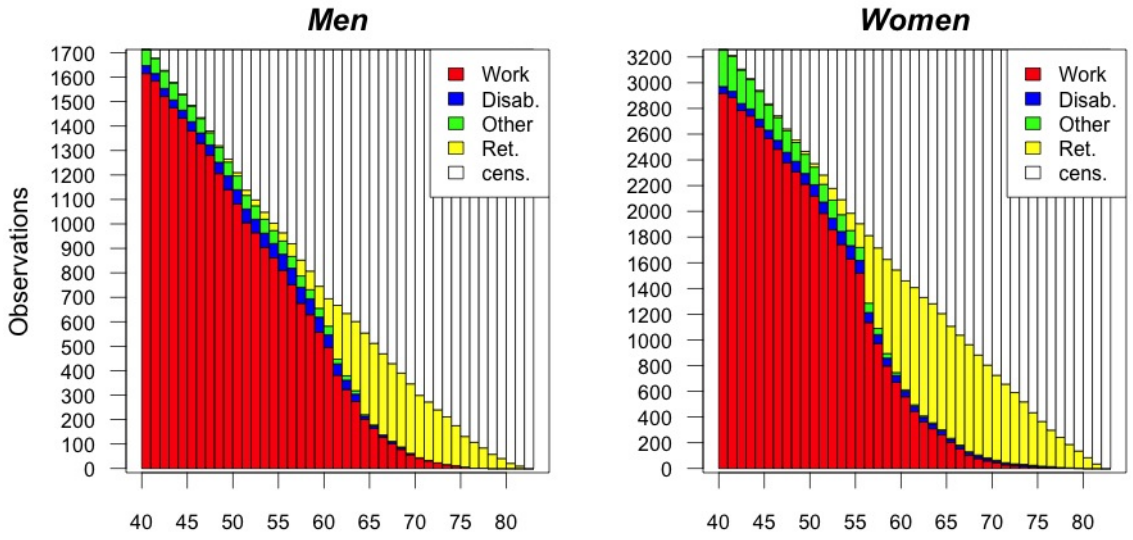


Figure 4: State occupancies over age

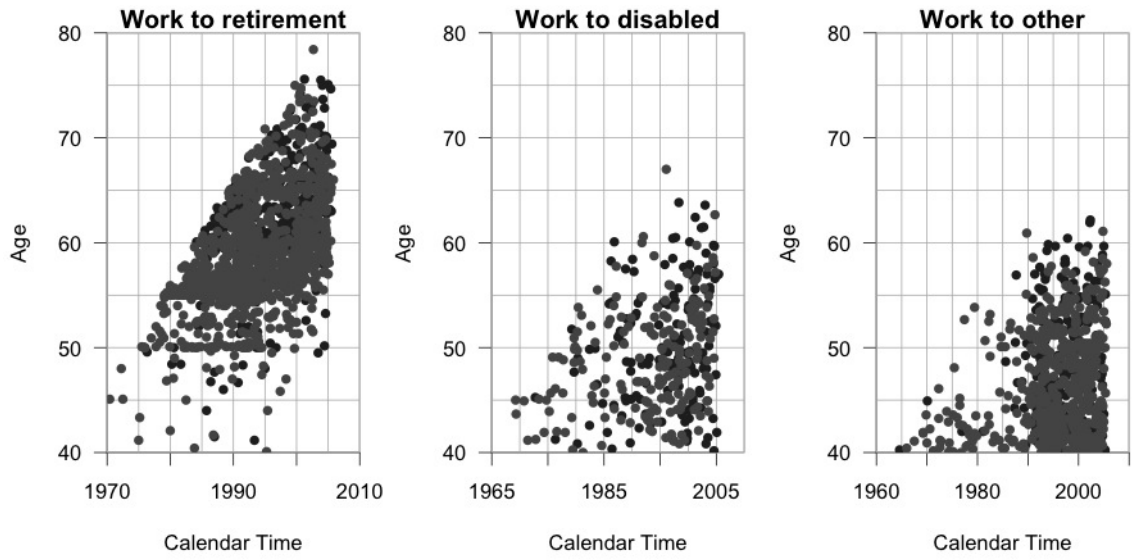
In order to get an idea how the events of retirement are distributed over age and calendar period, it is convenient to graph them on the Lexis diagram. For background information, events of transitions to other, more frequently appearing states are included. Figure 5 shows the transition events from employment to other states. Obviously exit from work to retirement below age 50 is rather unusual. This group is mostly mothers with 5+ children and representatives of specific occupational groups (of course, we cannot exclude possible misreporting, e.g. old-age retirement event was mentioned instead of disability retirement). The total number of first[5] retirement events in the basic event history model is 1,642.

Movement from work to disability status is more frequent in the market economy period. As one can see, there are few transitions to disability that happen above the statutory retirement age. The problem with these cases is whether they should be regarded as old-age retirement. The same counts for the transition from work to "other", the latter being mostly unemployment in the market system.

Bearing the multi-state analysis in mind it is reasonable to graph some other possible transitions as well, shown in Figure 4 of the Appendix. For instance, the approximate amount of moves from disability back to work is of interest, because the denominator in

[4] State occupancies and Lexis diagrams are graphed using *Biograph* package (Willekens 2011). The same package is used for preparation of the data for multi-state transition rate modelling.

[5] Some people (approximately 180 in the data set) actually return to work after retirement. They maintain their pension, i.e. legally being retired, but participate in the labour force, thus counting as active population.



Dark dots represent males, lighter dots females

Figure 5: Transitions from employment

the work-to-retirement hazard partly depends on it (the basic event history model does not account for this). Movements from "other" to retirement and from disability to retirement have a visible age pattern for certain calendar years. In the first case these are mostly women retiring from inactive state during the state socialist period. In the second case, the age pattern indicates the switch from disability pension to old-age retirement pension.

Plotting of survival curves may point out some contrasts that are expected in the event history model. One of the anticipated differences is timing of retirement between men and women, so the plots are presented separately for both sexes. First, it is advisable to observe whether transition to retirement differs between the groups that represent the retirement cohorts of socialist and market economy regimes.

