EKONOMIHÖGSKOLAN
Lunds universitet

Master Thesis

Health Effects on the Households' Stockholding Decisions

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Date: 2012-06-02

Abstract

This study investigates the relationship between health and households' decisions whether to participate in the stock market or not. We construct a set of health variables and out of these, we choose the most important health factors, such as self-assessed health, mobility limitations and mental health. To test empirically the hypothesis that healthier households are more likely to participate in the stock market than unhealthy ones, we adopt a probit model in which we control for the influences of wealth, age, gender, marital status, education as well as country effects. Obtained results are consistent with the theory of background risk and show that worsening of self-assessed health and an increase in the number of mobility limitations indeed lower the likelihood of households' stockholding. The estimated marginal effects of these factors provide us with an understanding of the magnitudes of these influences. In our work, we do not find any evidence that mental health affects the households' stockholding decisions.

Keywords: household portfolio choice, household stock market participation, health effects, background risk

Acknowledgements

We would like to thank our supervisors Hossein Asgharian and Frederik Lundtofte for their time and valuable input in this work.

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1. Introduction

Portfolio choice of an individual or household has been a subject of interest for finance researchers for at least five decades. In the early 1950s Markowitz formulated the mean-variance criterion for the construction of portfolio frontier and consequent construction of the set of efficient portfolios. Expected utility theory assumes the full specification of return distribution and complete information about individual's preferences, thus the optimal portfolio can be determined. The individual preferences can be affected by a wide range of factors such as income, age and gender. Consequently, these factors influence the choice of the optimal portfolio composition. The portfolio allocation problem implies the determination of the proportions of risky and safe assets, thus the decision of stockholding (stock market participation) is closely related to the portfolio composition. The availability of data and development of theories encourage researchers to conduct empirical studies and estimate the impacts of various factors on the individual and household's decisions on the stock market participation. Among other factors health and its effects on the portfolio allocation have gained increasing attention during recent years; however, the influences of this factor have not yet been fully studied.

It is difficult to overestimate the importance that health has in every aspect of a person's life. The choice of a profession, living and working places, daily habits as well as investment behavior are highly influenced by health. There are a wide range of theories and concepts that can provide explanations for why health factors affect portfolio choice. The life-cycle theory is useful in establishing the linkage between health and the evolution of consumption and saving patterns through the life span. Intuitively, health problems can affect the funds available for investing through costly medical care and through the decrease in income caused by the loss of working abilities. Hence, the deterioration of health changes

consumption and saving behaviour, which results in portfolio adjustments. The precautionary saving concept proposed by Kimball (1990, 1993) states that the presence of background risk, which can be related to health issues, under certain restrictions increases savings and causes portfolio reallocation. Thus, when the investor faces health risk and desires to keep the total risk exposure unchanged, under certain assumptions other types of risks must be reduced. Gollier and Pratt (1996) introduce the concept of risk vulnerability and define the conditions under which an individual becomes more risk averse while facing an unfair background risk factor that is associated with the lower share of risky assets in the models of portfolio choice. Edwards (2005, 2008) solves the multi-period model of portfolio allocation treating health as a background risk factor and shows that the share of risky assets is indeed lower for unhealthy individuals. Existing empirical studies prove that households' decisions on portfolio allocations are affected by the health condition as well. Hence health factors affect not only agents' behavior in daily life, but also investment decisions and attitudes towards risk. Therefore, the problem of portfolio allocation with respect to health factors is an interesting research area.

In our work we test the hypothesis that the probability of stockholding is higher for healthy households than for unhealthy ones. Our work contributes to the research on the relationship between health and portfolio choice and departs from previous studies in several ways. Firstly, previous studies of this problem are based mainly on the data from surveys in the USA or the first wave of Survey of Health, Ageing and Retirement in Europe (SHARE). However, in our study the latest data from the second wave of the SHARE is used. Secondly, based on the analysis of the correlation matrix of constructed health variables we choose the most important health factors. Thirdly, the approach of creating variables for the total and direct stock market participation differs from the approach previously used. Finally, the marginal effects of the health variables on the probability of stockownership are estimated.

The objective of this study is to evaluate the health effects on the household's stock market participation across fourteen European countries. To reach the objective and test the hypothesis, we apply the limited dependent variable model (probit) on a data set of constructed dependent and independent variables. The dependent variables are household's total and direct stockholding while the independent variables capture the household's health condition. The impact of the health factors on portfolio choice is evaluated, controlling for gender, age, wealth, education, marital status and country effects, since there is evidence that these factors can explain the cross-sectional variation in portfolio allocations as well.

The rest of the paper is organised in the following way. Chapter 2 provides a theoretical background as to why health can affect the decision to participate in the stock market. In Chapter 3, the findings of a number of studies devoted to the investigation of the relationship between health and portfolio allocation are discussed. The model used in the empirical estimations as well as the created data set is presented in Chapter 4. In this chapter, we discuss the methodology, construct dependent, independent and control variables, and motivate why the particular factors are included in the model. In Chapter 5, we summarize the descriptive statistics of the data and present the analysis of the obtained empirical results. The last section of the paper, Chapter 6, concludes the study and makes a number of suggestions for further research.

2. Theoretical foundations

Investment decisions and portfolio choice go hand in hand with consumption and saving patterns of individuals and households. Income level and consumption preferences determine how much to be saved, i.e. to be allocated in various financial and non-financial instruments. However, there are also other factors that may affect investment decisions, among them individual health. There are several theories that aim to explain why the portfolio composition is affected by the health factors and health shocks.

