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How portfolios evolve for the old

A cross-country comparison in Europe using SHARE data

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How Portfolios Evolve For the Old: A Cross-country Comparison in Europe using SHARE Data

by

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Abstract

As aging is a serious social problem and wealth composition of the older households in Europe varies largely, studying factors influencing old people's asset ownership rates and asset shares is urgent and important. Using five waves of panel data from SHARE, this thesis adopts random effects and fixed effects Logit models to study several variables' effects on asset ownership rates and concludes that fixed effects fit better. I found that the effect of ageing generally follows a quadratic form in asset ownership rates. Behavioral risks factors are associated with owning different assets but causal effects cannot be concluded. Cognitive abilities are positively related to asset ownership rates but causal effects cannot be concluded either. Secondly, this thesis uses random effects and fixed effects Tobit models to investigate factors influencing asset shares. It is found that ageing is still very significant in many cases but not in risky financial assets in the fixed effects model. Behavior risks factors are more significant in influencing asset shares: the older households who drink more often or do more vigorous activities seem to have higher asset shares; starting smoking has a causal negative effect on holding risky assets while stopping smoking has a causal positive effect on holding risky real asset (other real estate). Cognitive abilities are strongly causal associated with holding more risky financial assets.

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1. INTRODUCTION

It is a fact that the total amount of wealth and the portfolio choice of the older households differ a lot in the world. What are the reasons of holding different portfolios for the old? Many researchers have done numerous works regarding this topic. Factors such as age, bequest motives, health shocks etc. are extensively studied in the past. Following the existing literature, this thesis further examines the effect of ageing on the older households' total wealth and different assets' holdings. Moreover, this thesis brings up more relatively new social economic ideas about this issue. Behavioral risks including smoking, drinking and vigorous activities are, to the best of my knowledge on the past literature, the first time to be tested empirically as a factor influencing the elderly's asset holdings. Especially, in this thesis four waves of panel data are used, and hence the changing of these behaviors (also a form of health shock to a certain degree) across waves can be described including starting and stopping smoking, which enables to even more thoroughly explore this issue. Lastly, the relationship between the wealth composition and cognitive abilities is empirically researched using the panel data for the first time as well.

Studying the wealth composition and the portfolio choice for the elderly is a meaningful and urgent task. Currently, pension contracts have a rich diversity around the world, yet voluntary life annuity insuring against micro longevity risk is not prevailing in most countries (Bateman and Piggott, 2010**)**. Meanwhile, in many European countries defined contribution schemes are integrated in their pension systems instead of pure defined benefit schemes. For example, in the Netherlands, in spite of a relatively high defined benefit level in the first and second pillars, various defined contribution products are provided in the voluntary third pillar. As a result, people have more freedom to tailor for individual needs and more and more people reach retirement age with low-risk savings through their careers, pensions, insurance policies, various bonds, stocks, real estate and other assets in order to fight against health shocks, to act according to their bequest motives etc. But at the same time, the defined contribution system requires people to make financial decisions themselves, which poses threats to people with poor financial literacy. Old people confront higher mortality risks than the young and they have, more or less, different lifestyles from the young people, which could lead to other portfolio holdings for the elderly. Moreover, some emergencies such as health shocks demand a large sum of money if the healthcare system is not very sound. These unpredictable expenditures actually could cause a higher level of difficulty on the wealth management of the elderly. Under the situation of ageing in Europe and around the world, more and more researchers perform studies on the issue on managing wealth well and making wise portfolio choices for the elderly.

Plenty of past research focuses on portfolio choices of the elderly. On one hand, Jagannathan and Kocherlakota (1996) show theoretically that in the life cycle investment, older people should invest less in stocks than younger people, because younger people can recover from potential losses through a larger amount of human capital. The derivation of optimal equity-bond-annuity portfolios for retired households by Pang and Warshawsky (2010) demonstrates that the health spending risk and the household's income play a crucial role in determining the portfolio. On the other hand, empirical research finds that asset shares invested in stocks vary dramatically with investors' wealth and agents' horizon (Ameriks and Zeldes, 2004). Moreover, Christelis, Jappelli and Padula (2005) using the Survey of Health, Ageing and Retirement in Europe (SHARE) point out that the European elderly's investing in stocks is positively related to social interactions, financial literacy and bequest motives, but negatively influenced by health status. Finally, many writings, including studies of Börsch-Supan (2003), Love et al. (2009) and Hulley et al. (2013), indicate that the decumulation of wealth after retirement is slower than theories predict.

Besides financial assets, real assets owned by the elderly, such as real estate and cars, can change total wealth and influence portfolio choice as well. There are also quite a few studies considering both the financial assets and the real assets for the old. Based on six waves of panel data from the Health and Retirement Study (HRS), Coile and Milligan (2009) reach the conclusion that for U.S. older households, the impact of ageing and shocks such as the death of the spouse on a household's total holding of principal residences, vehicles, financial assets, businesses, and real estate are negative. They also found people are more likely to own more liquid assets and less likely to hold risky assets with the increase of the age. Moreover, Spicer, Stavrunova and Thorp (2013) use data from an Australian panel survey to illustrate that retired households reduce the risk and increase the liquidity of their portfolios, but maintain their residence with respect to the increasing age. Unlike in the U.S., the effect of health shocks on the households' wealth is small, possibly because of better medical coverage in Australia.

Determinants of wealth composition and portfolio choice are widely analyzed in the past literature. Through computational methods, for example, Samuelson (1969) proves that a constant share of the wealth in equity is the optimal solution to invest if one has constant relative risk aversion. Gollier (2001) concludes that an increase in risk aversion decreases the demand for the risky asset in his standard portfolio problem. Empirical research, however, mostly uses econometric methods to find factors which are significantly related with the data of wealth and portfolio composition. Previous studies have put emphasize on several factors. For instance, background income risks such as earnings uncertainty (Guiso, Jappelli and Terlizzese, 1992) and entrepreneurial risk (Heaton and Lucas, 2000) are shown to significantly influence portfolio choice. Marital status and health status are also considered to cause different wealth and portfolio composition: Hurd (2001) notes that changing marital status from married to single has an impact on an individual's asset composition. Feinstein and Ho (2001) find that a spouse's passing away is significantly related to decreasing total wealth at a later time. Barber and Odean (2001) also reveal that married people and single people manage their stocks differently. Wu (2003) documents that health changes affect total wealth of older households. Using cross section data from HRS, Rosen and Wu (2004) illustrate that a poor health condition of households is associated with a lower share of risky assets. Moreover, financial literacy is a common element examined in the existing literature (Van Rooij, Lusardi and Alessie, 2012; Christelis, Jappelli and Padula, 2010; King and Leape, 1998). Furthermore, the investor's horizon or age is a complicated factor: Veld-Merkoulova (2011) notes that in the Netherlands people hold more risky financial assets over a longer horizon based on the cross section data, while Ameriks and Zeldes (2004) find a hump-shaped relationship between the investor's horizon and assets' ownership. The bequest motive is an important element as well and Hurd (2002) mentions that bequest motives of the old interact with their horizon of investing, which is different from bequest motives of the young. He argues that a bequest motive may make the old people's time horizon longer and "eliminate any effects of mortality risk". Other factors such as social interactions (Grinblatt and Keloharju, 2001; Hong, Kubik and Stein, 2004; Christelis, Jappelli and Padula, 2005) have drawn attention from researchers as well.

Built on the existing literature, this master thesis first examines the impacts of ageing on portfolio composition of the elderly. Following Spicer, Stavrunova and Thorp (2013) and Coile and Milligan (2009), I will check how they evolve with time for the same household using four waves of panel data. By using panel data instead of cross-section data, several problems are overcome or reduced. When performing cross-section analysis, it is impossible to separate the ageing effect from the cohort effect. People from different cohorts grew up in different circumstances and as a result may have built their wealth differently, may be subject to different government policies and may have different ideas about reasonable asset allocations. By using panel data, a certain age does not automatically correspond to a specific birth year and cohort, allowing for separation between the cohort and age effects.

Moreover, as wealth is negatively correlated with mortality, survivorship bias may play a role. Wealthier individuals may allocate their wealth differently, and including wealth as a control variable may not fully capture that effect. By looking at the same households over time, this bias can be reduced although not fully eliminated.

Furthermore, there may be other household characteristics influencing portfolio choice which are not part of the models. Fixed effects models include a household variable which captures all time-independent effects that are correlated to the dependent variable, eliminating what is called the household effect.

Thus, the cohort and household effects are isolated from the ageing effect. Furthermore, a specific health shock, becoming widowed, is at the same time investigated in this master thesis. Some literature (Hurd, 2001; Feinstein and Ho , 2001; Coile and Milligan, 2009) reveal that the shock of the death of the spouse plays a significant role in the elderly households' wealth composition. A recent study by Van Rooij, Lusardi & Alessie (2012) also suggests that the spouse's passing away has a negative consequence on the survivor's wealth. By researching the widowhood issue in Europe using recent years' panel data, this study provides new comparisons with other researchers' results and draws a firmer conclusion on the effects of widowhood on wealth composition and portfolio choice.

Secondly, this thesis studies the effect of behavior risks on the elderly's assets ownership and the share of asset holdings. Although a few studies have shown that health conditions affect the elderly's wealth and portfolio composition, to the best knowledge of the author, unhealthy life habits which arouse great interest from our society have never been considered specifically in the wealth allocation problem for the old. It is assumed in these studies that heavy smoking, excess alcohol and vigorous activities affect the health status of the elderly, and consequently they affect the wealth composition. These effects on health are well established. For instance, in a longitudinal research of Østbye, Taylor and Jung (2002), they find smoking is strongly associated with mortality and with poor health conditions for middle-aged and old Americans. However, these habits may also influence financial decisions in other ways; Numerous researchers conclude that alcohol abuse greatly increases the chance to have physical or psychiatric problems, such as Perreira and Sloan in 2002. Thus, it is interesting and meaningful to the society to separate the effect of smoking and excess alcohol drinking from the general health effect on the older households' wealth composition.

Moreover, past studies indicate that alcohol and smoking influence people's risk aversion level. In an experiment conducted by Lane, Cherek, Pietras and Tcheremissine (2004), they find acute alcohol intake increases people's risk taking, which is consistent with other literature. As for smoking, Ida and Goto (2009) point out that heavy smokers are the least risk averse while ex-smokers are the most risk averse; current smokers are less risk averse than nonsmokers. Therefore, the elderly with unhealthy habits such as smoking or alcohol abuse are assumed to be less risk averse and consequently, invest a larger share in risky assets.

Despite that little is known about the wealth allocation problem for the old, a few papers have researched the total wealth effect of smoking in the entire population. Zagorsky (2004) documents smoking is related to a decrease of net worth of nearly four percent each year of U.S. baby boomers. Using cross section data from the Australian Bureau of Statistics (ABS), Siahpush, Borland and Scollo (2003) conclude that smoking households are significantly more likely to encounter financial stress than non-smoking households, but the causal effect cannot be proven.

Thirdly, this thesis explores whether the cognitive ability influence the decision of holding a specific class of asset and the friction of investing in that type of asset for the elderly, which is rarely examined before. As discussed in the beginning, defined contribution schemes have become more popular in recent decades, which require people to have a sufficient level of financial knowledge to make reasonable decisions for their asset holdings in retirement. This individual financial management for retirement can help tailor for individual needs, yet at the same time, it exposes people to higher levels of financial risks and causes failures in financial management during retirement due to insufficient financial literacy, especially among women, less educated people and older people (Lusardi and Mitchell, 2011).

To gain a better insight of the relationship between literacy and asset holdings, Benjamin et al. (2006) find experimental evidence that more asset holdings, better understanding of pension plans and bigger financial market participation are related to mathematical skills. Van Rooij et al. (2007) note that people have a smaller probability to own stocks if they have low level of financial literacy, adopting data from a Dutch household survey. However, there is endogeneity of financial literacy because of reverse causality. Moreover, the measurement of financial literacy contains errors which may lead to a downward bias. Nevertheless, guessing correct answers of questions regarding the level of financial literacy causes biased results as well. On the one hand, Alessie, Van Rooij and Lusardi (2011) solve these problems by finding instrumental variables for financial literacy and still find out a strong relationship between stock holdings and financial literacy. On the other hand, Christelis, Jappelli and Padula (2010) adopt simple cognitive abilities data focusing on three basic aspects of cognitive abilities: numeracy, fluency and recall abilities, which are not influenced by holding more stocks. They use wave one data from Survey of Health, Ageing and Retirement in Europe (SHARE) in 11 European countries, and empirically show a strong relationship between stock investment and cognitive ability for the elderly for the first time.

Following Christelis, Jappelli and Padula (2010), this thesis further proves that cognitive ability is associated with the asset holdings of old households. But instead of using data collected mainly in 2004, I use four waves of panel data from Survey of Health, Ageing and Retirement in Europe (SHARE), in order to confirm the relationship. Moreover, more asset categories are studied in this thesis. Seven asset categories are included instead of only looking at the stock holding.