Figure 6 shows the difference in retirement timing for men and women by retirement cohort (the label "under statutory age" refers to people who have not reached the pensionable age by the interview time). Before 1994, for both sexes almost one third of transitions to retirement happened around the statutory age of retirement (men 60 and women 55). Afterwards, changes in retirement age are more prominent for females. The male retirement has been postponed only modestly, whereas there is more evident increase in age at labour market exit for females. The median survival has increased to 64.8 years for women in the period 1994–2005, but it is still below the men's 65.3 years (as a comparison, in pre-1994 period the respective figure was 57.3 for women and 61.1 for men). For males there is a slight indication of the possible unemployment effect, leading to earlier retirement in the post-1994 period for ages below 60, but in ages over 60 there is also postponement of retirement. Survival curves also imply a possible problem with proportionality of hazards if the retirement cohort variable is included in the model.

We do the same using health indicator to determine the difference in survival. As previously, Kaplan-Meier survival curves are plotted in the basic event history setting where health events are taking place at precise ages. The results that are shown in Figure 7. The male part of the graph has to be taken with reservations as there are only 307 retirement events for men with the long-term disease condition. Nevertheless, the effect of disease episode seems to be important for both sexes since age 60 (240 months since age 40), where it leads to sooner retirement. It also has an effect of causing the difference in retirement

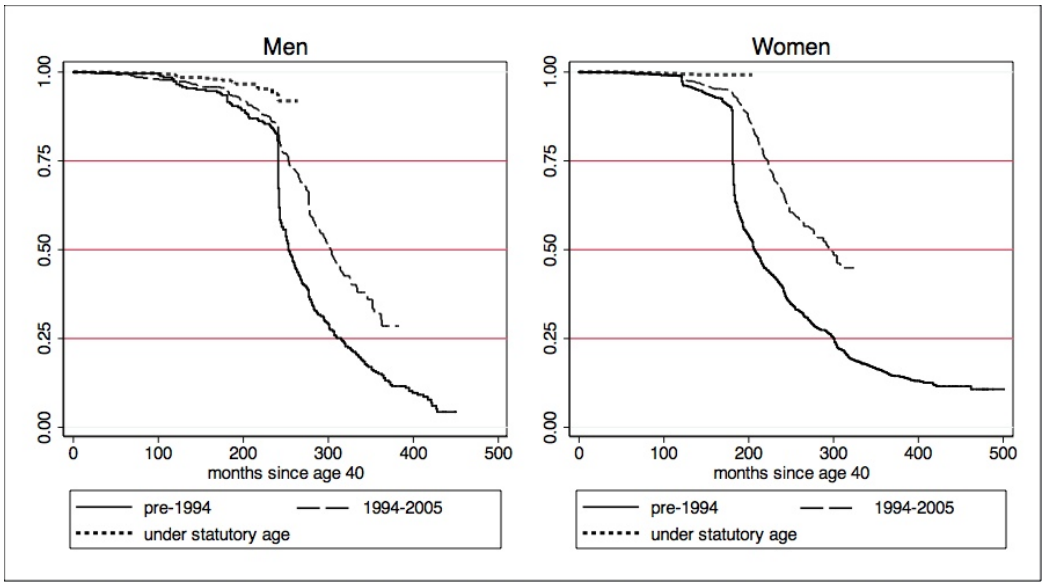


Figure 6: Survival to retirement by retirement cohort

before the statutory age, the drop is visible for both men and women. Around the statutory retirement age the effect of health status appears more important for males.

6.2 Event history models

Survival modelling begins with checking the appropriateness of log-logistic distribution. Three full models, including interactions of educational attainment with retirement cohort, and time-varying health status with retirement cohort, are fitted. The three are: log-logistic with and without gamma-frailty, and piecewise constant model with 5-year interval baseline. Results are presented in Table 2 in the Appendix. Log-logistic model coefficients, when exponentiated, can be interpreted as factor change in survival time caused by one unit change in the covariate, for instance coefficient -.178 for female in the gamma frailty model translates into 84% of survival time compared to males ($e^{-0.178} = 0.84$). Consequently, if mean retirement age for men is 62, the model predicts mean retirement age as 58.5 for women. For easier interpretation, instead of coefficients time ratios are presented in log-logistic models and hazard ratios in the exponential model. The 5-year age group variable clearly shows that retirement hazard peaks at age 60 and begins to decline after that. This supports the choice of log-logistic hazard shape for modelling. Likelihood ratio test for θ appears significant, suggesting that inclusion of frailty improves the model.

From the full models the following can be observed. Health status and retirement cohort interaction is strongly significant for the market economy period, indicating that the effect of long-term disease on retirement timing is correlated with the societal regime change. Partnership status does not emerge in any of the models as statistically significant variable, although the sign for "out of partnership" is expectedly positive, meaning that single seniors tend to stay longer in the labour market.[6] Educational attainment is significant only for the tertiary education, the strength is as expected – much stronger in the market economy, but also present during the state socialist regime. Male-female, urban-rural, and native-immigrant dichotomies are strongly significant in all models. Dichotomous health status

[6]It requires further investigation whether being in or out of partnership is a good specification to capture the changes in household composition that may have influence on retirement.