2.1. Life-cycle theory

The life-cycle theory describes how the patterns of consumption and savings evolve over a person's lifetime when she moves through the most significant age limits such as childhood, working age and retirement. Development of the life-cycle theory started in the first half of the 20th century with the ideas given by Fisher (1930) and Harrod (1948). In the fifties, more advanced studies on the linkages between the evolution of consumption, wealth and expectations of income were carried by Modigliani and Brumberg (1954), Friedman (1957) and Fisher (1956). However, the work of Modigliani and Brumberg focused more than the other two studies on the age factor.

The key idea is that the relationship between individuals' consumption needs and their income varies through the person's life span. For young people consumption exceeds income, since they have to obtain "starting" capital for education and housing. As a result they are not able to accumulate significant amount of funds. In the middle age individuals usually have stable income that is sufficient to satisfy their current needs and acquire saving accounts. Finally, it is usually expected that individuals use the accumulated capital to cover their living costs in the retirement.

Some empirical studies found results against the life-cycle hypothesis. It is stated that retirees continue to save after they leave labour market. Some possible motivations for such behaviour are mentioned by King (1985). One motivation is the change in risk aversion with age, since there can be an increase of uncertainty about the future. However, other empirical studies support the life-cycle theory and present evidences of portfolio reallocation towards less risky assets after reaching certain age. Another reason could be favourable pension systems in a range of western countries that provide retirees with income larger than consumption needs. On the other hand, if we treat pension accounts as a part of the total wealth of a retired individual, it is obvious that receiving pay-outs from these accounts can be considered as dissaving that is consistent with the life-cycle hypothesis. Finally, health factors, important for this paper, can be viewed twofold with respect to the life-cycle hypothesis. It is argued that when health deteriorates consumption decreases to the levels lower than income, thus savings increase. Conversely, an increase of out-of-pocket health expenditures in the retirement phase of the life encourages dissaving among individuals and households.

2.2. Precautionary saving

Another theoretical concept that describes consumption and saving behavior is the precautionary savings concept. The precautionary saving occurs when one faces uncertainty about future income. As it is stated, the precautionary motive leads to postponing of consumption in the case when insurance against the risk, causing income uncertainty, is not available. As a result, current consumption is reduced to secure resources for the case when a risk event is realized, thus consumption smoothing is observed. According to Carroll and Kimball (2006) risks that drive the precautionary motive are health risk, business risk, unavoidable expenditures, and risk of labor income change.

The theoretical background of this concept was developed by Leland (1968) and Sandmo (1970) who show that the positive third derivative of the utility function (thus, the function has convex marginal utility) indicates the precautionary saving motive implying that uncertainty about the future income forces an individual to reduce his current consumption and increase savings. Kimball (1990, 1993) extends the concept, defining three precautionary motives relevant to agent's demand for assets – prudence, temperance and precautionary demand for liquidity (a response to risk by holding liquid assets, for instance, money).

Firstly, using analogy to the Arrow-Pratt measure of absolute risk aversion, Kimball introduces the notion of prudence that forces an agent to accumulate more wealth as a response to risk. The researcher shows that the negative of the marginal utility function has the same implications for precautionary savings as the utility function does for absolute risk aversion. Therefore, concavity of the utility function u ($u''<0$) implies risk aversion, and concavity of $-u'(u'''>0)$ (or alternatively, convexity of the marginal utility function) indicates the positive precautionary saving motive. Further, the index of absolute prudence ($\eta(s)$) is introduced and it indicates the strength of the precautionary motive:

$$\eta(w,c) = \eta(s) = -\frac{\left(-u'(s)\right)''}{\left(-u'(s)\right)'} = -\frac{u'''}{u''} \tag{1}$$

where w, c and s denotes wealth, consumption and savings respectively.

Furthermore, more convex marginal utility functions imply stronger precautionary saving motives. In the presence of background risk, decreasing absolute risk aversion (DARA) together with positive prudence implies positive precautionary savings. Comparing the strength of the precautionary saving motive to the strength of risk aversion (it is done by comparing the measures of absolute prudence and absolute risk aversion) it is concluded that

under the assumption of DARA absolute prudence exceeds absolute risk aversion. As a result it means that the precautionary motive is stronger than risk aversion. Similar to the risk premium in the case of Arrow-Pratt's risk aversion, Kimball introduces the measure of the precautionary premium that is a compensation for a risk averse agent for not changing his behaviour when facing new uncertainty (under DARA the precautionary premium is larger than the risk premium). Kimball's two-period model shows that when the risk premium is large enough to keep expected utility unchanged savings increases, since it leads to the larger marginal utility in the second period. As it is concluded by Hochgurtel (2003), this means that higher savings makes it more desirable to take compensated risks. In addition, if savings and compensated risks are considered to be complementary, then compensated risks make savings more attractive. Altogether it means that prudent agents respond to risk by accumulating more wealth than they would do in the absence of risk.

Secondly, the presence of background risk not only increases savings, but also causes portfolio reallocation (due to the hedging behaviour). Kimball introduces the notion of temperance that describes the desire of investors to reduce their exposure to risky assets. Temperance is usually measured as $\tau = -\frac{u''''}{u'''}$. Defining decreasing absolute prudence (DAP), it is shown that temperance is greater than prudence (under DAP or DAP with DARA that is defined as standardness, $\tau \geq \pi \geq \alpha > 0$, where α is the index of risk aversion). That implies that two independent risks that increase marginal utility are substitutes in the way their affect expected utility. As a result it is concluded that any risk that leads to an increase in precautionary saving reduces investor's demand for risky assets (not only in absolute terms, but also in relative terms). It can be summarized that prudence increases precautionary saving and temperance leads to portfolio reallocation towards less risky assets. Health can be

viewed as a risk factor, thus, the change in the portfolio composition towards safer investments can be observed.