Finally, it is interesting to find out which patterns of wealth composition and portfolio choice exist in different countries or different regions (Nordic, Central and Mediterranean countries) within Europe.

According to a study of Wealth and Portfolio Composition in The Survey of Health, Ageing and Retirement in Europe (SHARE), Christelis, Jappelli and Padula (2005) note that risky asset holdings are more prevailing in Nordic countries than in Mediterranean ones. In particular, more than 40% of financial wealth in Sweden and between 30% and 40% of that in Switzerland for the elderly are invested in risky assets, yet in Spain, the rate is lower than 10%. What are the reasons for such a big difference in investing decisions for the old within Europe? SHARE (The Survey of Health, Ageing and Retirement in Europe; www.share-project.org) offers a new and rich source to investigate this question.

The rest parts of my thesis are structured in the following way: Part two describes the data used in the thesis and analyzes variables I will study in the regressions; Part three introduces models adopted in the empirical analysis, and shows results from those models; Part four discusses results, gives explanations of them and draws conclusions.

2. DATA

The sample used in this master thesis is drawn from five waves of panel data from the Survey of Health, Ageing and Retirement (SHARE). This dataset contains a substantial amount of information about various economic and non-economic conditions of Europeans over the age of 50, covering a period of almost 10 years. The latest wave, completed in November 2013, contains information from fifteen countries, but only eleven European countries participated in all five waves. From this last category, Sweden, Denmark, The Netherlands, Germany, Spain and Italy are selected to represent Nordic, Central and Mediterranean countries respectively. This is done in order to keep the overview while still being able to compare results across countries and regions. The selection is not as restrictive as one might think; whereas the total amount of individuals surveyed in the SHARE dataset is about 86.000, more than 51.000 individuals are still contained in this selection.

The third wave, dubbed SHARELIFE, is substantially different from the other waves, whose questionnaires are quite similar to each other. Conducted in 2008 and 2009, SHARELIFE's focus is on respondent's life histories. Detailed questions are asked about a large variety of subjects such as health, childhood circumstances and financial history, which are not or to a lesser extent covered in the other waves. Vice versa, most of the questions asked in the other waves are not repeated in the third. Consequently, there are usually four measurements across time to evaluate, while the SHARELIFE data can provide supplementary time-constant independent variables. Among variables in the third wave, whether or not the household has experienced financial hardship is a new and interesting variable, which is included in this study as a control variable.

The sample statistics which contains sample means and standard errors per wave can be found in the Appendix.

2.1 Main Variables

The SHARE data includes relevant and sufficient information to study the three main points of interest of this master thesis. Besides basic information such as age, gender and household composition (including widowhood), participants are also asked about such things as their self-reported health, income, expenditures, asset holdings and debts. In particular, there are questions about the value of their real and financial assets. Real assets are comprised of the main residence, other real estate, own share of businesses, and cars (all net of any debts and mortgages). Respondents are also requested to specify seven kinds of financial assets; bank and other transaction amounts, government and corporate bonds, stocks, mutual funds, individual retirement accounts, contractual savings for housing, and life insurance policies. Some of them will be grouped, as discussed in the section on item non-response. Net financial assets are defined as the sum of these financial assets minus any other debt, i.e. the sum of all debts not pertaining to any of the specified real assets. To enhance cross-country comparability, all monetary values are converted into euros and adjusted for purchasing power parity. With these data, I will address the first research question of this thesis, which is about the effect of age and widowhood on the elderly's portfolios. As for the indication of widowhood, this thesis not only considers the static data, but also generates the variable representing dynamic widowhood shock. The widowhood shock is defined as 1 if the marital status changes into widowed in the current or an earlier wave and 0 otherwise. Then the effect of becoming a widow can be more clearly studied. Besides, it is also of interest to construct another variable indicating the separation shock, which is 1 if for other reasons households become single such as divorcing. The reason to do so is because the author thinks the two different shocks may have different effects on the older households' asset holdings, as the separation of a household usually involves asset splits among members, which is not the case of becoming widowed.

This paper's second goal is to explore the effects of smoking, alcohol and vigorous activities on the older people's wealth and asset allocation. Besides the already mentioned information, SHARE also covers these behavioral risks. Specifically, in wave one a respondent is first asked whether he or she has ever smoked cigarettes, cigars, cigarillos or a pipe daily for a period of at least one year. If the answer is 'Yes', follow-up questions ask about current smoking, the number of years of smoking, age of stopping (if applicable), what is or was smoked, and the average amounts smoked per day. In the second wave, the same is asked except the age of stopping, which is replaced by whether or not the respondent has stopped smoking since the last interview. Note that the age people stopped smoking cannot be imputed precisely in wave two, as it is not asked exactly when they stopped; in subsequent waves SHARE does request this information. The fourth wave and fifth wave do not contain questions about the smoking type nor frequency. Hence, if a change occurs in these habits, they are no longer recorded in the last two waves. Assumptions must be made if this information is to be used in longitudinal studies such as this master thesis.

Instead of imposing such assumptions, I will only make use of the available information regarding smoking. Even though the age elderly have stopped smoking is asked or can be estimated with an error of at most 2 years, this information will not be used either. Besides the need for estimation, which lowers the reliability, this age intuitively does not seem to be very important. This leaves three variables to work with: whether or not one has ever smoked daily for at least one year (*esmoked*), whether or not one is currently smoking (*smokenow*) and how many years one has smoked in total (*ysmoked*). Besides, smoking has a habit formation process, and thus it is necessary to look at the dynamic effect of changing from non-smoker to smoker, which is defined as *startsmoke* (1 if *smokenow* is 1 in a certain wave and is 0 in previous wave) and the dynamic effect of changing from smoker to non-smoker, which is defined as *stopsmoke* (1 if *smokenow* is 0 in a certain wave and is 1 in previous wave). The reason to construct these two variables instead of including a lag term of *smokenow* is that starting to smoke does not necessarily have the opposite effect of stopping. The past literature (Ida and Goto, 2009) suggests people stop smoking are most risk averse, and in such a way the effect of stopping to smoke on the older households' wealth composition can be separated out.

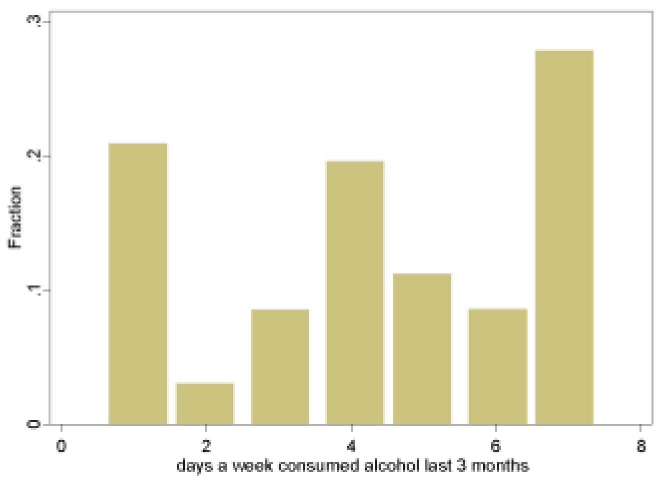
As for alcohol consumption, the questionnaire changes with every wave, complicating comparison across time. The first wave covers its frequency in the past six months in general, as well as the frequency of drinking more than two glasses in a day of a specific category of alcoholic beverages. These categories are (1) beer and cider, (2) wine and (3) cocktails and drinks of hard liquor. From the second wave on, participants are asked about their alcohol consumption in the past three months, instead of six. Moreover, the distinction between different types of alcoholic drinks is no longer made. Furthermore, new questions are introduced, asking whether or not the elderly had ever consumed alcohol, how many drinks they had on the days that they do drink and how often they drank more than four of them on a single occasion. In the fourth wave, the amount of drinks in the last question is replaced by six, and the question is absent in the fifth wave. The last two waves also ask whether or not excessive drinking has been a problem at any time, and finally, wave five asks if it has been a problem since the last interview.

As a result, none of these variables provided by SHARE are fully consistent across the four waves, even after imputation. The variable which is, in my opinion, the most consistent, contains the answers to the question: “During the last six (three) months, how often have you drunk any alcoholic beverages, like beer, cider, wine, spirits or cocktails?” This is the only variable regarding alcohol consumption that this thesis will use, even though its author recognizes that the number of drinks per day or occasion may also be relevant. The main reason for this exclusion is the inconsistency across the waves; note that because in the first wave a distinction is made between different types of alcoholic drinks, limited information can be drawn from this about the total amount of alcohol that is consumed. For example, if someone regularly drinks 2 beers, 2 wines and 2 cocktails on an occasion, he would answer ‘no’ to the three questions in wave one about how often he drinks more than 2 per type in a day, giving the impression that the total consumption is fairly low. When asked how many drinks they consume on the days they drink in another wave, the answer would be ‘six’, giving a completely different impression while consumption hasn’t actually changed.

Figure 1 describes older households’ drinking frequencies in the sample. Since the variable regarding days a week consuming alcohol in last 3 months is the most consistent variable in SHARE data across waves, the thesis chooses this variable as the indication of the level of drinking among the older households. The variable ranges from 1 to 7, and scale 1 means almost drink every day, scale 2 means five or six days a week, scale 3 means three or four days a week, scale 4 means once or twice a week, scale 5 means once or twice a month, scale 6 means less than once a month and scale 7 means not at all in the last 3 or 6 months. The sample mean is 4.34, corresponding to once or twice a week, and the standard error is 2.22. From the figure below, we can see around 28% old people do not drink, which is the biggest share. Around 20% old people drink almost every day or once or twice a week, which represent heavy drinkers and moderate drinkers respectively.

As for the third indication of behavioral risk, vigorous activities, SHARE contains the following question in every wave except for wave 3: “We would like to know about the type and amount of physical activity you do in your daily life. How often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labor?” The answer is on a 1-4 scale, which corresponds to more than once a week, once a week, one to three times a month and hardly ever or never. So 1 means more than once a week and 4 means hardly ever or never. Figure 2 shows that more than 40% of the old people hardly ever or never do vigorous sports or activities while around 37% big fans of it do more than once a week. This seems reasonable as people keen on vigorous activities usually do it quite often,

Figure 1. Sample distribution of the frequency of consuming alcohol in all waves



especially for the old who are still healthy and do not have to work. They have more leisure time to enjoy activities they like. I suppose that household members who seldom do vigorous sports or activities are more risk averse and they are more likely to own safe assets than risky assets. Vice versa, household members often do those activities which are more risky and possibly hold more risky assets.

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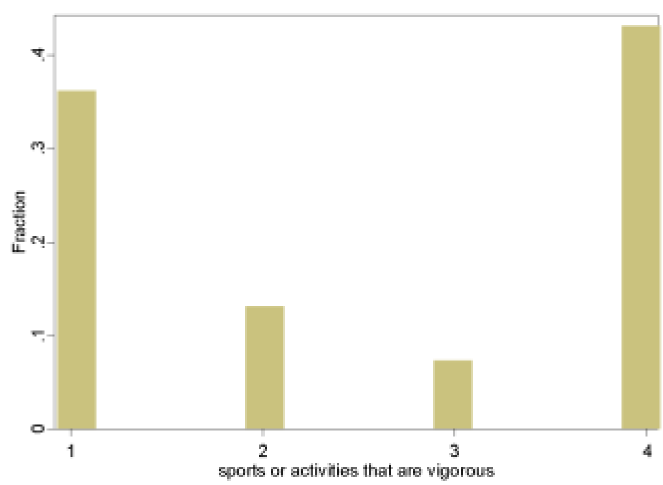
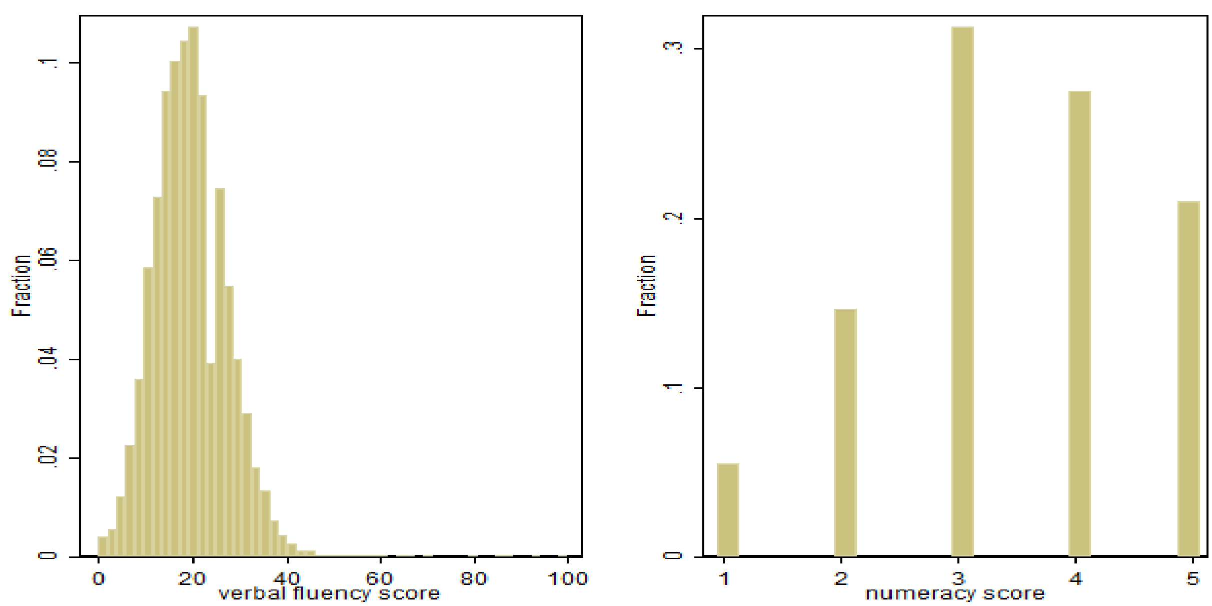
Figure 2. Sample distribution of the frequency of doing vigorous sports or activities in all waves



For the third topic of the master thesis, the SHARE data offers information about the elderly's cognitive functions. Combined with the basic and economic information discussed before, the effect of cognitive abilities on the wealth composition and portfolio choice can be examined. SHARE has a whole section about cognitive functions in every wave, yet some questions change or are asked in different ways. For instance, one domain of the survey is memory. In wave 1 and wave 2, respondents are asked to recall the words immediately after interviewers read those words; however in wave 4 and 5, there are other questions in between reading the words and recalling the words, so respondents are asked to recall the words quite some time after interviewers read those words. Thus, this variable is not included in the panel analysis since it is not fully consistent in every wave.