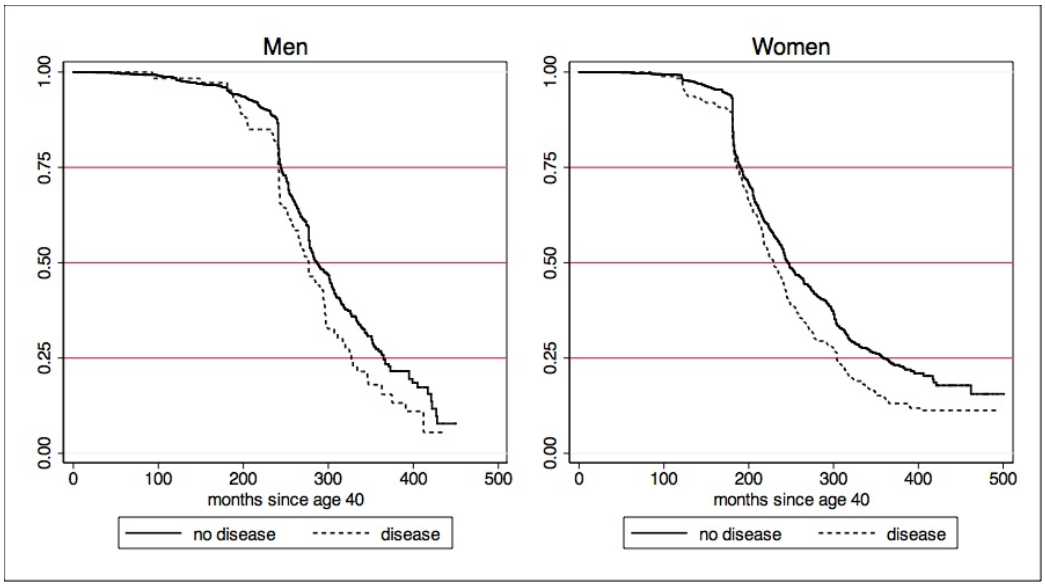


Figure 7: Survival to retirement by disease condition

variable indicates that survival time for those with disease would be reduced by almost 7% in the model without heterogeneity and about 5.6% in the gamma-frailty model. While this is a relatively modest influence, we need to remind that those who exit to disability status are censored in the event history model. Nevertheless, the effect of disease status on retirement is as expected. The difference between socialist and market economy regime is captured by the retirement cohort variable. As it seems, the hazard of retirement is lower in the market economy period. The estimate of the hazard function under both regimes, obtained from the frailty model, is shown in the Appendix in Figure 3.

In the next step, two separate log-logistic gamma frailty models are fitted – one for the state socialist period retirement cohort and the other for the market economy period. Compared to the full models, partnership status has been dropped as no effect was observed previously. Also, the birth cohort variable is dropped because it will have different levels included in the two models to be compared. The purpose of separate modelling is to capture the regime change effect without interacting single variables with the retirement cohort. The results are presented in Table 1. Long-term disease has no significant effect in the pre-1994 period, but is shortening the time to retirement in the market economy period by about 12%. Educational attainment level has more clear outcome in the post-1994 period – tertiary education extends the time to retirement by about 13%, whereas in the pre-1994 period the gain is only half of it. Also, basic level of educational attainment contrasts with the secondary education in the later period, but for the state socialist period there does not seem to be difference.

Females are retiring earlier under both regimes, but the gap with males has decreased in the post-1994 period, thus being line with the data about labour force participation rates presented in the section on country background. Contrast in retirement between urban and rural areas seems to be a little bit lower in the second period. An interesting result appears for the native-immigrant distinction – foreign origin population retires earlier under both regimes, but in the post-1994 period the gap between the two has grown larger. This may support the arguments about the appearance of less favourable conditions for immigrants in the labour market. The pre-1994 period difference in native-immigrant variable, however, remains unexplained (occupational segregation, which we are not able to control for, may be one of the reasons).

Table 1: Event history model: pre- and post-1994 retirement cohorts

	pre-1994 retirement		post-1994 retirement	
Long-term disease	0.989	(-0.49)	0.882***	(-3.73)
Education: basic	0.996	(-0.18)	0.945^{+}	(-1.66)
Education: vocational	1.026	(0.97)	0.989	(-0.35)
Education: tertiary	1.074*	(2.31)	1.130**	(3.11)
Female	0.798***	(-12.36)	0.903***	(-4.09)
Rural	0.930***	(-4.06)	0.951^{+}	(-1.74)
Foreign origin	0.912***	(-5.09)	0.862***	(-5.37)
LOC: internal	0.994	(-0.32)	1.090**	(3.05)
LOC: external	0.974	(-1.43)	1.024	(0.63)
Number of childern	0.991	(-1.25)	1.001	(0.09)
Number of jobs	1.006*	(1.98)	1.011*	(2.01)
γ (Std.Err)	.12306	(.0052)	.18465	(.0110)
θ (Std.Err)	.73144	(.0693)	.24475	(.1803)
AIC	1084.2		1102.8	

Time ratios shown instead of coefficients; t statistics in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Reference categories: no disease, secondary education, male, urban, native, LOC: middle

Individual's belief about controlling the events that happen to him/her is presented here by locus of control variable. It has no contrasting effect for the pre-1994 period, but appears to develop importance under the market economy system. Respondents with internal locus of control, i.e. those who believe that they control their life events, experience approximately 9% longer time to retirement. Number of children and number of jobs are not, or are weakly, related to the timing of retirement. While it would be possible to argue that more career-oriented people change positions more often and also work longer, the effect is rather weak (one extra job episode postpones the retirement age by 1.1% in post-1994 period compared to the average number of job episodes).

6.3 Multi-state transition rate model

In this section, a model is estimated that considers transition rates not only to retirement, but also to other states. A pre-programmed package *mstate* (de Wreede *et al.* 2010; 2011, Putter *et al.* 2007) is applied to do the estimation of individual effects on transition intensities. All retirement cohorts are modelled together, which means that the transition intensity matrix and the respective covariate effects on the intensities are a cross-section of different societal regimes and different birth cohorts. Since this is an important limitations, the results are better interpreted taking into account the previous event history analysis results. State probabilities from the model without covariates are given in Figure 5 in the Appendix. The multi-state model without covariates predicts more than 50% probability to be employed at age 60. Disability probability is increasing until age 65. Probability to be in the state "other" decreases after age 45. Predictions based on covariate profile were not done at this stage.

In the model with covariates, only those transitions are chosen that are of more interest: from employment to different destination states and from other states (except retirement) to employment. Some of the transitions are dropped from estimation as they seem not to have any explanatory power. All intra-state transitions (e.g. change of work

place) are ignored. The results are presented using the transition number to denote the transition as shown in Table 2.