2.3. The concept of risk vulnerability

One of the natural restrictions that should be imposed on utility functions due to Gollier and Pratt (1996) is that adding unfair background risk to wealth makes risk-averse individuals behave in a more risk-averse way with respect to other independent risk. This concept was named "risk vulnerability" and it can eliminate counter-intuitive results from the paradox related to the situation when undesirable risk becomes desirable in the case of the presence of other mean-zero risk (Gollier and Pratt, 1996). These restrictions on utility functions are particularly interesting for our investigation of the relationship between the health status of a household and its decision on stock market participation, since health risk can be treated as an unfair background risk factor (Edwards, 2005). In the models of portfolio allocation increased risk aversion is often associated with lower propensity to hold risky assets; thus under risk-vulnerability, demand for risky assets lowers (Gollier and Pratt, 1996). Therefore, the set of utility functions for which the unfair background risk factor decreases the optimal share of portfolio held in risky assets is crucial for our research as a starting point of theoretical foundation as to why poor health can lower the propensity of stockholding.

Denoting $Eu(w+\tilde{y}) = v(w)$ and meaning that the effect of introduction of the background risk factor $\tilde{y}$ on wealth is equivalent to investigating the effect of the change in preferences from v to u, the risk vulnerability is defined as (Gollier and Pratt, 1996):

$$-\frac{Eu''(w+\tilde{y})}{Eu'(w+\tilde{y})} \geq -\frac{u''(w)}{u'(w)}, \forall w \tag{2}$$

where w is wealth, $\tilde{y}$ is a background risk factor with non-positive expectation, u is an increasing and concave von Neamann-Morgenstern utility function.

This definition means that v is more concave (thus more risk averse) than u. Gollier and Pratt (1996) prove that under DARA the sufficient condition for the utility function to be risk vulnerable is:

$$ARA'' \geq ARA' \times ARA \tag{3}$$

where ARA is the coefficient of absolute risk aversion.

Since the family of HARA (hyperbolic absolute risk aversion) exhibits decreasing convex absolute risk aversion, all utility functions from this set (CARA, CRRA, Quadratic) are risk vulnerable. Therefore, in the presence of a background risk factor an individual becomes more risk averse and has a lower share of wealth held in risky assets in the models of portfolio allocation (Gollier and Pratt, 1996). Kliger and Levy (2009) show that ARA functions of individuals are indeed decreasing and convex in their empirical investigation of the properties of utility functions based on the data from the USA. Hence the HARA specification of utility functions can be adopted for modeling individual preferences. Concluding, utility functions that are currently most often used for preferences specifications are risk-vulnerable; therefore, the introduction of an unfair background risk, which can be related to health risk, decreases the amount invested in risky assets (Gollier and Pratt, 1996, Edwards, 2005, Kliger and Levy, 2009).

In the next section we provide the readers with the multi-period model of portfolio choice based on the CRRA-preferences that treats health risk as a background risk factor.

2.4. Health as a background risk factor in the portfolio allocation model

Several theoretical works have tried to explain empirical evidence about large cross-sectional variation of individuals' and households' portfolio allocation. Heaton and Lucas (1996, 2000) trying to provide with explanations as to why investors hold particular fraction in stocks versus bonds, suggest the theoretical model with the presence of a background risk factor that is related to the different sources as the labor or entrepreneurial income risks. Edwards (2005, 2008) states that health risk can be considered as a type of an undiversifiable background risk factor. Thus individual utility functions depend on the health status. Consequently, the theoretical multi-period model of portfolio choice in the presence of health risk factor was developed by Edwards (2005, 2008).

There are two types of infinitely-lived investors in the model (Edwards, 2005). One is a healthy investor (h) that constantly faces the risk of becoming unhealthy with a constant probability $\pi_h \in (0,1)$. The second investor is unhealthy (u) and needs to purchase health. There is no uncertainty for this investor, however π_h equals to 1. Both of investors have Cobb-Douglas tastes over consumption C_t and health H_t, and a constant subjective intertemporal discounting rate δ. Preferences are specified as CRRA (constant relative risk aversion). The individual problem is the following:

$$\max_{\{C_s,H_s,\alpha_s\}_{s=0}^{\infty}} E\left[\sum_{t=1}^{\infty} \delta^t \frac{(C_t^{\Psi} H_t^{1-\Psi})^{1-\gamma}}{1-\gamma}\right] \tag{4}$$

$$s.t. W_{t+1} = \left(W_t - C_t^h\right) R_{p,t+1} \ (for\ healthy\ investors)$$

$$s.t. W_{t+1} = \left(W_t - C_t^u - P_{h,t} H_t\right) R_{p,t+1} (for\ unhealthy\ investors)$$

$$R_{p,t+1} = \alpha_t R_{1,t+1} + (1-\alpha_t) R_f$$

where $\Psi \epsilon (0,1)$, $\gamma > 0$, $P_{h,t}$ is the price of health, $R_{p,t+1}$is a return on portfolio that consists of the share α_t held in risky assets with a return $R_{1,t+1}$ and the share (1- α_t) held in bonds with a risk-free return R_f.

After solving this model, Edwards (2005) arrives to the important conclusion about the fraction of wealth invested in risky assets α_t by healthy and unhealthy individuals. It is shown that as long as the parameter γ >1 effective risk aversion for the healthy individual is lower than the one for the unhealthy investor (Edwards, 2005). Therefore, the share of wealth invested in risky assets is higher for healthy investors, who face health risk, than the fraction held in risky assets by unhealthy investors.