Following Christelis, Jappelli and Padula (2010), this paper will use the numeracy and the fluency as explanatory variables but exclude the memory from the regression. The ability to do numerical operations (numeracy) and the executive function (fluency) are two important elements in cognitive abilities and they are considered to be related to making financial decisions. Regarding the ability to conduct numerical operations, in every wave, SHARE conducts a small numeracy test. It consists of four multiple choice questions requiring respondents to perform simple calculations, the answers to which are translated to a numeracy score ranging from 1 to 5 (higher is better). It seems reasonable to suspect numerical skills to be related to the composition of people's financial assets, so the numeracy score is included. Moreover, the executive function (fluency) in SHARE is a score of the number of animals respondents can recall and speak in 1 minute. The following figure describes the sample distribution of fluency and numeracy. The sample mean of verbal fluency score is 19.6 and it has a standard error of 7.68. A few old people can recall near 100 animals in 1 minute which in my point of view is still reasonable, and thus I do not take them as outliers. As for the numeracy score, the old people's average score is 3.4 with a standard error of 1.14. Around 31% respondents receive a score of 3.

Figure 3. Sample distribution of verbal fluency score and numeracy score in all waves



2.2 Other variables

In order to exclude the effects of other variables, I include several control variables in every regression such as the household income, number of children and gender. In this section I describe some major control variables obtained from SHARE data.

As mentioned before, the third wave provides information about the elderly's life history. Many of these variables might be slightly relevant for people's asset compositions, but there is only one question which seems particularly relevant, namely, whether or not the respondents suffered a period of financial hardship or not. This factor is, to the best of my knowledge, never studied or included as a control variable in the existing literature, but it may be an important element influencing people's investment strategies. My hypothesis is that those who did suffer from such conditions are more risk averse when it comes to personal financial management. In particular, I expect them to own less stocks, bonds and mutual funds. Most of the households interviewed by SHARE do not appear in all 5 waves; about half of the observations from the other waves cannot be associated with this or any other variable from wave 3. Therefore, I will not include this variable in the main regressions, but it will appear in one of the robust checks.

Health status is another important factor which is considered in this thesis. Among past literatures, a vast number of researchers use self-reported health status data from the Health and Retirement Study (HRS). In this thesis, self-reported health status from SHARE is adopted in order to, on the one hand, have better comparisons with other studies. On the other hand, I believe data of self-reported health status is more important than objective health data such as whether or not suffering from chronic disease when individuals make portfolio choices, as decisions are mostly based on perceptions, not objective data. In SHARE, self-reported health status has five scales, from one to five. One means that one's health status is considered to be excellent while five represents that one's health status is considered to be poor. The lower the number is, the better the health status he or she thinks.

Apart from health status, education level of the elderly is included in the study. In wave 2, wave 4 and wave 5, there are direct data regarding years of education. However, in wave 1, years of education are not asked and only the country specific ISCED-97 codes of respondents are available, from which years of education could be roughly interpreted by the Appendix C in the release guide of wave 1&2 of SHARE. In the wave one, the education variable is reconstructed into higher educated and lower educated: If ISCED-97 codes are 0-2, which means respondents received 0-10 years of education, I rename them into lower educated; If ISCED-97 codes are 3-6, which means they received 10-25 years of education, I rename them into higher educated. In order to be consistent across waves, the education variable in wave 2, wave 4, wave 5 is reconstructed into lower educated if years of education are between 0-10, and higher educated if years of education are more than 10.

Bequest motives, the motivation to leave any inheritance to others, is an important control variable as well. Bequest motives could change one's time horizon and render individuals to have different investing strategies. SHARE includes the probability to leave an inheritance greater than 50,000 euros only in the first and second wave. Unfortunately there are no substitute questions on this aspect in wave four and wave five, nor are there any better wave-consistent alternatives. Thus, I have to exclude this factor in four waves of panel data analysis, yet I include this factor in a robust check which involves only first two waves, in order to show the results are still valid.

It should be noted that the probability to leave an inheritance of at least 50,000 euro is of course related to the total wealth of the household. This, in turn, is also likely to influence the elderly people's asset allocation. The log of the household's net worth, defined as the sum of all assets minus liabilities, is therefore also included as a control variable. Almost 4% of the observations have a net worth lower than 1, and they are set equal to 1 before taking the log. Not only wealth, but also income is likely to influence portfolio choice. Therefore, similar transformations are done (less than 0.8% of the observations report an income below 1) and the natural logarithm of total household income is taken as another explanatory variable.

The table below shows all the variables used in this thesis which may not be immediately clear. The appearance in different waves is also shown.

Table 1. Variable descriptions

		Waves				
Name	Description	1	2	3	4	5
Age	Age of oldest household member	X	X		X	X
Gender	0 = Female, 1 = Male	X	X		X	X
nChild	number of children	X	X		X	X
logIncome	Log(max(income, 1))	X	X		X	X
logNetw	Log(max(net worth, 1))	X	X		X	X
Numeracy	numeracy score; ranging from 1 to 5, higher is better	X	X		X	X
Health	Self-reported health; ranging from 1 to 5, lower is better	X	X		X	X
AlcFreq	Alcohol frequency; ranging from 1 to 7, lower is more often	X	X		X	X
VigSport	Vigorous sports < will be updated >	X	X		X	X
Reading*	Self-reported reading; ranging from 1 to 5, lower is better	X	X		X	X
Fluency	Fluency score; ranging from 0 to 100, higher is better	X	X		X	X
HigherEdu*	1 if ISCED-1997 ≥ 3, or, if missing, years of education > 10, 0 otherwise	X	X		X	X
eSmoked	1 if ever smoked daily for at least 1 year, 0 otherwise	X	X		X	X
ySmoked	Years of smoking daily	X	X		X	X
StopSmoke	1 if stopped smoking since last wave, 0 otherwise		X		X	X
StartSmoke	1 if started smoking since last wave, 0 otherwise		X		X	X
SmokeNow	1 if smoking in current wave, 0 otherwise		X		X	X
Couple	0 = Single, 1 = Couple	X	X		X	X
Widowhood	1 if widow, 0 otherwise	X	X		X	X
WidowShock	1 if newly widowed since first appearance in data, 0 otherwise		X		X	X
SepShock	Separation shock; 1 if household size decreased from 2 to 1 for another reason than widowhood		X		X	X
BequestMot	Probability to leave an inheritance greater than 50,000 euros	X	X			
FinHardship	1 if experienced financial hardship, 0 otherwise			X		

*not asked again if answered in a previous wave

2.3 Financial head

Before household level analysis can begin, a decision has to be made about how to use individual characteristics such as age and smoking habits on a household level. To simplify analysis, improve accuracy and enhance comparability with other papers such as Spicer et al. (2013), only couples and singles living without other family members are considered. Spicer et al. (2013) state that the convention is using the male as the head, and consequently using his characteristics (except for the age, which is defined as the age of the oldest household member) in empirical studies. While I follow them by using the same definition of age, I believe that it is more appropriate to use the financial respondent, because the one who is the "most able one to answer questions about [their] finances" is likely to have a greater influence on the finances. To avoid confusion with definitions posed by other papers, this person is defined to be the financial head. When both partners are financial respondents, I will stay as close to convention as possible by defining the male as the financial head. As for the same sex couples with two financial respondents, I choose the person who does the survey first.

When performing longitudinal analysis, the comparability over time can be enhanced by avoiding the financial head to change across the waves. Therefore, the person who answers more surveys is defined to be the financial head across all the waves. If the financial head is not yet chosen in this way, the same criteria as above are used for wave 1. For the same reason of enhanced comparability across waves, the financial head defined in the first wave will remain to be so in subsequent waves even if his or her partner becomes the only financial respondent in future waves. In the same spirit, the financial heads of newcomers in other waves are chosen using the same rules, and remain to be so in subsequent waves if they appear in the data.

2.4 Item non-response

Large household surveys such as SHARE suffer from the problem of item non-response, which occurs when respondents don't know an answer or refuse to provide it. While this is not a major problem for most of the variables, where the fraction of non-response is lower than 5%, it is for the amounts of assets, liabilities, income and expenditures. Fortunately, a fairly large amount of initial item non-respondents do provide a range for the values. In wave one, for example, this still leaves about 15% of the owners of stocks and shares to provide no information at all about their worth. To avoid a smaller sample and biased inference (as non-response may be related to the actual amounts), the missing data is imputed, the details of which may be found in the SHARE Release Guide 2.6.0, pages 24-25.

The method implemented by SHARE is the multiple imputation method, which in this case means that five imputed data sets are provided. The underlying idea is to mimic the distribution of missing values, conditional on other variables' observed values. The fully conditional specification method is only used for the mentioned monetary variables for which item non-response constitutes a major problem. Simple hotdeck is applied to the remaining variables, to simplify the imputation model. When used properly, increased noise due to imputation can be reduced by analyzing each imputed set separately and taking the average of the results other than the standard error. This term can be computed in a bit more complicated way to perform statistical tests, the details of which may also be found in the SHARE Release Guide 2.6.0, pages 24-25.

In the fourth and fifth wave, the imputations are performed in a different way. While there are several changes, the most important one for the purposes of this thesis is the method used to handle non-responding partners. In particular, the value of the holdings of stocks, bonds and mutual funds is imputed on an aggregate level from the fourth wave on, whereas before they were imputed separately. Similarly, individual retirement accounts, contractual savings for housing and life insurance policies are combined into one variable called savings for long-term investments. This aggregation unfortunately renders the study of portfolio compositions and changes to be less detailed, but it increases reliability. In wave 1 and 2 the separate values are aggregated to accommodate comparison across waves and increase accuracy, even though the latter is still a bit lower because imputations have been done separately.

Another change of interest is that an alternative measure of household income is introduced, namely from the one-shot question about household income. All the waves contain the (possibly imputed) original measure of household income, found by aggregating its separate components. The new measure is not used in this study to keep the variables consistent over time. When SHARE completes its plans to extend the new imputation model to the first and second waves, reliability and in general comparability across time may be improved.

When comparing countries and regions, cross-section or longitudinal calibrated weights may further reduce problems of unit non-response and sample attrition. The calibration is done separately per country to make the sample as representative as possible for each nation. In particular, calibration margins are set for the size of the national population across NUTS1 regional areas and several age-gender groups. In this way, respondents which are overrepresented according to these criteria get a lower weight and vice versa, so that we can more reliably compare countries with each other.

SHARE provides a selection of calibrated weights, but they should not be used directly in this master thesis. This is because some households are excluded (those households who have more members besides a couple or single person), so the weighting should be done with only the remaining households. Fortunately, Stata codes to do the calibration are also provided in wave 4, which, with some effort, may be altered to also be used for wave 1 and 2. For the last wave, however, considerable work is still needed which is beyond the scope of this thesis. As it would be too time-consuming to compute weights for the last wave, longitudinal calibrated weights are not used here. Calibration is applied for cross-section analyses on waves 1, 2 and 4.

2.5 Further imputations

While SHARE imputes some variables, others still need to be imputed from the other waves. Moreover, the age imputed by SHARE is not consistent with the given birth and interview dates; doing the age imputation myself, the minimum amount of deviations (0.11%) I can get from SHARE's imputed age is by subtracting the interview year by the birth year. However, the birth month and interview month are also available and used in this paper, allowing for a more accurate imputation of age at the time the answers are given.