Table 2: Transition matrix

	Work	Disability	Other	Retirement
Work	NA	1	2	3
Disability	4	NA	NA	5
Other	6	NA	NA	7
Retirement	NA	NA	NA	NA

Number 1 in the matrix marks the transition from work to disability, 2 from work to "other", 3 from work to retirement, etc. In order to spare space, only the results for gender, health and educational attainment covariates are given in Table 3. Reference categories are the same as in the event history model: male, no disease, and secondary education. Each parameter estimate has a number of the transition attached to the end of its name. Gender is significant for transitions 3 and 7. Being female increases the risk of retirement by almost 70%, which is greatly over-estimated compared to the piecewise constant event history model (39% higher hazard). Transition from "other" to retirement is more than three times higher for women. It is evident that confidence intervals for some transitions are very large which suggest that the coefficients should be interpreted with reservations and the focus should be more on the sign of coefficients.

Having long-term disease seems to have a positive effect on movements from work to disability and from disability to work, but the latter has to be ignored (this is most likely an artefact due to transition-specific health covariate – the onset and stopping of disease is not observed at exact times but only at the change of activity status). The presence of a disease has a negative effect on movement from work to "other" state and also movement in the opposite direction. Most importantly, however, disease does not have any significant impact on the hazard of retirement from any of the other states. The latter means that the present multi-state model fails to capture the effect of health that was recorded in the event history model.

Educational attainment has diverse effects on transition intensities. Compared to the secondary educated, basic education increases the risk of retirement by approximately 21%. It also lowers the odds that a person will move from the "other" state to employment. A logical explanation would be that unemployment is correlated to extreme ends of educational attainment scale. Vocational education has only slightly significant effect on movement from the "other" state to employment, but it is with a positive sign. Tertiary education is the level with highest number of significant outcomes: it lowers both the risk of employment-to-disability movement and retirement from labour market by 40% compared to secondary education. Also, it increases the "other"-to-employment transition risk by 56%. Higher education is the only educational level lowering the risk of transition from employment to "other" (consisting mostly of unemployment).

Results for other variables in the same multi-state model are presented in the Appendix in Table 3. The coefficients suggests that in the market economy period movement from job to disability, from employment to "other", and retirement from the "other" state have increased considerably compared to the previous period (respectively 3.3, 1.8, and 2.1 times). Retirement from employment has decreased (30% lower compared to the the socialist period, which is rather close to the 40% difference obtained from the piecewise constant model). This refers to the emergence of unemployment in the market economy period and old-age retirement through unemployment status. Interestingly, the nativity variable indicates that the latter does not apply for the foreign origin population. Non-natives have 1.5 times higher risk of retirement from job than the natives, but lower risk to retire from the "other" state (only 32% of that of the natives).

An interesting finding is that foreign origin population exhibits about 24% lower risk

Table 3: Multi-state transition model: all retirement cohorts

	β	exp(β)	2.5 %	97.5 %	p-value
Female.1	-0.1917	0.8256	-0.4346	0.0513	0.1221
Female.3	0.5208	1.6834	0.4003	0.6413	0.0000
Female.5	-0.4125	0.6620	-1.1344	0.3095	0.2628
Female.6	0.0610	1.0629	-0.0994	0.2214	0.4561
Female.7	1.1938	3.2995	0.6527	1.7348	0.0000
Disease.1	1.4621	4.3152	1.2319	1.6924	0.0000
Disease.2	-0.6704	0.5115	-0.9588	-0.3821	0.0000
Disease.3	0.0497	1.0509	-0.0719	0.1712	0.4232
Disease.4	0.8651	2.3753	0.4201	1.3101	0.0001
Disease.5	0.6027	1.8270	-0.1264	1.3317	0.1052
Disease.6	-0.8274	0.4372	-1.3250	-0.3297	0.0011
Disease.7	0.6093	1.8392	-0.1127	1.3313	0.0981
Edu:basic.1	0.2006	1.2221	-0.0886	0.4898	0.1741
Edu:basic.2	-0.0400	0.9608	-0.2293	0.1493	0.6787
Edu:basic.3	0.1913	1.2109	0.0465	0.3362	0.0096
Edu:basic.5	0.7704	2.1607	-0.4467	1.9875	0.2147
Edu:basic.6	-0.4485	0.6386	-0.6411	-0.2559	0.0000
Edu:basic.7	0.2074	1.2305	-0.3708	0.7857	0.4820
Edu:vocational.1	-0.1242	0.8832	-0.4102	0.1617	0.3945
Edu:vocational.2	-0.0515	0.9498	-0.2066	0.1036	0.5154
Edu:vocational.3	-0.0282	0.9722	-0.1846	0.1283	0.7242
Edu:vocational.5	1.0586	2.8822	-0.2512	2.3683	0.1132
Edu:vocational.6	0.1495	1.1612	-0.0122	0.3111	0.0700
Edu:vocational.7	0.1588	1.1721	-0.4782	0.7959	0.6251
Edu:tertiary.1	-0.5315	0.5877	-0.9148	-0.1482	0.0066
Edu:tertiary.2	-0.7541	0.4704	-0.9662	-0.5421	0.0000
Edu:tertiary.3	-0.5253	0.5914	-0.7150	-0.3356	0.0000
Edu:tertiary.5	1.0405	2.8306	-0.6088	2.6898	0.2163
Edu:tertiary.6	0.4473	1.5641	0.2348	0.6598	0.0000
Edu:tertiary.7	-2.0073	0.1344	-4.0519	0.0374	0.0543

n= 20,190, number of events= 4,098.
Rsquare= 0.084 (max possible= 0.937).
Likelihood ratio test= 1763 on 67 df, p=0.
Note: other variables shown in Table 3 in the Appendix.

to experience disability status after employment (although being at the border of 5% level of statistical significance). It is quite unlikely that the general health status of non-natives was better than that of the natives during any of the analysed periods. One explanation is that foreign origin population under-reports severe health problems and their disability episodes get mentioned less frequently.