Taking into account that CRRA with the assumption that γ >1 is one of the most often used specification of individual preferences in the microeconomic theory, this theoretical model by Edwards (2005, 2008) is able to provide explanations for empirical evidence that individuals with poor health are less likely to participate in the stock market.

This section summarizes the main theoretical concepts that are attributable to the problem of portfolio choice with respect to health. In the next section we provide an overview of empirical studies devoted to this problem.

3. Previous research

Individual or household's portfolio choice has been a subject of interest for many researchers. Merton (1969) has proposed a continuous-time model and investigated the problem of portfolio choice and consumption rules for an individual. He finds that with the constant investment opportunity set under assumptions of CRRA for individual preferences and the Wiener Brownian-motion process for the rate of returns the weights in portfolio are constant. However, empirically we observe the changes in individual portfolio allocations. As a result, a large number of scientific studies investigated individual and household's decisions of portfolio choice and tried to discover what factors drive investors' behaviour. The most widely studied factors are income and wealth (Smith, 1999, Christelis, Jappelli and Padula, 2005), age (Ameriks and Zeldes, 2004), gender, marital status and a number of children (Bertocchi, Brunetti and Torricelii, 2011, Love, 2010, Love and Smith, 2010), education and cognitive abilities (Cristelis, Jappelli and Padula, 2010). Interactions between these factors are studied as well. Recently health factors gained special attention in the individual portfolio allocation problem. This section presents the most important results of these studies, where various aspects of the relationship between health and portfolio choice as well as other factors are investigated.

It is known from theory that portfolio choice is strongly affected by the total wealth, income, consumption and savings. Thus, at the beginning, we would like to give an overview of a debate that is present in the scientific world about the direction of causality between health and wealth – whether wealth is a determinant of health or conversely. Both directions of causality are quite intuitive and logical. For instance, health affects working abilities and labour hours one can offer to the market. The changes in these characteristics result in higher or lower income and wealth. Another explanation is that individuals in poor health face

various health care expenditures that can decrease their total wealth. On the other hand, wealthier individuals may have a better access to the qualitative and timely medical care. In this case wealth is the cause of better health. Smith (1999) shows that the health factors affect wealth of individuals. These effects are especially significant for older people, but the opposite relationship can be observed in childhood and early adulthood, when current and future health is highly affected by the economic factors. Smith concludes that worsening of health leads to a decrease in consumption and labour market participation, since sick individuals are forced to retire, and that results in a decline of the total wealth of individuals.

Fan and Zhoa (2009) paper, a contribution to the research of causality and heterogeneity in the relationship between health and wealth, goes further and searches for the relationship between health and portfolio composition. Authors use various health indices and apply different methods, namely the ordinary least squares (OLS) and fixed effects models, to check whether there is significant correlation between the indicators and to ensure the robustness of the results. Empirical testing shows that OLS correlations are significant and poor health affects the total wealth as well as portfolio composition. However, correlations between health and wealth disappear when using the fixed effects model. This method allows researchers to conclude that correlations between health and levels of various assets may be significantly affected by some unobserved individual characteristics. As for causality, authors find a minor response of wealth to changes in the health status and argue that there is no strong evidence that causality between the variables runs in both directions. Finally, one of the conclusions presented in the paper states that deterioration of health encourages individuals to reallocate their portfolios from risky assets to less risky ones, but the total level of assets or wealth remains unchanged.

Similar results are presented by Rosen and Wu (2004) according to whom health affects asset choice. However, the difference in the findings allows authors to conclude that worsening of

health not only changes portfolio composition, but also reduces holdings of every asset type. Rosen and Wu find no evidence of causality that wealth affects health. The authors consider a possibility to have the third variable, which drives both health status and portfolio choice, and assume that such a variable could be, for instance, education of a person and his parents or income volatility. However, the data set used in the research does not allow the authors to explore such influences.

The results above are in line with Edwards (2008) who states that retired individuals experience higher risk associated with the future health shocks and this risk is correlated with hedging behaviour. Results that are obtained using the data of American households indicate that individuals in the age over 70 years hold safer financial portfolios when they experience significant uncertainty about their health in the future. Yogo (2009) solves a life-cycle model for optimal consumption and portfolio allocation and concludes that the optimal share of stocks in a portfolio is increasing in health, but the optimal share of bonds is decreasing in health.

Love and Smith (2010) raise a question whether the differences in portfolio allocations because of health come from the extensive or intensive margin (or both). That is whether sicker households are less likely to own any stocks (e.g. risky assets) or they are likely to reduce (if they already own stocks) the share of stocks in their portfolios. The authors find the evidence that more strongly supports the extensive margin, since households in the lowest self-rated health group is about 20 percentage points less likely to hold any stocks compared to households in the highest health group. As for the intensive margin, the share invested in equity varies between 45% and 50% for all health groups indicating that the intensive margin is less viable in portfolio choice with respect to the health status.

The results above are attributable to older and retired individuals, but, as the paper of Toussaint-Comeau and Hartley (2009) shows, results for working-age respondents are the same. These individuals also tend to reduce holdings of risky assets when their health status declines.

However, once accounting properly the effects of unobserved heterogeneity trough correlated random effects and fixed effects estimators, Smith and Love (2010) find no relationship between health and portfolio choice. Trying to explain such striking results opposite to a number of other papers, authors propose a possibility that health and portfolio choice are related, but in the expectations' level. Assuming that health changes are more or less predictable, we can expect that individuals change their portfolio well before the negative health event happens. In a sense such an argument is proven by the study of Atella, Brunetti and Maestas (2012) where they introduce the measure of future health risk. This measure captures subjective believes of households about how their health will develop over a certain time period. The findings of the paper states that future health risk determines portfolio allocation, but the direction of the relationship depends on the level of education. Additionally, results of Atella, Brunetti and Maestas (2012) suggest that effects of future health risk are stronger for relatively younger households and decline with age.