The provided variables for smoking need particular attention. The only variable imputed by SHARE is the one regarding whether or not the person has ever smoked at least daily for one year in his or her life, and it has only been done for the last two waves. There seems to be an error in this imputation. About

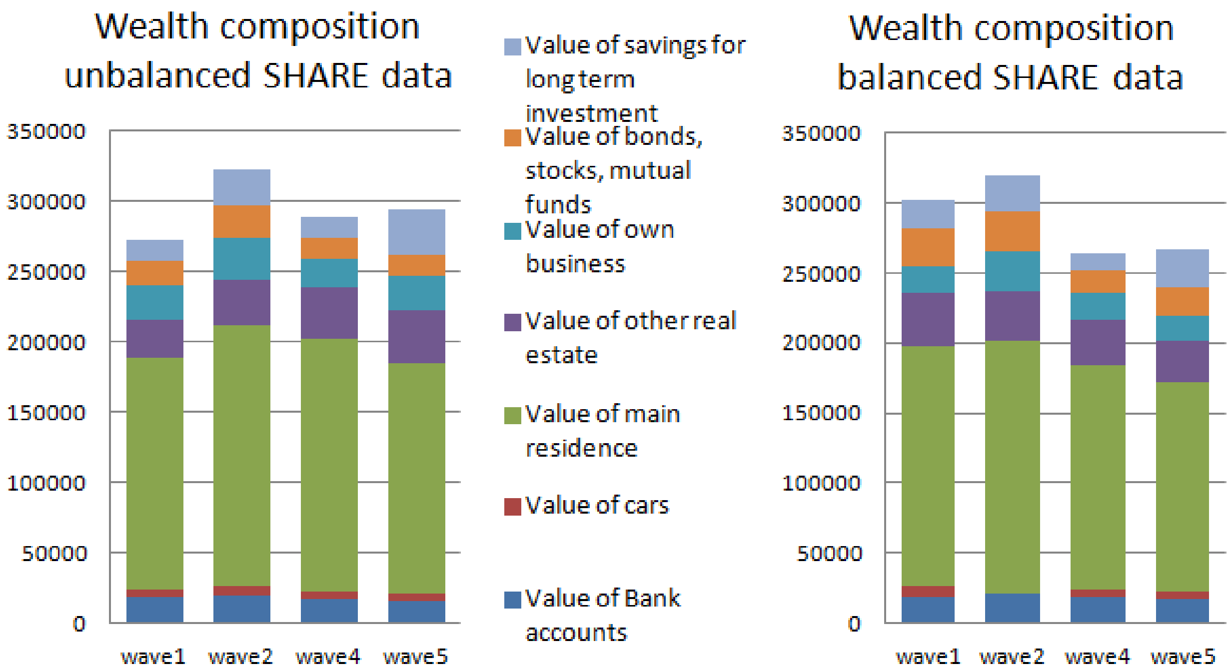
1/3 of those individuals who appear to have done so, in wave 4 suddenly seem to have never smoked in wave 5. Interestingly, many of them never smoked in wave 2 and are not currently smoking. I assume, therefore, that this is a mistake so I adjusted their values to have never smoked daily for more than 1 year, when at least one of those scenarios occurred. It is possible, however, that the error is not fully corrected in this way.

Furthermore, the years of smoking is often missing, but in many cases can be imputed from other waves. When, for instance, someone was smoking in the previous wave and still is, the number of years smoking is imputed to be the difference in years between the interviews. The same is done if a person answers the years of smoking in a subsequent wave and smokes in both. When a respondent stopped or started smoking in such situations, it is assumed that the change of habit occurs one wave before the change is recorded. Usually this means the number of years remains the same, because most of such instances happen when one stops smoking and does not specify when. This is not always the case, though. For example, when a survey-taker states to be smoking in wave 1 and has smoked for a total of 10 years, does not appear in wave 2, is not smoking in wave 4 and does not specify the total amount of years smoked, this person will be assumed to have smoked for a total of 13 years (the first wave being mostly collected in 2004, and the second in 2007).

2.6 More sample statistics for seven asset categories

The graphs below show the means of the values of different asset categories for two different groups. The left figure is constructed on the basis of the full unbalanced set, where households appearing in multiple waves constitute up to 4 separate observations. To rule out the effect of respondents entering and leaving the survey in different waves, the right figure shows the statistics of the balanced set.

Figure 4. Average wealth composition across waves

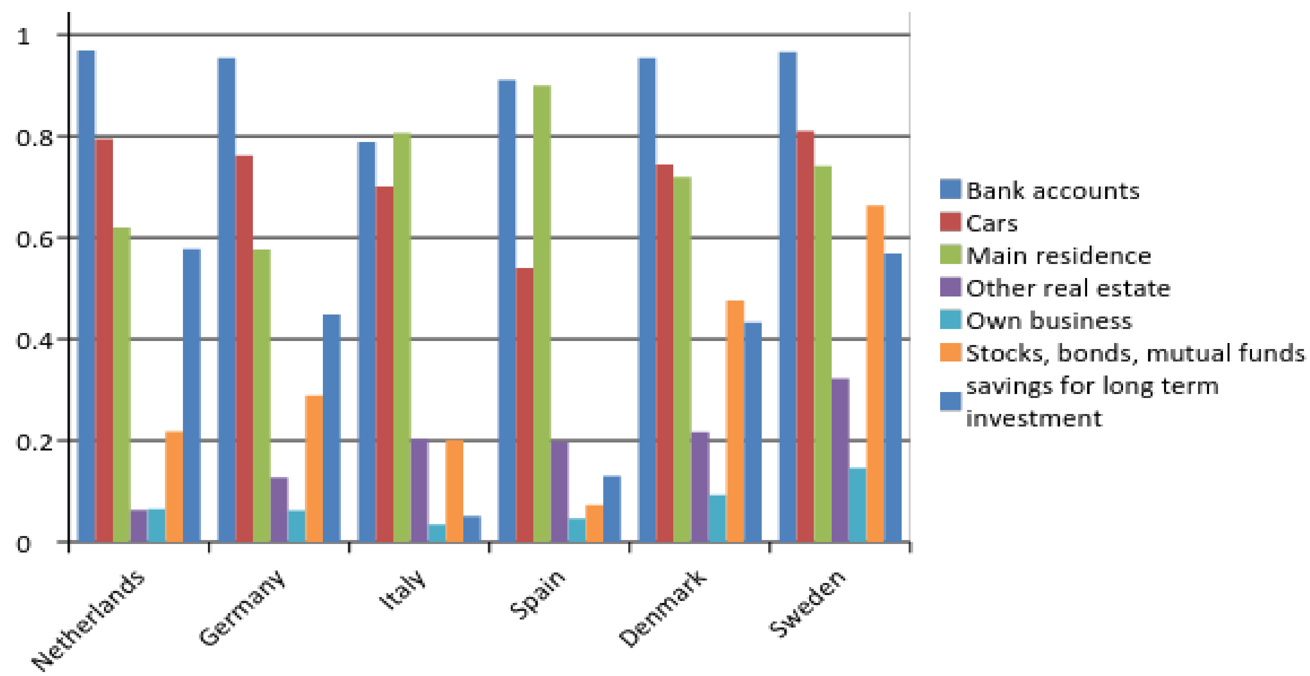


It can be seen that the graphs are quite similar, so that on this basis there is little reason to differentiate between the balanced and unbalanced panel. From wave 1 to 2, the total wealth increases for all asset categories, and most significantly so for the values of savings for long term investment, and bonds, stocks and mutual funds. This is in accordance with the European stock markets, as they rose strongly between 2004 and 2007. After the financial crisis, it can be seen that in wave 4 (2011) the total wealth unsurprisingly declined. The same categories which rise sharply between wave 1 and 2, now decline the strongest, while the value of own businesses now also change more than 30%.

It is also interesting to see the difference across countries. The figure below shows the ownership rates of the asset categories by country for the unbalanced set. The differences are substantial; households in Spain and Italy have very little ownership in savings for long-term investments, whereas more than half of those in Netherlands and Sweden do own those types of assets. The ownership rates for the countries in Southern Europe are all smaller compared to the other countries, except for main residence, where they have the highest fractions of ownership. As for other real estate, Netherlands has the lowest ownership rate and Germany has second lowest rate, while more than 20% of the older households in other countries on average own other real estate.

The categorization into Central, Northern and Southern Europe seems to be justified on the basis of this figure; the variation between the countries in these categories looks much smaller as compared to cross-category variations. Therefore, grouping these countries into these regions will be applied in some cases, even though I will always check if the results are not qualitatively different if grouping would not have been done.

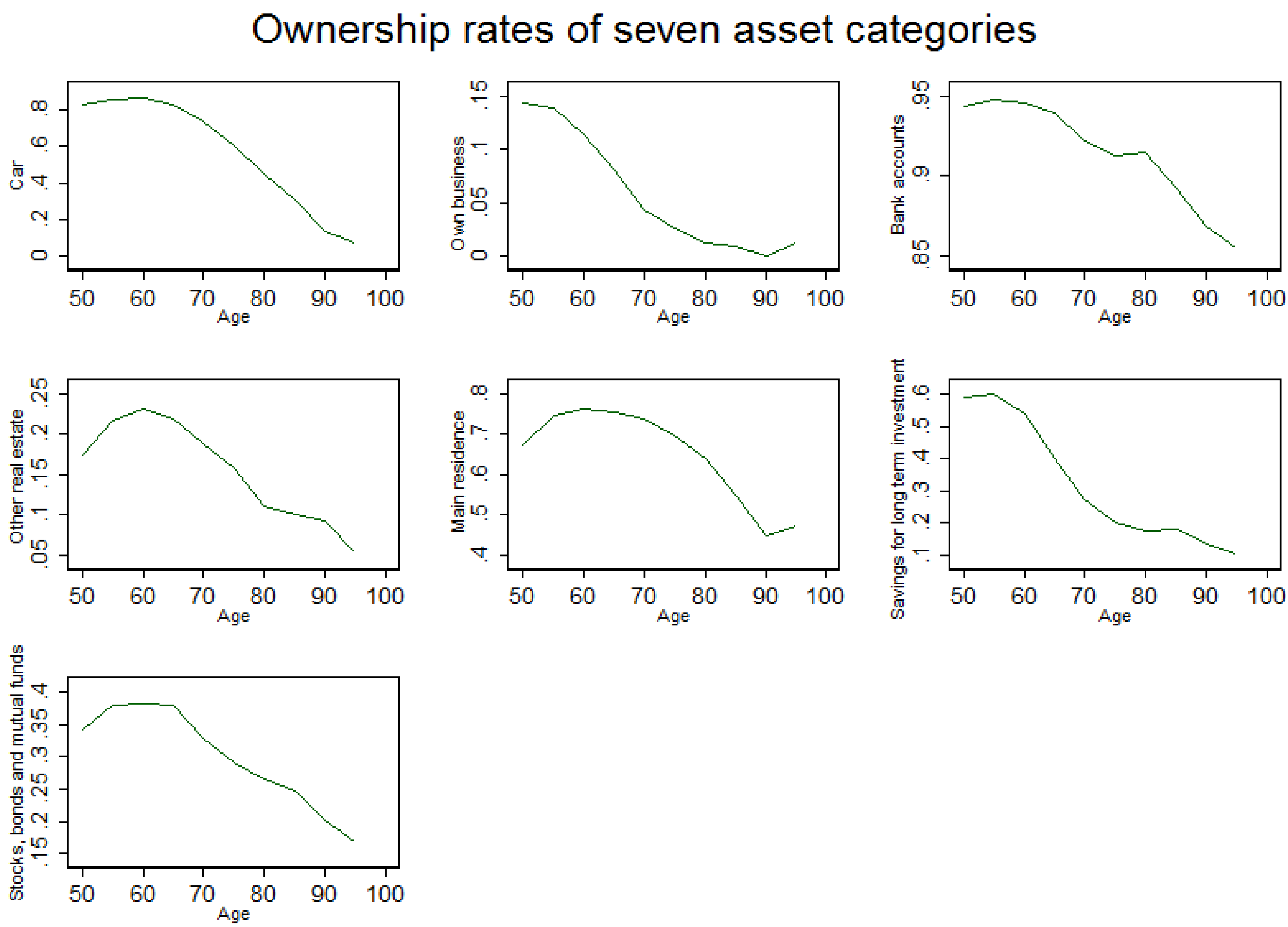
Figure 5. Average wealth composition across countries



2.7 Ageing

To answer one of my research questions, I start by looking at the ownership rates of the seven asset categories of interest. The graphs below show the ownership rates per asset category by age group using the unbalanced panel data. To smooth the lines, households are grouped per 5 years. This means that the observation of age equal to 60 actually represents the households whose age is at least 60 and at most 64.