To conclude, the results of multi-state analysis partly confirm the event history results, but are in some aspects greatly overestimated. It appears that multi-state model in this form fails to capture some of the effects seen in basic survival models, most importantly the time-varying disease effect that is specified differently than in the basic event history model. At this point it is advisable to lean towards simpler approach and rely on the event history model, at least as far as health status is concerned.

7 Discussion

This paper started with a purpose to explore and analyse the Estonian GGS data from the perspective of old-age retirement. It was established theoretically that both institutional and individual factors are important in determining the timing of retirement. It was also noted that the Estonian case offers an interesting opportunity to study retirement process in the context of substantial institutional change from the state socialist system to market economy. In addition to that, Estonian case is a potentially interesting one due to simultaneously existing high labour force participation rate of older persons and relatively bad health indicators. From the methodological point of view, simple event history modelling was done in together with multi-state analysis.

Returning to the questions and hypotheses raised in section 4, the following results need to be discussed. There is a notable change in the timing of retirement as state socialist and market economy periods are compared. Certain amount of this change can be attributed to increasing statutory retirement age since 1994, but the difference between the two periods is perhaps too large to be explained only by shift in age. It is possible that change in educational and occupational composition has led to longer work career. Material necessities, which encourage continuation of work during the societal transition times, form another explanation. However, there is still a lot of interaction that we are not able to capture in the event history model, such as unemployment pressure or competition for jobs. Multi-state model suggests that in the market economy period hazard of movement to "other" state has increased considerably (as well as retiring from the "other" state), whereas retirement from employment has decreased. This may indicate that the alternative pathway to old-age retirement through unemployment is actually captured in the data.

As of the health status, the event history models suggest quite clear effect on retirement timing. It was hypothesised that the disease condition would shorten the time to retirement and the results support this idea. However, the effect is observed only in the market economy period and not during the socialist period. The disease effect, which was also observed on the Kaplan-Meier survival graphs, is strongly significant for the post-1994 retirement cohort. Interpretation of the health effect, however, may lead to several directions. It may be argued that in the market economy period disability status and long-term disease are more clearly distinguished from each other. While persons with severe health conditions move to disability status, the contrast between healthy retirement and retirement with long-term disease becomes more visible. This would be the "net" effect of disease status that was to be estimated with the analysis. Furthermore, in market economy the disease condition becomes more critical disadvantage as there is stronger competition for jobs compared to the socialist period. However, the disease effect can also be more pronounced due to increasing pensionable age. This would be an indication that population's health status has stagnated or worsened, or improved slower than is the increase rate of statutory retirement age.

In the multi-state analysis the disease condition has no significant effect on any transition to retirement. It may be that multi-state analysis is not specified correctly to capture the disease effect or that the transition-specific disease variable, which does not follow exact times, is the culprit. On the other hand, there may be heterogeneity that is not controlled for in the semi-parametric multi-state model. The future extensions of the present study need to determine what are the main reasons behind this discrepancy. A more desirable alternative to the present multi-state model would be the one that allows more transparent interaction of age with the health variable.

The hypotheses about the difference between social groups included one regarding educational attainment and the other about nativity. In the basic event history analysis only tertiary education exhibited significantly different retirement timing compared to secondary educated. Both in the socialist period and market economy period the highly educated showed higher age at retirement than other educational groups. The result is not exactly consistent with results from (Saar *et al.* 2011), who registered the highest retirement age for those with vocational education. As expected, the effect of higher education is stronger

in the market economy period, but the difference in comparison to the socialist period is perhaps smaller than was expected.

In the multi-state model the educational differences become more visible. Compared to the secondary educated, basic education increases the risk of retirement, but lowers the chances to return to employment from the "other" state. Such results, even though with wide confidence bounds, are well in accordance with the idea that lower education makes staying in and re-entry to labour market relatively more difficult. Multi-state results also indicate that tertiary education reduces both the retirement hazard and the risk of unemployment ("other" state). It also decreases the risk of moving to disability status, which is most likely to be the industrial and occupational composition effect. The highly educated are also more likely to return to employment from the "other" state than the secondary educated.

Nativity was thought of as a possible differentiating factor regarding the timing of labour market exit. Interestingly, foreign origin population exhibits higher retirement hazard than the native population both during the socialist and the market economy period. It was proposed in the literature (Saar *et al.* 2011) that sooner retirement on non-native population in the market economy period was the effect of less favourable labour market conditions. Since the effect appears in both periods, the reason must be somewhere else, for instance industrial branch or occupational composition of the two population groups. Multi-state model extends the effect of nativity to other transitions and it appears that foreign origin population is somewhat less likely to move from employment into disability status, which speaks against the occupational composition explanation (assuming that more hazardous jobs that allow earlier retirement cause also higher rate of disability). Also, they have lower risk of retiring from the "other" status, thus not confirming the unemployment-to-retirement route for this group. As the nativity effect in the event history model grows stronger for the post-1994 period, the non-favourable treatment in the labour market cannot be ruled out as an explanation of difference between the two population groups.

As of the different approaches to model the retirement process it seems that in the present case simpler solution produces more easily interpretable results. However, the results from the multi-state model demonstrate that movement to retirement is not necessarily a process with one single direction, but there are competing transitions which can bias the estimation of retirement risks. There are several exits from employment and more than one way to enter old-age retirement, which is an issue that should be taken into account. Due to time and space constraints, the improvement and extension of the multi-state part of this study remains out of the scope and has to be done in the future. There is also certainly more heterogeneity in the retirement process than the present study could account for. Inclusion of occupation could be one of the way to reduce possible bias. It would also be most desirable to check the results of the present study with other survey data, SHARE being one of the candidates for this.