Some studies distinguish the health effects on financial (securities, bonds, deposits, etc.) from the health effects on non-financial (for instance, real estate holdings) wealth. Yogo (2009) finds that both housing and financial wealth comprises higher percentage of the total wealth for households with good and excellent health. Berkowitz and Qui (2006) investigate how health affects not only holdings of financial assets, but also holdings of non-financial assets, and find that impact of the health factor on financial and non-financial wealth of households is asymmetric. Berkowitz and Qui (2006) conclude that health shocks lead to a larger decline in financial assets than non-financial ones. According to the authors, one

reason for such behaviour is a liquidity effect, implying that households are more likely to restructure their financial portfolios than non-financial portfolio, while facing the health shock and increasing need for health care expenditures.

Rosen and Wu (2004), and to some extent Edwards (2005, 2008), suggest several possible mechanisms that drive the relationship between health and portfolio choice. The mechanisms are risk aversion, planning horizon, life expectancy, bequest motives, and availability of health insurance as well as other mechanisms. Albeit Rosen and Wu (2004) find no evidence that those are the mechanisms through which health affects portfolio choice, other studies support the existence of such drivers. For instance, Qui (2005) finds a strong relationship between insurance coverage and portfolio choice. Qui (2005) and Edwards (2008) state that stock market participation and stock holdings in portfolios are higher for households with insurance than for those without insurance. The presence of the positive relationship is in line with theory, since insurance eliminates a part of risk.

The research of Toussaint-Comeau and Hartely (2009) suggests that health shocks force married and insured households in the working age to reduce their holdings of risky assets that is in line with the concept of risk vulnerability. Individuals who demonstrate their risk aversion by purchasing health insurance are likely to express their risk aversion also by decreasing risky positions, while incurring the health problems. However, the behavior of married and uninsured couples is opposite. Facing adverse health events, they are more likely to close safe assets accounts.

Every country has its own and specific health care system. Some systems are more protective and have wider coverage, some systems are less protective. Households purchase private insurance in the case when public insurance does not cover all medical services they may need. As a result, it is expected that portfolio allocation with respect to health and

significance of health shocks is different among households from various countries. Atella, Brunetti and Maestas (2012) study influence of health on the decisions of stockholding across European countries with different health care systems. Consistent with the theory of a background risk factor, it is found that health risk affects portfolio allocation, but it is observed only in the countries where the health care system is not fully covering and less protective. Summarizing the various results, we can conclude that not only private, but also public health insurance is important in portfolio choice. Moreover, it is stated by Qui (2005) that the growth of financial markets is associated with the development of the social security system. Thus author argues that the results of households' portfolio allocation with respect to the presence of health insurance are important in the implication of country's social protection policy. Policy includes not only the health care system, but also social benefit policy. Hence, uncertainty about the future social benefits (in the case of illness and retirement) as well as health risk acts as background risk, changing households' financial behavior and affecting portfolio allocation. The empirical study of Delevande (2010) confirms this statement and implies that higher level of uncertainty about future benefits (the main income source after retirement) lowers the share of stocks in the portfolio.

Health effects on portfolio choice and wealth are estimated controlling for various variables, for instance, education, social activity, income, gender and marital status. Wu (2003) finds that health shocks to women have an effect on household's wealth accumulation but shocks to men do not. When estimating the interaction between the level of education and health, Atella, Brunetti and Maestas (2012) find that as future health risk increases less educated households are more likely to hold risky assets. This finding is inconsistent with the background risk theory. On the other hand, more educated households behave in the way suggested by the theory. These households are more likely to reduce their risk exposure in financial portfolios.

Summarizing the research overview, we can conclude that the subject of health effects on portfolio choice has wide coverage in scientific studies. However, results are not always in line with major theories attributable to the problem of portfolio choice in the presence of health risk. In the next section we provide the readers with the methodology that we adopt to test the hypothesis that healthier households are more likely to participate in the stock market.

4. Methodology and Data

4.1. Econometric methods

In order to investigate the relationship between the decision of holding risky assets and individual health, we use the general method adopted in the previous research and employ the probit model specification. Such a model was used by Atella, Brunetti and Maestas (2012), Smith and Love (2010), Bertocchi, Brunetti and Torricelli (2011), and Rosen and Wu (2004) in their studies of the health effects on the decision of stockholding. This type of models is applied in the case when a dependent variable can take on a limited number of values and belongs to the class of binary response models (Wooldridge, 2002 and Brooks, 2008). In our research observations on the explained variable are series of ones and zeros. The dependent variable takes the value of one if a household participates in the stock market by holding risky assets. The value of zero is obtained in the case when a household has no risky assets in its portfolio and thus does not participate in the stock market. Therefore, each observation can be presented in the form of the conditional probability, such that the probability of holding risky assets (probability that y_i=1) depends on a number of explanatory variables:

$$P(y_i = 1|H_i, C_i) = G(\beta_0 + H_i\beta_h + C_i\beta_c) \tag{5}$$

where H_i is the set of all explanatory variables that are related to health characteristics of a person (e.g. a number of mobility limitations), C_i is the set of all control variables, such as education and wealth (all health and control variables are discussed in details later in this section).