Figure 6. Ownership rates of seven asset categories among the old



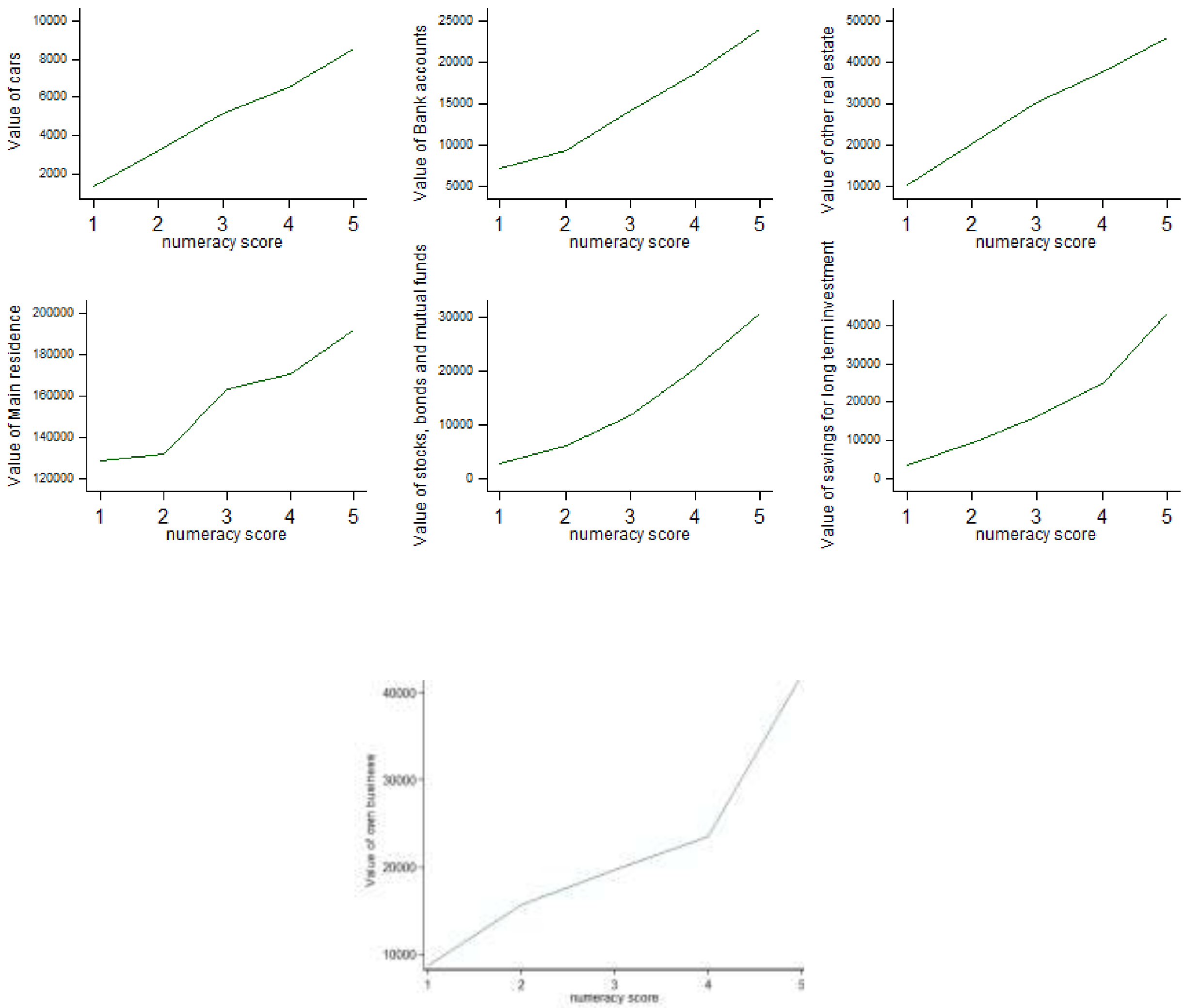
Most ownership rates rise until the retirement age of about 65 and decline more or less linearly afterwards; only the rate of ownership for own business decreases from the youngest age in the remaining sample. The rise shown at the end of the ownership rates for main residence and own business can be attributed to chance as the last age group is relatively small.

Because of the peak at the pension age, there is a good reason to separate the sample into households younger and older than 65. Also intuitively, it makes sense that retired households may face their asset allocation problem differently. The approximate linear decline shown in the graph suggests age can be included, without transformation, as an explanatory variable in regressions using ownership dummies as dependent variables.

2.8 Numeracy

The figure below shows the mean values for the seven financial asset categories by numeracy score. A strong and approximately linear relationship can be seen with all the categories. Therefore, the numeracy variable ranging from 1 to 5 will be used as an explanatory variable without manipulation. As total wealth is the sum of the values of these asset categories minus any other liabilities, numeracy must also be strongly correlated with total wealth. Therefore, numeracy on its own may or may not be significant in regressions when the log of total wealth is also included, and its significance may vary from one asset category to the other. In particular the values of own businesses, savings for long term investment, and values of stocks, bonds and mutual funds are expected to be significantly correlated to the numeracy score, even after controlling for total wealth. Similar figures can be plotted for fluency score as well. Fluency scores are also positively correlated with the value of asset holdings.

Figure 7. Value of seven asset categories and numeracy



3. EMPIRICAL METHODS AND RESULTS

3.1 Asset ownership rates estimated by Logit models

In this section, the author first uses SHARE data to examine the ownership rates of seven categories' asset holdings of the old, namely, bank accounts, cars, main residence, other real estate, own business, risky financial assets (stocks, bonds and mutual funds) and savings for long term investment. It is manifest that not all people own those seven categories of assets, and the reasons behind it seem to be interesting. This thesis tries to provide insights in this area by adopting random effects and fixed effects Logit models. The estimation with random effects is explained first. Using five waves of panel data, I regress the ownership of a certain category of assets (0 or 1 binary variable) on several factors such as age, the frequency of drinking alcohol, numeracy and other characteristics for household i at time t for seven times on different categories:

$$y_{jit}^{*} = \beta_0 + \beta_1' X_{it} + \gamma_t + \alpha_i + \varepsilon_{it} \tag{1}$$

Where $The\ ownership\ of\ a\ certain\ category\ of\ assets_{jit}$ is 0 if $y_{jit}^{*} \leq 0$, which means that household i does not own a certain type of assets at time t; $The\ ownership\ of\ a\ certain\ category\ of\ assets_{jit}$ equals 1 if $y_{jit}^{*} > 0$, which suggests household i owns a certain type of assets at time t. X_{it} is a vector of explanatory variables (c.f. specification in the section Results) and γ_t are wave dummies. The unobserved characteristics go into α_i and ε_{it}. For random effects specifically, it is assumed that α_i is normally distributed and independent of X_{it} and ε_{it}. As for ε_{it}, it is assumed that ε_{it} follows a logistic distribution and is independent of X_{it}. Then random effects Logit model can be run in Stata using the multiple imputation commands; estimation is done by maximum likelihood methods while taking into account the imputations.

In the second estimation, household fixed effects are taken into account and the model is as follows:

$$y_{jit}^{*} = \beta_0 + \beta_1' X_{it} + \alpha_i + \varepsilon_{it} \tag{2}$$

Here, α_i captures household fixed effects and the rest is similar to the random effects model. Note that wave dummies are excluded because of the collinear relationship between one of independent variables, age, and the time between the waves. The method used is Conditional Maximum likelihood (Chamberlain,1980).

3.2 Results of Logit models

Table 2 contains results of random effects Logit models regarding ownership rates of seven different asset categories. In these regressions, it is assumed that ownership rates depend on the following variables: country dummies, indicators of household endowments (log form of household income, log form of household net worth), number of children, a dummy for education level, wave dummies, gender, a dummy for couples, three indicators of cognitive abilities (numeracy score, fluency score and self rated reading score), indicators of behavioral risks (frequency to consume alcohol, frequency to do vigorous activities or sports, ever smoke before, smoke currently or not, years of smoking), a dummy for widowers, age and age square. Due to limited space, Table 2 only reports part of the regression's results but full results are available on request.

Firstly we take a look at country dummies. Estimates show that Germany, Denmark, Sweden, Spain and Italy are significantly different from Netherlands with respect to most of asset categories. For an average household, compared with Dutch older households, the probabilities of owning bank accounts, cars, main residence and long-term savings are significantly lower for German older households, although differences are subtle. The biggest difference is in owning long-term savings. German older households' probability of holding savings for long term is 0.222*0.44 *(1-0.44) =0.055, or 5.5% lower than for the elderly in Netherlands, in which 0.44 is the mean value of ownership rates of savings for long term in the sample (these and all other results are ceteris paribus). However, German old people have significantly higher probabilities owning other real estate and risky financial assets. As for Danish older households, all seven categories are significantly different from old people in Netherlands, and most of the differences are much bigger than those for German older households. For instance, in Denmark old people are 53.38% (same method of calculating the marginal effect as before) more likely to hold risky financial assets and 53.46% more likely to own their homes. In Sweden older households are significantly different from Dutch ones in all but two of the asset categories, Bank accounts and Savings for long term. Just like in Denmark, old people in Sweden have a lot higher chances of holding risky financial assets and approximately 50% higher probabilities of owning homes. When it comes to southern Europe countries Spain and Italy, almost all asset categories are significant except for cars in Italy. Spain's and Italy's older households are both much less likely to own savings for long term compared to Dutch ones. However, they are much more likely to own their homes than for Dutch older households.

Secondly, with respect to variables capturing patterns of ageing effects, both age and age square are significant in six asset categories except for Bank accounts. As in the discussion above about Figure 6, asset holdings seem to follow a quadratic pattern of age in several cases, which are mostly confirmed here by precise estimation. For Cars, Main residence, Other real estate and Business, marginal effects of age square are negative while marginal effects of age is positive, which are exactly consistent with graphs in Figure 6. Regarding Savings for long term, we can see the corresponding graph in Figure 6 is not likely to be the graph of a quadratic function. And in the regression result, age term is significantly negative while age square term is slightly positive. For example, if someone is one year older, the probability of holding savings for long term decreases by 6.25% but the probability of owning risky financial assets is 1.72% higher, which may be the result of survivorship bias. All in all, ageing effects are captured quite well in this model, assuming there are no cohort and time effects.

Thirdly, considering behavioral risks including drinking smoking and vigorous activities, the results are as follows. The frequency to drink alcohol is significant in all seven regressions at 1% confidence level and mean marginal effects are all negative. It means if the frequency of consuming alcohol increases by 1 unit, all probabilities of holding the seven asset types decrease. In other words, if older households drink less often alcohol per week, probabilities of owning these assets decrease. This is an interesting result, and reasons could be that drinking more frequently increases probabilities of having more social connections, as social activities are shown to be positively related to owning more stocks (Christelis, Jappelli and Padula, 2010). Looking at the frequency of doing vigorous sports or activities, patterns are similar to the effect of alcohol consumption. All marginal effects are slightly negative and only the effect on bank accounts is not significant. So if the old people do less often vigorous activities per week, probabilities of having positive asset holdings will decrease. This could also be explained by the reason of social interactions. The strongest marginal effect is on the main residence: if VigSport increases 1 unit, probability to own homes decreases by 3.69%. When we look at smoking indicators, they are less significant overall among the seven regressions. If the old people smoked in the past but are not smoking now, probabilities of holding bank accounts, cars, risky financial assets and savings for long term are significantly higher (2.22%, 11.3%, 4.2% and 4.98% respectively) than for the people who never smoked. If one smokes at present, then the marginal effect of smoking is the sum of marginal effects of eSmoked and SmokeNow. Among the seven regressions, effects on owning bank accounts, cars, risky financial assets and savings for long term are significant. If someone smokes now, probabilities of owning cars and savings for long term increase by 2.74% and 1.13% respectively, yet probability of owning risky financial assets decreases by 3.9%. The last indicator years of smoking is significantly negatively associated with ownership rates of main residence and savings for long term, but marginal effects are small. Overall, patterns of behavioral risks seem to be not very consistent with past literature in this random effects Logit model.

Fourthly, estimates show that three indicators of cognitive abilities are highly significant with respect to ownership rates of several asset categories. Marginal effects of numeracy are all positive on seven asset categories. For example, when numeracy increases by 1 unit, the probability of owning cars increases by 8.27% and the probability of owning risky financial assets increases by 5.43%. Reading levels are significant in four asset categories and marginal effects are almost as big as numeracy scores. When self rated reading level gets 1 level worse, the probability of owning risky assets decreases by 5.06%. Fluency scores are mostly significant except for Savings for long term, but marginal effects are much smaller than the other two indicators, probably because it is less related to make financial decisions. If fluency score increases by one unit, the probability of owning risky financial assets increases by 0.44% points.