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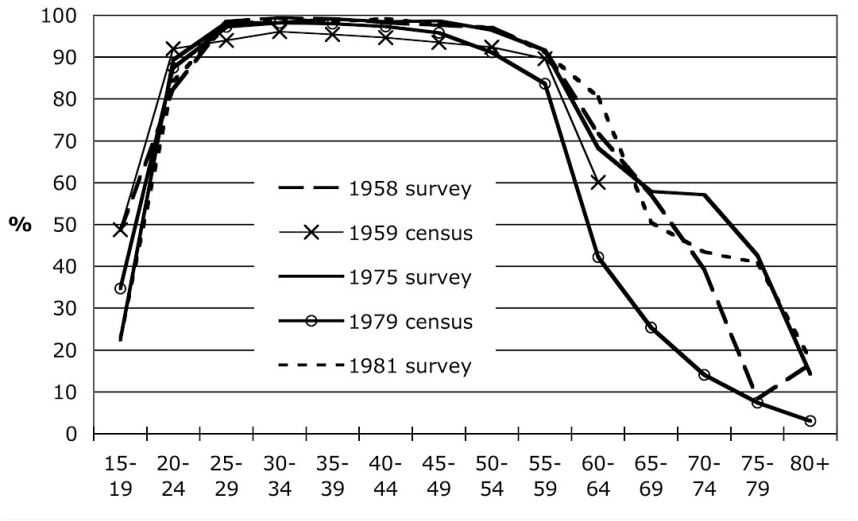
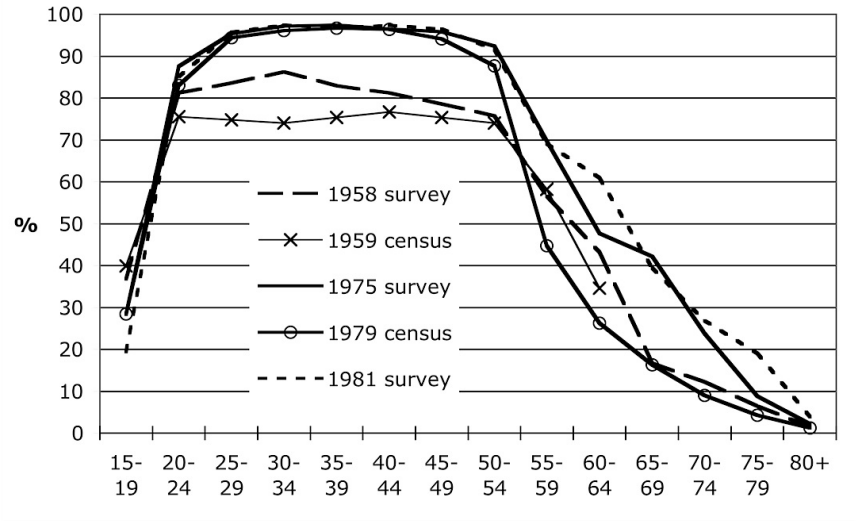
Appendix

Table 1: Number of GGS respondents in analysis

	Age group					
	40–49	**50–59**	**60–69**	**70–79**	**80+**	
Gender						
Male	502	510	418	294	17	1741
Female	890	898	799	706	69	3362
Educational attainment						
Basic	99	210	388	534	51	1282
Secondary	469	414	243	119	9	1254
Vocational	511	476	371	220	19	1597
Tertiary	313	308	215	127	7	970
Nativity						
Native	946	916	849	727	50	3488
Foreign origin	446	492	368	273	36	1615
Place of residence						
Urban	974	1005	826	691	64	3560
Rural	418	403	391	309	22	1543
Retirement eligibility						
before 1994	0	0	303	952	86	1341
1994–2005	0	279	864	48	0	1191
Under statutory age	1392	1129	50	0	0	2571
Locus of control						
Internal	585	516	318	210	19	1648
Middle	713	743	713	563	39	2771
External	94	149	186	227	28	684
Total	1392	1408	1217	1000	86	5103



(a) Men



(b) Women

Figure 1: Employment rate estimates for the state socialist period

Sources: Individual data from the Estonian household income surveys 1958, 1975, and 1981. Author's estimates.

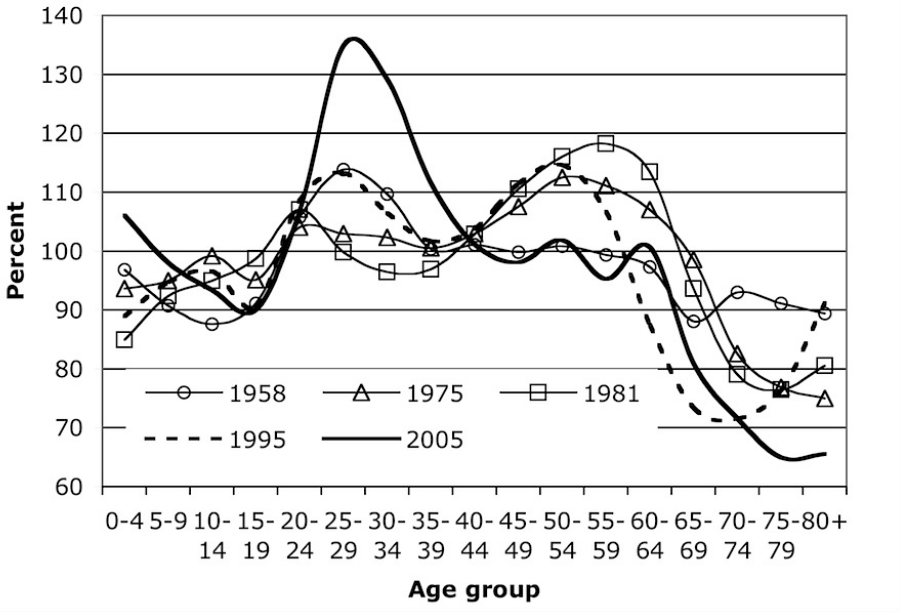


Figure 2: Age profile of equivalised household income. Average income in each year = 100.

Sources: Individual data from the Estonian household income surveys 1958, 1975, and 1981; Labour Force Survey 1995 and 2005. Author's estimates.