In the case of the probit model the function G is the cumulative distribution function for a standard normally distributed random variable, hence the probability of participating in the stock market lies between zero and one (Brooks, 2008, Wooldridge, 2002 and Greene, 2003) such that:

$$G(z_i) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{{z_i}^2}{2}\right),\ G(z_i)\ \epsilon\ [0,1] \tag{6}$$

$$z_i = \beta_0 + H_i\beta_h + C_i\beta_c \tag{7}$$

Since the function G is nonlinear, the method of maximum likelihood estimation is used in order to obtain coefficients. This method is based on the principle of choosing parameters in the way that jointly maximize a log-likelihood function (Brooks 2008 and Geyer, 2010). For each observation the probability of observing y_i is obtained from the Bernoulli distribution:

$$p(y_i|H_i, C_i, \beta) = [G(H_i, C_i, \beta)]^{y_i}[1 - G(H_i, C_i, \beta)]^{1-y_i} \tag{8}$$

The log-likelihood function for a single observation is given by:

$$l_i(\beta) = y_i \log[G(H_i, C_i, \beta)] + (1 - y_i)\log[1 - G(H_i, C_i, \beta)] \tag{9}$$

Therefore, the log-likelihood function for the whole sample is calculated by summing up all individual log-likelihood functions:

$$L(\beta) = \sum_{i=1}^{n} y_i \log[G(H_i, C_i, \beta)] + (1 - y_i)\log[1 - G(H_i, C_i, \beta)] \tag{10}$$

Estimates of parameters $\hat{\beta}$ are the ones that maximize $L(\beta)$ (Geyer 2010, Wooldridge 2002, Greene 2003).

When the coefficients are estimated, we test their significance and evaluate the effects of the health variables on the probability of holding stocks in the portfolio. The t-statistics is calculated in the usual way and follows t-distribution (Wooldridge, 2002 and Brooks, 2008):

$$t = \frac{\hat{\beta}_i}{SE(\hat{\beta}_i)} \tag{11}$$

Following Wooldridge (2002), in order to estimate the partial effect of an explanatory variable on the probability of stockholding, we calculate the difference between probabilities when the value of the independent health variable goes from H_k to H_k+1:

$$\Delta P(y = 1|H, C) = G\left[\hat{\beta}_1 + \hat{\beta}_{h1}\breve{H}_1 + \ldots + \hat{\beta}_{hk-1}\breve{H}_{k-1} + \hat{\beta}_{hk}(H_k + 1) + \hat{\beta}_{c1}\breve{C}_1 + \cdots + \hat{\beta}_{cn}\breve{C}_n\right]$$

$$-G[\hat{\beta}_1 + \hat{\beta}_{h1}\breve{H}_1 + \ldots + \hat{\beta}_{hk-1}\breve{H}_{k-1} + \hat{\beta}_{hk}H_k + \hat{\beta}_{c1}\breve{C}_1 + \cdots + \hat{\beta}_{cn}\breve{C}_n] \quad (12)$$

where $\breve{H}_i$(i = 1, 2…k, k- a number of health variables) and $\breve{C}_j$ (j = 1, 2…n, n- a number of control variables) is zero or one, depending on which value is more often observed in the sample in the case when the explanatory health or control variable is a binary one. If $\breve{H}_i$ or $\breve{C}_j$ is either a discrete or continuous variable, the sample average is taken instead.

Such an approach of differences in probabilities is used, since all health variables in this research are represented either in the binary or discrete form (Wooldridge, 2002).

All estimations, except marginal effects evaluation, are carried out in the EViews7. The marginal effects are calculated in Excel.

4.2. Data description

The official webpage defines the SHARE as a multidisciplinary and cross-national panel database of micro data on health, socio-economic status, social and family networks of more than 55,000 individuals from different European countries in the age of 50 and above (the SHARE brochure). The survey is harmonized with the Health and Retirement Study and English Longitudinal Study of Ageing that are carried out in the USA. By now there have been conducted four waves of the SHARE. The third wave, called a retrospective survey, is not comparable to the other waves. It is planned that the results of the fourth wave will be available in November of 2012. Our study is based on the data from the second wave that was conducted in 2006/2007.

The SHARE 2006 covers fourteen European countries and its main questionnaire consists of 22 modules, including such topics as basic demographics, mental and physical health, households' income, assets, consumption as well as other modules.

4.3. Construction of variables

Dependent variables – direct and total stock market participation

In line with Christelis, Jappelli and Padula (2010) we study the relationship between individual health characteristics and both direct and total stock market participation separately. Direct participation is referred to the case when a household owns stocks in its private portfolio directly. For total participation we consider not only direct stocks owning, but also include stock market participation through managed investment accounts, individual retirement accounts (IRAs) or mutual funds. Therefore, we are required to construct two variables that reflect direct stockholding and total stockholding.

The dummy variable for direct stock market participation is formed in the following way. In the SHARE (2006), respondents are asked whether they currently have any money in stocks or shares that are listed or unlisted in stock markets. Therefore, if a household has any stocks, this observation is denoted as one. Otherwise, the value of this dummy variable takes the value of zero.

For the dummy variable that reflects total participation other questions from the SHARE (2006) are considered in addition. There are two questions where respondents are asked about any amount of money in mutual funds, managed investment accounts and individual retirement accounts (IRAs). In the case of the positive answer the survey investigates the composition of such assets further. Respondents answer what these mutual funds, managed investment accounts and IRAs mostly consist of. There are three possibilities to answer for

these questions. These are either “mostly stocks” or “mostly bonds”, or “half stocks and half bonds”. The dummy variable for total participation takes the value of one when household’s mutual funds, managed investment accounts or IRAs consist of either mostly stocks or half-half, or in the case of direct stockholding. An observation obtains the value of zero only in the case, if a household simultaneously has no direct stockholding and all mutual funds, managed investment accounts and IRAs (if any) are mostly in bonds, or when a person holds no money in any of them. In other words, in the case of any stockholding (direct or through mutual funds, managed investment accounts or IRAs) an observation is denoted as one. Otherwise, it is zero. If respondents do not answer these questions the cells in the database are left empty and, therefore, these observations are not considered in the regression estimation.