Wave dummies are significant in most regressions. In particular, in wave 2, the probability of owning risky financial assets is 3.36% lower than in wave 1. And in wave 4, compared to wave 1, the old people are 5.83% less likely to hold risky financial assets. Finally the older households in wave 5 are about 20% less likely to own risky financial assets. As for main residence, trends are opposite. The old people in wave 2, wave 4 and wave 5 are more likely to have homes than in wave 1.

Other control variables such as log form of income, log form of net worth, health, a dummy variable of couple, a dummy variable of gender and a dummy for higher educated are significant in most regressions. A dummy for widowhood is only significant for owning main residence and business but marginal effects are largely positive.

Results of fixed effects Logit models for ownership of the seven different asset categories are displayed in Table 3. Each regression has been run seven times, and in brackets Z scores are reported. I assume that ownership rates depend on the following variables: indicators of household endowments (log form of household income, log form of household net worth), a dummy for couples, a dummy for experiencing widowhood shocks, a dummy for experiencing separation shocks, self-perceived health status, two indicators of cognitive abilities (numeracy score and fluency score), indicators of behavioral risks (frequency to consume alcohol, frequency to do vigorous activities or sports, start smoking and stop smoking), age and age squared.

The interpretation of the results from the fixed effects model must be done with care, because the regression includes the household fixed characteristics. Therefore, only effects of changes in the variable values can be evaluated, which is often even more interesting. I will briefly describe some of the most interesting results.

Firstly, the ageing effects are strongest for car ownership. Let's have a look at certain stages of ageing. When the household age is 50, the probability of owning a car is predicted to increase by a little over 3% per year, which goes down to a negligible 0.04% when the age is 60. As expected, the effect turns negative for older households, implying a decrease in the car ownership probability of about 4.5% when the household age is 75.

Secondly, an increase of the alcohol frequency is associated with a positive effect on the ownership of all asset categories, albeit insignificant except for bank accounts. The strongest effect is on car ownership, where drinking alcohol one more day per week increases the ownership probability by approximately

2%. The coefficient for vigorous sports is significant at the 5% confidence level for car and other real estate ownership, and their signs are negative. This implies that, for example, a change from doing vigorous activities more than once a week to once a week decreases the other real estate ownership probability by almost 2%.

As for smoking, most of the coefficients are not significant. Only for owning risky financial assets, starting to smoke is significant at the 0.05 confidence level, implying a decrease of ownership probability of about 17%. The reason of the insignificance is likely to be a result of a very limited number of people who started or stopped smoking, and changed their ownership in the same or later periods in our sample.

Looking at the cognitive abilities, the numeracy coefficient is not significantly for any asset category. The coefficients are also small and both positive and negative. As reading is excluded from the fixed effects model because it is only asked once, the only remaining variable for cognitive abilities is the fluency score. Similar to the indicator numeracy, the coefficients of fluency are both positive and negative. They are also insignificant at except for savings for long-term investment, which is just significant at the 5% confidence level. The implication is relatively weak: if one is able to say five less animals within a minute, its ownership probability is expected to decrease by 1.9%. Also note that for the cognitive abilities, there are 14 coefficients and only one of them significant at the 5% confidence level can simply be explained as being random.

The other variables are the control variables for income, net worth, health and the widow and separation shocks. Only the coefficients for the log of net worth are all highly significant. The insignificance of variables like WidowShock may be explained by the small sample, but it somehow makes sense that the separation shock is more significant for car and business ownership; when a couple separates, the assets are divided between the partners, but when one becomes a widow the assets remain largely in the household. Widowers may need more time to reallocate their assets.

Table 2. Random effects static Logit model on asset ownership

Variable	Bank accounts	Cars	Main residence	Other real estate	Business	Risky financial assets	Savings for long-term
Germany	-0,306	-0,476	-0,803	1,997	-0,397	0,874	-0,901
	(-2,50)*	(-2,82)**	(-4,53)**	(13,13)**	(-1,78)	(9,17)**	(-12,42)**
Denmark	-0,504	-0,749	2,640	3,068	0,618	2,29	-1,142
	(-4,15)**	(-4,25)**	(12,82)**	(19,27)**	(2,60)**	(21,53)**	(-14,85)**
Sweden	-0,178	0,389	2,483	4,244	1,898	3,725	-0,017
	(-1,45)	(2,23)*	(11,80)**	(25,73)**	(7,51)**	(33,44)**	(-0,24)
Spain	-1,059	-2,303	6,304	3,314	4,614	-0,884	-2,892
	(-8,86)**	(-12,49)**	(18,05)**	(18,88)**	(12,97)**	(-6,48)**	(-24,96)**
Italy	-2,354	-0,318	3,731	3,418	3,443	0,601	-4,212
	(-20,08)**	(-1,72)	(15,12)**	(19,71)**	(10,97)**	(5,03)**	(-25,53)**
Age	-0,010	0,715	0,362	0,078	0,258	0,074	-0,256
	(-0,29)	(12,91)**	(6,04)**	(1,84)	(3,61)**	(2,41)*	(-10,28)**
Age^2	0,000	-0,006	-0,003	-0,001	-0,003	0	0,001
	(0,09)	(-15,60)**	(-7,02)**	(-2,25)*	(-5,70)**	(-2,09)*	(6,42)**
Widow	0,085	0,239	0,957	-0,057	0,942	0,179	0,050
	(0,90)	(1,62)	(5,06)**	(-0,41)	(4,76)**	-1,84	(0,70)
Numeracy	0,102	0,430	0,123	0,043	0,321	0,233	0,013
	(3,32)**	(9,02)**	(2,19)*	(1,15)	(4,64)**	(8,42)**	(0,57)
Fluency	0,012	0,041	0,019	0,020	0,061	0,019	0,004
	(2,42)*	(6,37)**	(2,54)*	(4,16)**	(5,71)**	(4,61)**	(1,54)
Reading	-0,132	-0,490	0,053	-0,076	-0,127	-0,217	-0,090
	(-4,39)**	(-9,51)**	(0,87)	(-1,86)	(-1,71)	(-7,38)**	(-4,14)**
HigherEdu	0,183	0,207	0,329	0,219	0,418	0,389	0,425
	(2,56)*	(2,10)*	(2,78)**	(2,87)**	(2,77)**	(6,97)**	(9,67)**
AlcFreq	-0,065	-0,104	-0,100	-0,089	-0,098	-0,122	-0,044
	(-4,88)**	(-5,32)**	(-3,96)**	(-5,57)**	(-3,09)**	(-9,93)**	(-3,99)**
VigSport	-0,007	-0,179	-0,182	-0,069	-0,273	-0,066	-0,044
	(-0,28)	(-5,73)**	(-5,00)**	(-2,88)**	(-5,38)**	(-3,60)**	(-3,05)**
eSmoked	0,364	0,588	-0,131	0,170	0,112	0,18	0,202
	(3,35)**	(3,62)**	(-0,71)	(1,46)	(0,46)	(2,11)*	(3,05)**
SmokeNow	-0,272	-0,445	-0,402	-0,194	-0,420	-0,348	-0,156
	(-2,78)**	(-3,30)**	(-2,46)*	(-1,80)	(-2,04)*	(-3,88)**	(-2,47)*
ySmoked	0,001	-0,008	-0,021	-0,003	-0,006	-0,004	-0,006
	(0,42)	(-1,81)	(-3,92)**	(-0,96)	(-0,92)	(-1,50)	(-2,97)**
#obs.	35526	35526	35526	35526	35526	35526	35526

Note: All regressions also include some other control variables including logIncome, logNetw, nChild, Health, Gender, Couple (Please check Table.1 for detailed descriptions). Z scores are presented in brackets. * $p<0.05$; ** $p<0.01$

Table 3. Fixed effects Logit model on asset ownership

Variable	Bank accounts	Cars	Main residence	Other real estate	Own business	Risky financial assets	Savings for long-term
Age	0.347	0.970	1.368	-0.227	0.494	0.053	-0.156
	(1.75)	(4.42)**	(4.74)**	(1.38)	(1.25)	(0.45)	(1.53)
Age2	-0.002	-0.008	-0.010	0.001	-0.005	-0.001	0.002
	(1.10)	(5.17)**	(4.91)**	(1.21)	(1.84)	(1.42)	(2.12)*
Widowshock	-0.340	0.039	0.108	0.282	1.026	-0.166	-0.081
	(0.68)	(0.08)	(0.16)	(0.57)	(0.94)	(0.48)	(0.32)
Sepshock	-0.081	-1.186	0.211	-0.362	-1.855	0.015	-0.137
	(0.23)	(3.02)**	(0.44)	(0.96)	(2.79)**	(0.06)	(0.69)
Numeracy	-0.372	0.074	-0.207	-0.083	0.181	-0.127	0.002
	(0.81)	(0.18)	(0.45)	(0.28)	(0.24)	(0.49)	(0.01)
Fluency	-0.018	0.015	0.005	0.003	-0.017	0.003	-0.015
	(1.29)	(0.87)	(0.25)	(0.28)	(0.55)	(0.31)	(2.07)*
AlcFreq	-0.167	-0.109	-0.009	-0.076	-0.070	-0.056	-0.053
	(3.48)**	(1.71)	(0.10)	(1.84)	(0.58)	(1.56)	(1.65)
VigSport	-0.047	-0.160	0.026	-0.118	-0.084	0.030	0.044
	(0.67)	(2.02)*	(0.29)	(2.09)*	(0.57)	(0.72)	(1.32)
StartSmoke	-0.401	0.435	0.891	0.645	-0.959	-0.742	-0.206
	(0.62)	(0.72)	(1.07)	(1.40)	(0.75)	(2.00)*	(0.70)
StopSmoke	-0.058	0.281	0.584	0.304	0.591	0.000	-0.168
	(0.16)	(0.70)	(1.32)	(0.98)	(0.77)	(0.00)	(0.93)
LogIncome	0.180	-0.027	-0.018	0.076	-0.207	0.127	0.001
	(3.71)**	(0.42)	(0.18)	(1.51)	(1.49)	(2.21)*	(0.03)
LogNetw	0.236	0.130	0.964	0.833	0.604	0.216	0.153
	(6.87)**	(2.92)**	(9.17)**	(9.42)**	(6.33)**	(5.94)**	(5.89)**
Health	0.006	-0.214	0.126	-0.122	-0.180	-0.070	0.019
	(0.06)	(1.88)	(0.91)	(1.52)	(0.83)	(1.16)	(0.39)
N	1091	1006	986	1703	563	2685	3717

Z scores are presented in brackets. * p<0.05; ** p<0.01

In order to test whether fixed effects or random effects models fit better, Hausman tests are adopted. The null hypothesis is that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. The alternative hypothesis is that the coefficients estimated by the efficient random effects estimator are not the same as the ones estimated by the consistent fixed effects estimator. If Prob>chi2 is smaller than 0.05, p-value is significant at 5% confidence level, then fixed effects estimator should be used. The table before is the test statistics and p-value for seven regressions. They indicate that in all seven regressions using multiple imputed data, fixed effects Logit models fit better than random effects Logit models.

Table 4. Hausman tests results

	chi2(9)	p-value
Bank accounts	47.74	0.0000
Cars	73.91	0.0000
Main residence	78.31	0.0000
Other real estate	89.35	0.0000
Business	45.68	0.0000
Risky financial assets	155.82	0.0000
Savings for long term	274.23	0.0000

3.3 Shares of asset holdings estimated by Tobit models

Apart from ownership rates of different asset types, shares of holding a certain type of assets are also interesting and important to study. In this thesis, Tobit models are adopted to estimate shares of holding seven asset categories on a list of demographic variables. As in the last section, fixed effects and random effects models are both estimated. The estimation method is maximum likelihood.

The random effects Tobit model is as following:

$$y_{jit}^{*} = \beta_0 + \beta_1' X_{it} + \gamma_t + \alpha_i + \varepsilon_{it} \tag{3}$$

Where $Shares\ of\ a\ certain\ category\ of\ assets_{jit}$ is 0 if $y_{jit}^{*} \leq 0$, which means the household i does not own a certain type of assets at time t; $Shares\ of\ a\ certain\ category\ of\ assets_{jit}$ equals y_{jit}^{*} if

$y_{jit}^{*} \geq 0$, which is the real shares of owning a certain type of assets at time t for household i . ε_{it} is assumed to be normally distributed, independent of each other and independent of explanatory variables. α_i is assumed to be normally distributed, independent of explanatory variables and independent of ε_{it}. γ_t are wave dummies.

The fixed effects Tobit model is as following:

$$y_{jit}^{*} = \beta_0 + \beta_1' X_{it} + \alpha_i + \varepsilon_{it} \tag{4}$$

Where $Shares\ of\ a\ certain\ category\ of\ assets_{jit}$ is 0 if $y_{jit}^{*} \leq 0$, which means the household i does not own a certain type of assets at time; $Shares\ of\ a\ certain\ category\ of\ assets_{jit}$ equals y_{jit}^{*} if $y_{jit}^{*} \geq 0$, which is the real shares of owning a certain type of assets at time t for household i . ε_{it} is assumed to be normally distributed, independent of each other and independent of explanatory variables. α_i captures household fixed effects.