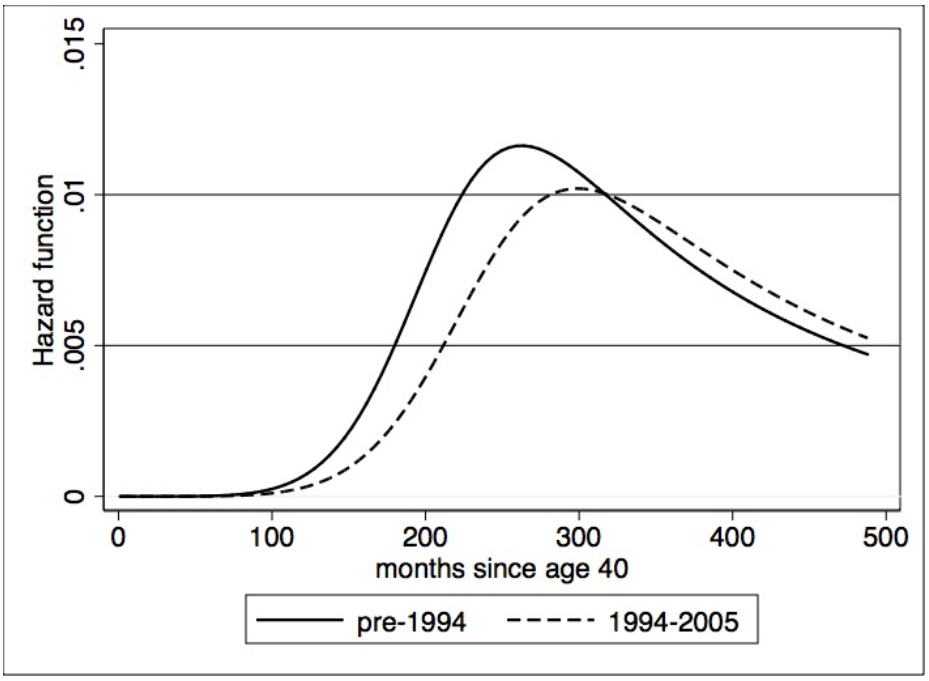
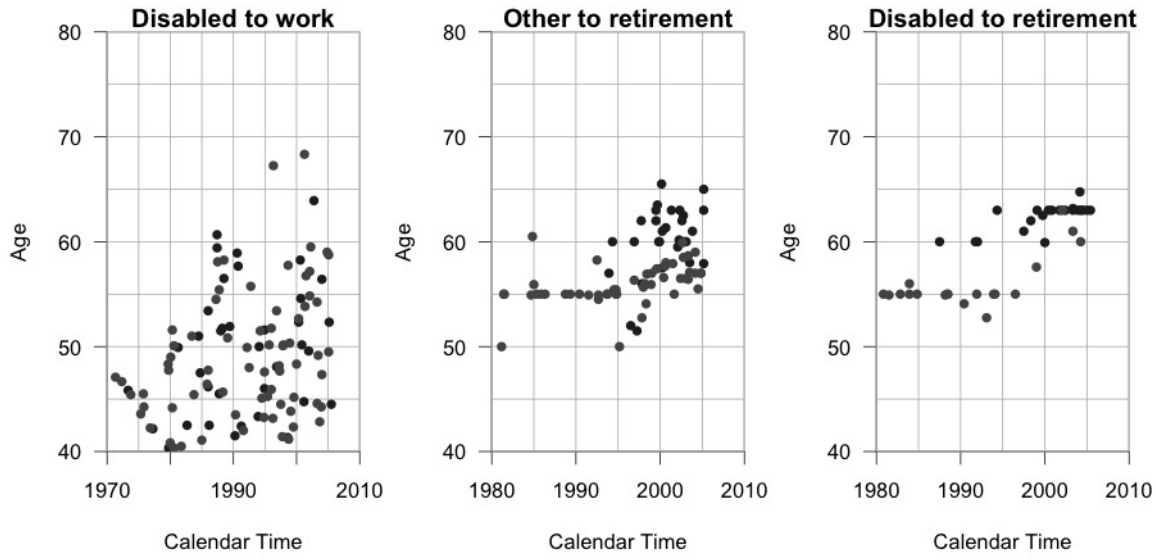