Individual health characteristics

In order to reflect the health status we, firstly, construct a wide range of different health variables and then choose the most important ones. As it shown in previous research the individual self-assessment of health is one of the key factors that can affect stockholding (Atella, Brunetti and Maestas, 2012). Therefore, we need a variable that can incorporate information about the perceived health condition of a household. There are two questions related to the self-assessment of the health status in the survey (the SHARE Release Guide, 2011). The questions are asked in different parts of the questionnaire in order to check for the consistency of the answers and ensure that respondents are objective in the assessment of their health condition and not affected by temporal mood swings. In the first question respondents are given the options regarding their health in general as “Excellent”, “Very good”, “Good”, “Fair” and “Poor”. Based on this information, the binary variable is constructed such that “Fair” and “Poor” health is denoted as one, otherwise, the dummy variable is zero. The second question asks to determine the level of health based on the scale

where 10 is the best imaginable and 1 is the worst imaginable health status. Hence, another perceived health variable is a discrete one with the range from 1 to 10.

To capture the information from both of these questions we create a new variable that is used to determine the self-assessed health condition of a household. This new variable is the sum of the first mentioned perceived health variable and the dummy variable (based on the second discrete self-assessed health variable), which takes the value of zero if a person determines her health in the range of 6-10, and the value of one if the range is 1-5. Thus this new constructed variable can take values from zero to two. Zero is obtained if a person determines the health status as a good one in the both question, hence the self-perceived health assessment is clearly “good”. One denotes the situation when one of the answers determines perceived health as “good” and another answer determines self-assessed health as “bad”. Therefore, it is unclear what the perceived health condition is. The value of two is in the case when both questions reflect the “bad” self-assessed health condition.

Other important characteristics of the household health condition are chronic illnesses (like asthma, diabetes, and cancer, etc.), different symptoms (as pain in the back, breathlessness, and fatigue etc.) and limitations in mobility (like sitting for about two hours or climbing several flights of stairs without resting, etc.). There are questions in the SHARE that ask individuals about persistence of a wide range of chronic illnesses (17 illnesses are mentioned), symptoms (12 symptoms are named), and limitations in mobility (10 limitations are suggested). Thus this information is incorporated in the discrete variables with the proper range. The variable for the number of chronic illnesses is from 0 to 17, the variable for the number of symptoms is from 0 to 12, and the variable for the number of limitations is from 0 to 10. Based on the similar questions the following three dummy variables were constructed in addition to the discrete variables above. In the case, if a respondent has zero or one chronic

illness (symptom/limitation in mobility), the dummy variable for chronic illnesses (symptoms/limitations in mobility) takes the value of 0. If a respondent has more than one chronic illness (symptom/limitation in mobility), the value is 1. Therefore, such a construction denotes a healthy household as zero and an unhealthy household as one.

Another category of personal characteristics that will be accounted in the assessment of the health condition is limitations in daily and instrumental activities. A list of thirteen such limitations is presented in the survey (e.g. limitations in bathing or showering, in getting in or out of bed, preparing a hot meal, etc.). Six of them are related to limitations in daily activities. Seven others are related to limitations in instrumental activities (the SHARE Release Guide, 2011). Based on this question we create both two discrete variables and two dummy variables for daily and instrumental limitations. The discrete regressor for daily limitations (instrumental) is ranged from zero to six (zero to seven). The dummy variable for each of the type of limitations is denoted as zero if a respondent does not experience any limitations. In the case of any number of limitations, the dummy variable takes the value of one (the SHARE brochure).

The last of health variables that is considered is mental health. The question of the SHARE names 12 different problems that are related to mental health of a person (the SHARE Release Guide, 2011), such as irritability, depression, or trouble with sleeping, etc. The discrete variable based on this data is the number of problems that are experienced by a respondent, thus the possible values for this variable are from zero to twelve. The dummy variable is zero if there are strictly less than 4 problems are mentioned. In the case of 4 or more problems, the dummy variable turns to the value of one.

When all health variables are created, we estimate the correlation matrix between the health factors. Based on matrix analysis we choose the variables that are used further in empirical

testing. This choice is motivated to avoid the problem of multicollinearity in analysis. Many of factors are highly correlated with each other that is natural, since all of the variables reflect household's health (see Appendix 1). For instance, the variable for determining limitations in mobility is highly correlated with almost all other variables. Therefore, we can choose only it instead of including all other variables that are highly correlated with limitations in mobility. Based on correlation matrix analysis, only three variables are considered. The first variable is the perceived health status constructed from the data in both question related to the self-assessment of the general health condition. The second variable is the number of limitations in mobility. The third factor chosen is mental health that is represented by the number of problems experienced.

Control variables

Following the previous research, we can conclude that there is a large number of factors that can affect individual portfolio allocation. Therefore, we include a set of independent variables in order to control for other effects, rather than health characteristics, that can influence the decision of stock market participation.