3.4 Results of Tobit models

In the first estimation of Tobit model, I run random effects Tobit models for seven times. Explanatory variables include country dummies, indicators of household endowments (log form of household income, log form of household net worth), number of children, a dummy for education level, wave dummies, gender, a dummy for couples, three indicators of cognitive abilities (numeracy score, fluency score and self-rated reading score), indicators of behavioral risks (frequency to consume alcohol, frequency to do vigorous activities or sports, ever smoke before, smoke currently or not, years of smoking), a dummy for widowers, age and age square. Due to limited space, Table 5 only reports part of the regression's results but full results are available by request. Marginal effects of Tobit models in this thesis are calculated by multiplying coefficients by the probability of owning a certain type of assets.

Firstly, country dummies are highly significant in these estimations. German older households' asset allocation strategy is similar to that of Dutch older households. Compared to older households in Netherlands, on average German old people have around 3% lower shares in bank accounts and main residence, which are the biggest differences among seven asset categories. As for Denmark old people, shares in risky financial assets are 1.55% significantly higher but shares in bank accounts are 7.11% significantly lower. When it comes to Sweden, shares in seven asset categories are significantly different from those in Netherlands. Shares in bank account are 9.16% significantly lower than the mean value in Netherlands again. Yet shares in risky financial assets are 2.52% higher than Dutch old people at 1% confidence level. As for Spain's older households, differences are obvious with respect to bank accounts and main residence. On average Spain old people holds 16.92% fewer shares in bank accounts than Dutch old people do. However, Spain older households own 16.8% more shares in their homes than Dutch older households do. Finally, results of Italian elderly are similar to those of Spanish elderly. Bank accounts' shares owned by Italian older households are 15.15% lower than those of Dutch older households, yet main residence's shares are 13% higher.

With respect to ageing effects, both age and age square variables are quite significant. Variable age square's coefficients are very small, and when I take three decimal places, they are all zero. Marginal effects of ageing on asset shares are calculated as following: $\beta_{age} \times p_{(asset\ shares>0)} + 2 \times \beta_{age^2} \times p_{(asset\ shares>0)}$.

Next, indicators of cognitive abilities are significant in several regressions. When numeracy scores increases 1 unit, shares of risky financial asset increase 0.19% on average. The effect of fluency scores is also significant at 5% confidence level though it is very small. Reading scores are also significant but the effect on shares of risky financial assets are slightly negative, which is not expected. But considering all three indicators, the overall effect on shares of risky financial assets is still positive. Also, the overall effect on shares of main residence is also positive.

Thirdly, marginal effects of behavioral risks' indicators are quite small by and large. Marginal effects of the frequency of drinking alcohol are negative on shares of other real estate and shares of financial risky assets, which means if someone drinks more often, he or she on average own more shares of risky financial and real assets. The effect of the frequency of doing vigorous activities and sports on the main residence is significantly negative. If the old turn to do less vigorous activities or sports, they will on average have 0.22% fewer asset shares in the main residence. Smoking variables again are not very significant. And years of smoking seem to do not influence asset shares much.

Finally, other control variables are mostly significant as well. In random effects Tobit models fractions of unsystematic variance ρ are between 30% and 60% in different regressions. So large fractions are explained by individual effects, and pooled regressions are not wise choices.

Results of fixed effects Tobit models are presented in Table 6. In fixed effects Tobit models, the author includes the following variables in regressions: indicators of household endowments (log form of household income, log form of household net worth), two indicators of cognitive abilities (numeracy score and fluency score), indicators of behavioral risks (frequency to consume alcohol, frequency to do vigorous activities or sports, a dummy for starting smoking and a dummy for stopping smoking), age and age squared. Widow and separation shocks are not included as they all turned out to be insignificant. Marginal effects of fixed effects Tobit models are calculated the same as in random effects Tobit models.

Table 5. Random effects static Tobit model on asset shares

Variable	Bank accounts	Cars	Main Residence	Other real estate	Business	Risky financial assets	Savings for long-term investment
Germany	-0.039	0.014	-0.045	0.031	0.000	0.020	0.017
	(7.48)**	(3.86)**	(5.93)**	(8.75)**	(0.08)	(7.13)**	(4.71)**
Denmark	-0.076	-0.036	-0.003	0.049	0.014	0.042	0.010
	(13.83)**	(9.70)**	(0.35)	(13.25)**	(6.81)**	(14.34)**	(2.75)**
Sweden	-0.098	-0.030	-0.036	0.076	0.014	0.068	0.009
	(18.49)**	(8.23)**	(4.67)**	(21.40)**	(7.11)**	(24.09)**	(2.44)*
Spain	-0.181	-0.032	0.234	0.071	-0.003	-0.008	-0.070
	(30.34)**	(7.80)**	(27.43)**	(17.78)**	(1.55)	(2.41)*	(16.87)**
Italy	-0.162	-0.004	0.181	0.068	-0.002	0.008	-0.080
	(26.78)**	(0.93)	(20.96)**	(16.92)**	(0.80)	(2.53)*	(19.26)**
Age	-0.002	0.006	0.011	0.001	-0.004	0.003	-0.016
	(1.30)	(5.36)**	(5.06)**	(0.90)	(5.88)**	(3.47)**	(13.14)**
Age^2	0.000	-0.000	-0.000	-0.000	0.000	-0.000	0.000
	(4.40)**	(6.62)**	(5.16)**	(1.15)	(4.31)**	(1.80)	(10.09)**
Widow	-0.011	-0.007	0.029	-0.001	-0.000	0.002	-0.011
	(2.08)*	(2.02)*	(3.86)**	(0.31)	(0.03)	(0.78)	(2.84)**
Numeracy	-0.002	0.002	-0.003	0.001	0.001	0.005	-0.003
	(1.42)	(1.90)	(1.59)	(1.20)	(1.43)	(6.51)**	(2.79)**
Fluency	-0.001	0.000	-0.000	0.000	0.000	0.000	-0.000
	(3.80)**	(2.55)*	(0.40)	(3.39)**	(1.67)	(2.54)*	(1.03)
Reading	0.001	-0.003	0.007	-0.002	0.002	-0.004	-0.001
	(0.45)	(2.87)**	(2.82)**	(1.84)	(2.89)**	(4.52)**	(0.80)
AlcFreq	0.001	0.001	0.000	-0.002	0.000	-0.002	0.001
	(1.65)	(2.84)**	(0.22)	(4.29)**	(1.25)	(4.45)**	(1.73)
VigSport	0.007	-0.000	-0.003	-0.001	-0.001	-0.000	-0.001
	(7.05)**	(0.35)	(2.51)*	(1.61)	(2.39)*	(0.13)	(1.47)
eSmoked	-0.006	0.003	-0.006	0.005	-0.002	0.003	0.004
	(1.23)	(0.79)	(0.87)	(1.49)	(1.04)	(0.94)	(1.26)
SmokeNow	0.009	0.005	-0.015	-0.003	0.001	-0.002	0.002
	(1.99)*	(1.78)	(2.54)*	(1.06)	(0.51)	(0.97)	(0.58)
ySmoked	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(2.81)**	(1.59)	(2.17)*	(0.19)	(0.49)	(1.20)	(0.34)
sigma_u	0.165	0.114	0.268	0.109	0.057	0.079	0.097
	(97.94)**	(99.12)**	(132.92)**	(102.41)**	(78.52)**	(89.78)**	(66.35)**
sigma_e	0.177	0.118	0.204	0.120	0.074	0.105	0.145
	(168.24)**	(165.22)**	(167.26)**	(175.45)**	(167.81)**	(185.73)**	(170.98)**
N	34989	34989	34989	34989	34989	34989	34989

. Note: All regressions also include other control variables, namely logIncome, logNetw, nChild, Health, Gender, Couple and HigherEdu (please check Table.1 for detailed descriptions).

Z-scores are presented in brackets.

* *p*<0.05; ** *p*<0.01

Table 6. Fixed effects Tobit model on asset shares

Variable	Bank accounts	Cars	Main Residence	Other real estate	Business	Risky financial assets	Savings for long-term investment
Age	-0.004	0.417	0.274	0.283	-0.301	0.143	-0.454
	(2.06)*	(2.70)**	(8.03)**	(4.30)**	(1.03)	(1.80)	(2.44)*
Age2	0.000	-0.033	-0.020	-0.020	0.010	-0.005	0.022
	(11.47)**	(2.81)**	(8.00)**	(3.67)**	(0.42)	(0.81)	(1.80)
Numeracy	0.026	0.026	-0.038	-0.012	0.004	0.037	0.018
	(9.63)**	(2.60)**	(7.88)**	(4.94)**	(0.54)	(6.49)**	(1.83)
Fluency	0.002	0.000	-0.005	0.002	0.006	0.005	0.004
	(5.39)**	(0.31)	(9.56)**	(55.52)**	(27.83)**	(7.24)**	(4.09)**
AlcFreq	0.002	-0.001	0.002	-0.003	0.020	-0.007	0.004
	(0.74)	(0.27)	(6.87)**	(10.46)**	(185.53)**	(2.46)*	(1.25)
VigSport	-0.001	-0.004	0.005	0.003	-0.010	0.005	-0.014
	(0.18)	(0.75)	(3.60)**	(1.88)	(82.84)**	(0.99)	(7.82)**
StartSmoke	0.004	0.000	0.001	-0.029	-0.008	-0.022	0.063
	(11.99)**	(0.04)	(0.07)	(2.01)*	(0.33)	(4.83)**	(1.82)
StopSmoke	0.004	-0.032	0.001	0.084	-0.020	-0.026	-0.049
	(15.20)**	(1.55)	(0.07)	(17.39)**	(0.30)	(1.33)	(1.65)
LogIncome	0.030	0.009	-0.040	0.011	0.025	0.063	0.036
	(10.24)**	(3.43)**	(22.97)**	(2.27)*	(1.47)	(15.83)**	(19.43)**
LogNetw	-0.121	-0.121	0.096	0.123	0.215	0.014	-0.027
	(34.82)**	(10.00)**	(3.21)**	(21.71)**	(41.33)**	(10.97)**	(2.69)**
Health	-0.001	-0.002	0.013	-0.012	0.006	-0.018	-0.002
	(6.07)**	(2.54)*	(4.20)**	(4.24)**	(0.69)	(2.99)**	(0.52)
N	15131	15131	15131	15131	15131	15131	15131

Z-scores are presented in brackets. * *p*<0.05; ** *p*<0.01

Firstly, ageing effects on asset shares are mostly significant and follow a quadratic form. Coefficients of age squared are very slightly negative and most coefficients of age are positive among these regressions, which is very reasonable. They are significant in asset shares in bank accounts, cars, main residence and other real estate.

Secondly, two indicators of cognitive abilities are highly significant in five out of seven regressions. For example, one unit increase in numeracy score will significantly increase shares in risky financial assets by about 1.4% at 1% confidence level. One unit higher in fluency score will significantly increase shares in risky financial assets by approximately 0.2% at 1% confidence level. Moreover, they both have positive marginal effects on savings for long term as well and both are significant at 1% confidence level. However, as for effects on shares of main residence, both numeracy and fluency scores have negative marginal effects. So we can see cognitive abilities have different influences on shares of different assets.

Thirdly, regarding indicators of behavioral risks, they are again not all significant but already show some patterns. For the frequency to drink alcohol, if someone drinks less often, the expected fraction of risky financial assets and other real estate will be slightly lower, which are consistent with results in random effects Tobit models. Other results are not significant. Doing vigorous sports or activities less frequently will significantly negatively (0.6%) influence savings for long term. The variable start smoking is only significant at the 1% confidence level for bank account and risky financial assets, but the effects are relatively small; only an expected decrease of 0.8% is seen for risky assets. Stopping smoking is also significant at the 1% confidence level for bank account and for other real estate, but not for other asset categories. Stopping to smoke is associated with an increase of almost 0.4% in the bank accounts.

Other control variables are quite significant and overall, the strongest one coming from the net worth, which has the strongest effect on bank accounts.

3.5 Robust checks

Lastly, robust checks are conducted to confirm the findings in this thesis. The idea is to include more explanatory variables in both Logit and Tobit regressions and to see if results are different from original ones. In order to keep my thesis concise, the check is only performed for the effect on ownership rates and fractions of holding risky financial assets for the random effect models. Indeed, both ownership of risky financial assets and fractions they constitute in portfolios are most interesting and show some patterns which can be explained by these models.