Figure 3: Log-logistic hazard of retirement

Table 2: Survival model comparison

	log-logistic		log-logistic with frailty		piecewise constant	
Birth cohort:1924	0.832***	(-4.38)	0.858***	(-4.21)	2.256***	(4.99)
Birth cohort:1934	0.824***	(-5.71)	0.832***	(-6.43)	2.182***	(5.46)
Birth cohort:1944	1	(.)	1	(.)	1	(.)
Birth cohort:1954	1.045	(0.29)	0.950	(-0.44)	0.704	(-0.47)
Birth cohort:1964	9.158	(0.00)	5.145	(0.00)	0.0000463	(-0.01)
No.disease-pre1994	1	(.)	1	(.)	1	(.)
No.disease-1994–2005	1	(.)	1	(.)	1	(.)
No.disease-under.statutory	1	(.)	1	(.)	1	(.)
Disease-pre1994	0.950+	(-1.76)	0.973	(-1.01)	1.039	(0.49)
Disease-1994–2005	0.880***	(-3.75)	0.894***	(-3.57)	1.495***	(3.57)
Disease-under.statutory	1.077	(0.48)	1.069	(0.56)	0.750	(-0.39)
Never in partnership	0.981	(-0.47)	0.981	(-0.52)	1.097	(0.67)
In partnership	1	(.)	1	(.)	1	(.)
Not in partnership	1.030	(0.98)	1.023	(0.84)	0.888	(-1.20)
Edu:basic-pre1994	0.976	(-0.79)	0.986	(-0.51)	1.095	(0.97)
Edu:basic-1994–2005	0.967	(-0.96)	0.952	(-1.58)	1.032	(0.24)
Edu:basic-under.statutory	0.905	(-0.76)	0.923	(-0.78)	1.470	(0.61)
Edu:secondary-pre1994	1	(.)	1	(.)	1	(.)
Edu:secondary-1994–2005	1	(.)	1	(.)	1	(.)
Edu:secondary-under.statutory	1	(.)	1	(.)	1	(.)
Edu:vocational-pre1994	1.014	(0.42)	1.022	(0.72)	1.010	(0.10)
Edu:vocational-1994–2005	0.993	(-0.22)	1.000	(0.00)	1.041	(0.31)
Edu:vocational-under.statutory	0.876	(-1.20)	0.904	(-1.18)	1.934	(1.24)
Edu:tertiary-pre1994	1.099*	(2.42)	1.078*	(2.09)	0.772*	(-2.16)
Edu:tertiary-1994–2005	1.143**	(3.23)	1.141***	(3.61)	0.614**	(-3.02)
Edu:tertiary-under.statutory	1.001	(0.01)	1.005	(0.04)	0.952	(-0.07)
Male	1	(.)	1	(.)	1	(.)
Female	0.861***	(-8.28)	0.837***	(-10.87)	1.390***	(5.37)
Urban	1	(.)	1	(.)	1	(.)
Rural	0.932***	(-3.88)	0.936***	(-4.08)	1.206**	(3.14)
Native	1	(.)	1	(.)	1	(.)
Foreign origin	0.881***	(-7.12)	0.886***	(-7.54)	1.443***	(6.38)
LOC:internal	1.049*	(2.54)	1.036*	(2.09)	0.852*	(-2.49)
LOC:middle	1	(.)	1	(.)	1	(.)
LOC:external	0.975	(-1.25)	0.984	(-0.93)	1.132+	(1.90)
Number of children	0.989	(-1.59)	0.988+	(-1.80)	1.013	(0.61)
Number of jobs	1.007*	(2.21)	1.007*	(2.38)	0.980+	(-1.88)
pre-1994 retirement	1	(.)	1	(.)	1	(.)
1994–2005 retirement	1.176***	(3.82)	1.191***	(4.62)	0.602***	(-3.50)
under statutory age	1.430***	(3.38)	1.305**	(3.14)	0.206**	(-3.22)
Year since age 40: 5					0.0581***	(-9.07)
Year since age 40: 10					0.198***	(-8.75)
Year since age 40: 15					1	(.)
Year since age 40: 20					7.723***	(23.63)
Year since age 40: 25					8.420***	(23.02)
Year since age 40: 30					7.067***	(17.36)
Year since age 40: 35					4.552***	(8.22)
Year since age 40: 40					2.987**	(2.62)
γ (Std.Err)	.2030471	(.0042948)	.1559111	(.0049476)		
θ (Std.Err)			.5053182	(.0583109)		
AIC	2626.8		2520.0		2192.4	

Likelihood-ratio test of θ=0: chibar2(01) = 108.84 Prob>=chibar2 = 0.000.
Exponentiated coefficients; t statistics in parentheses
Reference categories marked with 1
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Dark dots represent males, lighter dots females

Figure 4: Transitions from disability and the state "other"

Figure 5: State probabilities from multi-state Cox model without covariates

Table 3: Multi-state transition rate model (continued from Table 3)

	β	exp(β)	2.5 %	97.5 %	p-value
Rural.1	0.3588	1.4317	0.1244	0.5933	0.0027
Rural.2	0.2931	1.3405	0.1481	0.4381	0.0001
Rural.3	0.4114	1.5090	0.2953	0.5275	0.0000
Rural.5	-0.0973	0.9073	-0.7912	0.5966	0.7834
Rural.7	-0.3504	0.7044	-0.8377	0.1368	0.1586
Immigrant.1	-0.2755	0.7592	-0.5388	-0.0122	0.0403
Immigrant.2	0.1319	1.1410	-0.0142	0.2780	0.0769
Immigrant.3	0.4367	1.5476	0.3232	0.5503	0.0000
Immigrant.5	0.1710	1.1865	-0.6162	0.9582	0.6703
Immigrant.7	-1.1533	0.3156	-1.8852	-0.4214	0.0020
LOC:internal.1	-0.5507	0.5765	-0.8389	-0.2626	0.0002
LOC:internal.3	-0.2024	0.8168	-0.3295	-0.0752	0.0018
LOC:internal.5	0.5982	1.8188	-0.1802	1.3766	0.1320
LOC:internal.7	-0.0772	0.9257	-0.8546	0.7002	0.8456
LOC:external.1	0.6001	1.8223	0.3360	0.8642	0.0000
LOC:external.3	0.2818	1.3255	0.1548	0.4089	0.0000
LOC:external.5	-0.7617	0.4669	-1.6846	0.1612	0.1057
LOC:external.7	0.0793	1.0825	-0.5094	0.6680	0.7917
Ret.coh:94-05.1	0.5961	1.8150	0.0496	1.1426	0.0325
Ret.coh:94-05.2	1.1910	3.2904	0.9433	1.4387	0.0000
Ret.coh:94-05.3	-0.3547	0.7014	-0.5137	-0.1957	0.0000
Ret.coh:94-05.4	-0.1040	0.9012	-0.5669	0.3589	0.6597
Ret.coh:94-05.6	0.2956	1.3440	0.1178	0.4735	0.0011
Ret.coh:94-05.7	0.7727	2.1656	0.2379	1.3076	0.0046
Ret.coh:not.eligible.1	0.8506	2.3409	0.1590	1.5421	0.0159
Ret.coh:not.eligible.2	1.9222	6.8362	1.6864	2.1580	0.0000
Ret.coh:not.eligible.3	-1.1538	0.3154	-1.6498	-0.6579	0.0000
Ret.coh:not.eligible.4	-1.1270	0.3240	-1.6250	-0.6290	0.0000

n= 20,190, number of events= 4,098

Rsquare= 0.084 (max possible= 0.937)

Likelihood ratio test= 1763 on 67 df, p=0