The first variable to include is financial hardship, which is not included in the main models of this thesis because the related question only appears in wave 3, and not all households participating in SHARE appear in it. The results are shown below:

Table 7. Robust check: include extra variables for asset holdings of risky financial assets

Variable	Ownership (Logit)			Shares (Tobit)		
Germany	0.874	1.069	0.333	0.020	0.021	0.012
	(9.17)**	(7.37)**	(2.39)*	(7.13)**	(4.28)**	(2.50)**
Denmark	2.29	2.497	2.120	0.042	0.046	0.044
	(21.53)**	(17.49)**	(13.01)**	(14.34)**	(10.27)**	(9.12)**
Sweden	3.725	4.006	3.927	0.068	0.074	0.073
	(33.44)**	(25.04)**	(20.89)**	(24.09)**	(15.91)**	(16.24)**
Spain	-0.884	-0.911	-0.993	-0.008	-0.014	-0.015
	(6.48)**	(4.11)**	(3.68)**	(2.41)*	(2.46)*	(2.63)*
Italy	0.601	0.551	-0.228	0.008	0.006	-0.002
	(5.03)**	(3.35)**	(1.13)**	(2.53)*	(1.12)	(0.42)
Age	0.074	0.061	0.121	0.003	0.007	0.024
	(2.41)*	(1.22)	(2.34)	(3.47)**	(4.56)**	(1.41)
Age^2	-0.000	-0.000	-0.001	-0.000	-0.000	-0.000
	(2.09)*	(1.20)	(2.36)*	(1.80)	(3.43)**	(0.31)
Widow	0.179	0.349	0.299	0.002	0.009	0.002
	(1.84)	(2.37)*	(1.95)*	(0.78)	(1.85)	(0.35)
Numeracy	0.233	0.200	0.202	0.005	0.005	0.006
	(8.42)**	(5.07)**	(4.92)**	(6.51)**	(3.58)**	(4.63)**
Fluency	0.019	0.024	0.025	0.000	0.000	0.000
	(4.61)**	(4.52)**	(4.11)**	(2.54)*	(2.02)*	(1.81)
Reading	-0.217	-0.234	-0.202	-0.004	-0.003	-0.005
	(7.38)**	(5.14)**	(4.27)**	(4.52)**	(1.85)	(3.37)
AlcFreq	-0.122	-0.117	-0.109	-0.002	-0.001	-0.002
	(9.93)**	(6.49)**	(5.49)**	(4.45)**	(2.38)*	(3.18)**
VigSport	-0.066	-0.042	-0.102	-0.000	-0.001	-0.001
	(3.60)**	(1.73)	(3.45)**	(0.13)	(0.78)	(0.78)
eSmoked	0.18	0.306	0.110	0.003	0.006	-0.002
	(2.11)*	(2.28)*	(0.76)	(0.94)	(1.29)	(0.32)
SmokeNow	-0.348	-0.382	-0.389	-0.002	0.000	-0.003
	(3.88)**	(3.22)**	(2.87)**	(0.97)	(0.03)	(0.67)
ySmoked	-0.004	-0.008	-0.003	-0.000	-0.000	-0.000
	(1.50)	(2.09)*	(0.64)	(1.20)	(1.70)	(0.07)
FinHardship		0.083			0.001	
		(3.71)**			(1.98)*	
BequestMot			0.009			-0.000
			(9.08)**			(1.12)*
N	35526	17845	14125	34989	17599	13795

Note: All regressions also include other control variables, namely logIncome, logNetw, nChild, Health, Gender, Couple, HigherEdu and wave dummies (Please check Table 1 for detailed descriptions). Z-scores are presented in brackets for the shares and t-statistics for the ownership. * $p<0.05$; ** $p<0.01$

The results in Table 7 show that the variable FinHardship and the variable BequestMot are significant at the 5% confidence level for the Tobit model and for the Logit model. However, most results are consistent with each other when we compare column 2 with column 3, as well as column 5 with column 6. As for Logit models, when financial hardship and bequest motives included in the regression, ageing variables are not significant anymore for Logit models yet coefficients of both age and age^2 are close to results of the model without the variable financial hardship. Similarly, the variable VigSport is not significant after adding the financial hardship variable, but coefficients are close to each other. The decrease in significance can be explained by the fewer amount of observations. Tobit models generate similar results. Thus, I conclude that findings of this thesis are robust to the check of adding the variable related to having experienced a period of financial hardship or not.

The second robust check is done by including the variable BequestMot, a variable meant to capture the bequest motive of respondents. Its value equals the participant's estimate of the probability of leaving an inheritance worth at least 50.000 euro. The reason to exclude it from the main models is that it only appears in wave 1 and 2, so the data from the last two waves can be used as well. The results are also shown in Table 6, in the fourth and seventh columns; again the newly added variable is significant at the 1% confidence level for the Logit model and significant at the 5% confidence level for the Tobit model. Moreover, the qualitative results are again largely the same, except for some country dummies. Italy changes sign and Germany's coefficient is clearly reduced, becoming less significant as well. From figure 5 it can be seen that the ownerships rates over the whole sample do not differ much between Netherlands and Italy, but the major Italian stock market index FTSE MIB kept finding new lows until 2012, while the Dutch AEX started to recover in 2009. It is therefore plausible that the change of sign is not due to the inclusion of the bequest motive variable, but simply because of exclusion of the data from wave 4 and 5. To see if this is the case, I also run the main models for only the observations from wave 1 and 2. I find the same qualitative results as the model including the bequest motive variable, with Italy's coefficients -0.004 (z-score 0.76) and -0.087 (t-statistic 0.44), and Germany's coefficients 0.369 (t-statistic 2.70) and 0.011 (z-score 2.36), for the Tobit and Logit random effects models, respectively. I conclude that the results found in this thesis are robust for the inclusion of this bequest motive variable as well.

4. DISCUSSION

In this thesis, several factors influencing wealth composition and portfolio choice of the elderly in six European countries are studied by adopting fixed effects and random effects Logit and Tobit models. The results may be increasingly meaningful for policymakers and the general public, because the population in Europe is ageing. The following are some discussions of results and conclusions for major findings, which are found to be robust.

To begin with, country effects are greatly significant among estimations. Several patterns of holding different assets could be found in different countries and some could be found even in different regions of Europe, which are consistent to the sample statistics and my hypothesis. The old in Denmark and Sweden are much more likely to hold risky financial assets, yet the fraction of holding them is not that much different overall. Main residence, however, are held a lot more in southern Europe countries Spain and Italy, both ownership rates and shares. Moreover, it seems that Dutch old people on average have more shares of bank accounts savings, and German older households come as the second.

Second, ageing shows some similar patterns in all regressions. The quadratic form fits quite well in all models, most of which are significant. Ageing variables in Logit models in general are more significant possibly because ownership rates are less influenced by other factors such as survivorship bias than the actual shares of holding a certain type of assets. Generally speaking, results indicate that ageing has a negative effect on asset holdings when they are very old. Strong evidences are shown for causal negative effect on ownership rates and shares of bank accounts savings and savings for long term, which are reasonable as people need to consume them when getting older. However, for risky financial assets, cars and homes, some marginal effects are positive, which may be explained by wealthier people tend to live longer and hey hold larger fractions of risky assets. The proxy for owning economic resources variable net worth may not fully capture the wealth effect.

Third, results of behavioral risks are not very significant, especially smoking variables. This may be due to some other variables are not accounted for completely, the negative health effect that smoking has which causes the opposite effect compared to risk aversion level, or simply there is not much relationship. Behavior risks factors are more significant in influencing asset shares than asset ownership rates: the older households who drink more often or do more vigorous activities seem to have higher asset shares; starting smoking has a causal negative effect on holding risky assets while stopping smoking has a causal positive effect on holding risky real asset (other real estate). Results of alcohol consuming frequency and vigorous sports frequency are different from my hypothesis but are quite significant, which may be the result of social interactions suggested in other papers. Further research is needed on this topic.

Finally, a strong positive relationship between cognitive abilities and both ownership rates and assets shares for risky financial assets are found. In fixed effect Tobit model, they are still significant at 1% confidence level, so causal effects can be concluded in shares of risky financial assets but not ownership rates.

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APPENDIX

Sample statistics

	Wave 1			Wave 2		
Variable	**Obs**	**Mean**	**Std.Dev.**	**Obs**	**Mean**	**Std.Dev**
Age	7731	66,27	10,03	7927	66,93	9,98
Age2	7731	4492,67	1370,36	7927	4579,37	1372,59
Gender	7732	0,48	0,50	7927	0,46	0,50
nChild	7732	2,05	1,45	7927	2,08	1,39
Bank account	4791	17121	85522	5554	19083	105468
Cars	6897	6639	39896	7177	6284	11411
Income	2958	32213	32603	3185	24179	25020
Net worth	3148	171383	569766	3504	217472	395832
Main residence	6990	150469	527038	7125	166979	366372
Other real estate	7445	24026	170074	7543	27700	112679
bond, stock, mutual fund	6186	11084	56589	6774	17740	103547
savings for long term inv.	5783	7099	36947	5944	12038	66510
Couple	7732	0,65	0,48	7927	0,66	0,47
Widow	7732	0,19	0,39	7927	0,18	0,39
Widow shock	7732	0,00	0,00	7927	0,02	0,14
Separation shock	7732	0,00	0,00	7927	0,01	0,08
Numeracy	7732	3,36	1,17	7927	3,46	1,17
Fluency	7591	18,98	7,45	7745	19,86	7,72
Reading	7732	2,35	1,14	7546	2,25	1,12
Higher education	7702	0,49	0,50	7902	0,53	0,50
self-reported health	7732	2,94	1,08	7927	3,02	1,13
Alcohol frequency	7622	4,32	2,23	7680	4,23	2,23
Vigorous sports	7622	2,54	1,35	7680	2,58	1,36
eSmoked	7732	0,52	0,50	7792	0,53	0,50
SmokeNow	7732	0,20	0,40	7767	0,19	0,39
ySmoked	7712	15,45	18,55	7784	16,52	19,26
StartSmoke	N/A			4589	0,04	0,20
StopSmoke	N/A			4589	0,04	0,21
BequestMot	7479	52,03	44,80	7540	53,67	44,03
Holland	1532	(# equal to 1)		1502	(# equal to 1)	

Germany	1588	(# equal to 1)	1396	(# equal to 1)
Denmark	1020	(# equal to 1)	1538	(# equal to 1)
Sweden	1840	(# equal to 1)	1720	(# equal to 1)
Spain	820	(# equal to 1)	706	(# equal to 1)
Italy	932	(# equal to 1)	1065	(# equal to 1)

	wave 4			**Wave 5**		
Variable	**Obs**	**Mean**	**Std,**	**Obs**	**Mean**	**Std.Dev**
Age	7174	68,71355	9,628904	14535	68,15445	9,981331
Age2	7174	4814,255	1352,601	14535	4744,65	1392,272
Gender	7174	0,463897	0,49873	14535	0,46818	0,499004
nChild	7174	2,107471	1,381912	14535	2,050292	1,353818
Bank account	4934	15705,31	25694,05	9442	14787,28	26278,34
Cars	6440	5220,266	6917,883	12896	5166,97	6820,617
Income	5998	24325,88	20066,45	12184	24938,21	23718,1
Net worth	7174	234634,8	368390,5	14535	238792,1	407332,5
Main residence	5904	162216	265004,1	11916	144551,2	294814,4
Other real estate	6796	28289,96	109097,7	13790	27281,57	102954,8
bond, stock, mutual fund	6195	10111,53	35390,63	12785	10065,09	43753,24
savings for long term inv.	4729	7944,39	33492,06	9406	11845,95	48091,68
Couple	7174	0,66741	0,471174	14535	0,655384	0,475259
Widow	7174	0,156398	0,363258	14535	0,160028	0,366644
Widow shock	7174	0,012824	0,112523	14535	0,016443	0,127176
Separation shock	7174	0,038751	0,193015	14535	0,027657	0,163995
Numeracy	7174	3,454698	1,135144	14535	3,461094	1,095977
Fluency	7174	19,0046	7,598352	14535	20,13203	7,778292
Reading	6870	2,326346	1,158833	14535	2,261369	1,138238
Higher education	7174	0,446473	0,497161	14535	0,545717	0,497923
self-reported health	7174	3,074157	1,12017	14535	3,029171	1,121724
Alcohol frequency	7163	4,280329	2,284288	14514	4,450462	2,184283
Vigorous sports	7163	2,643725	1,353101	14512	2,556712	1,35502
eSmoked	7174	0,537078	0,498658	14535	0,51407	0,499819
SmokeNow	7166	0,180017	0,384228	14527	0,156605	0,36344
ySmoked	7041	15,97017	19,13408	14182	14,49972	18,50448
StartSmoke	4918	0,050834	0,21968	6017	0,048529	0,214899
StopSmoke	4918	0,057137	0,232128	6017	0,067642	0,251151
BequestMot	N/A			N/A		
Holland	1509	(# equal to 1)		2331	(# equal to 1)	
Germany	829	(# equal to 1)		2945	(# equal to 1)	
Denmark	1234	(# equal to 1)		2360	(# equal to 1)	

Sweden	1186	(# equal to 1)	2813	(# equal to 1)
Spain	1165	(# equal to 1)	2401	(# equal to 1)
Italy	1251	(# equal to 1)	1685	(# equal to 1)