One of the effects we would like to consider is wealth that is a very popular control variable among many researches who investigate the health influences on the stockholding decision. Berkowitz and Qiu (2006) include the logarithm of financial and non-financial assets to capture wealth-effects. Smith and Love (2010) control separately for financial wealth, nonfinancial wealth, Social Security wealth, and other annuitized wealth. Toussaint-Comeau and Hartley (2009) introduce a household income variable. Bertocchi, Brunetti and Torricelli (2011) use quadratic and linear terms of income and wealth. In order to construct the wealth control variable we refer to the question from the SHARE (2006) that reflects the total average month income for the whole household. Individuals are asked how much the overall

after tax income that an entire household had in an average month was in the previous year. Based on this number, the wealth variable is composed taking into account the differences between the price levels across different European countries. The outlines that are either extremely high or low are taken away. The wealth variable that is used in the regression is constructed in the following way:

$$w_i = \frac{x_i - \bar{x}}{\bar{x}} \tag{13}$$

where $\bar{x}$ is the average after-tax monthly income for a household in the country from which this household comes, x_i is the amount stated in the answer by a respondent.

Such a representation of the wealth variable allows us to capture positive or negative deviations from the average income for a household in the particular country. Therefore, it is a better measure of wealth than absolute numbers, since the latter do not reflect specific country differences in the purchasing power.

Another important control is an individual level of education. Atella, Brunetti and Maestas (2012) state that due to the diversity of educational systems in the different countries from the SHARE, the direct comparison of degrees obtained is almost impossible and rather the number of years in the full time education should be used instead. Following similar motivation and approach of these researches, we define the educational control-variable as a dummy one that takes the value of one, if an individual spent strictly more than nine years in the full education, or zero, if the number of years of the full education is less or equal to nine years. Therefore, educated individuals are defined as those who studied full-time strictly more than nine years. Reasoning for such a split is that the current compulsory education is nine years on average, thus an educated person is considered to be the one who studied above this number of years (Atella, Brunetti and Maestas, 2012).

Bertocchi, Brunetti, Torricelli (2011) argue that single women hold lower amount in stocks in comparison to married women and men, since marriage represents a type of a safe asset for women. However, this pattern erodes over time with the change of gender roles in society and female participation in the labor market (Bertocchi, Brunetti, Torricelli, 2011). Marital status as a control variable was also considered by Coile and Milligan (2006) and Atella, Brunetti and Maestas (2012). The latter group of researches includes a dummy variable for a gender as well. In attempt to capture gender and marital status differences, we include two dummy variables in addition. The gender dummy variable takes one for a male and the marital status dummy variable takes one for a married person or a person who is in a registered partnership.

Atella, Brunetti and Maestas (2012) give evidence that the health status affects portfolio allocation stronger in the countries with a less protective health care system. In order to capture heterogeneity across 14 countries from the survey, we introduce 13 dummy variables that take the value of one for the country which they denote and zero otherwise. For instance, if there is a dummy variable for Sweden, it takes the value of one, if a respondent is a citizen of Sweden, or the value of zero, if this person has any other citizenship. We do not create a binary variable for Germany; therefore, this country is the reference one.

All constructed variables are summarized in Table 1.

Table 1: Description of the constructed variables

	Variable	**Construction of the variable**
	1	**2**
Dependent variables	Direct stock market participation	Dummy variable 1- if a household holds any stocks directly 0-otherwise
	Total stock market participation	Dummy variable 1 – if a household holds stocks directly and/or shares of mutual funds and/or individual retirement accounts, and/or managed investment accounts consisting of mostly stocks or half-stocks and half-bonds 0 – otherwise

Table 1, continued: Description of the constructed variables

	1	2
Health variables	Self-health 1	Dummy variable 1 – if a respondent assesses its health is “fair” or “poor” 0- otherwise
	Self-health 2	Discrete variable, takes values from 1 to 10, where 10 is the best possible health and 0 is the worst possible health
	Self-assessed health	Variable constructed from “self-health 1” and “self-health 2” 1) Define a new dummy variable as follows: 0 - if “self-health 2” is in the range 6-10 1 - if “self-health 2” is in the range 1-5 2) Construct “self-assessed health” as a sum of “self-health 1” and the new variable constructed from “self-health 2”
	Chronic illnesses	Discrete variable, takes values in the range 0-17 depending on the number of illnesses stated by a respondent
	Chronic illnesses 2	Dummy variable 1 – if the number of chronic illnesses is in the range from 2 to 17 0 – if the number of chronic illnesses is 1 or 0
	Symptoms	Discrete variable, takes values in the range 0-12 depending on the number of symptoms stated by a respondent
	Symptoms 2	Dummy variable 1 – if the number of symptoms is in the range from 2 to 12 0 – if the number of symptoms is 1 or 0
	Mobility	Discrete variable, takes values in the range 0-10 depending on the number of limitations in mobility
	Mobility 2	Dummy variable 1 – if the number of limitations in mobility is in the range from 2 to 10 0 – if the number of limitations in mobility is 1 or 0
	Limitations in daily activity	Discrete variable, takes values in the range 0-6 depending on the number of limitations in daily activities
	Limitations in daily activity 2	Dummy variable 1 – if the number of limitations in daily activities is in the range from 1 to 6 0 – if the number of limitations in daily activities is equal to 0
	Limitations in instrumental activity	Discrete variable, takes values in the range 0-7 depending on the number of limitations in instrumental activities
	Limitations in instrumental activity 2	Dummy variable 1 – if the number of limitations in instrumental activities is in range from 1 to 7 0 – if the number of limitations in instrumental activities is equal to 0
	Mental health	Discrete variable, takes values in the range 0-12 depending on the number of the mental health problems
	Mental health 2	Dummy variable 1 – if the number of mental health problems is in the range from 4 to 12 0 – if the number of mental health problems is in the range from 0 to 3
Control variables	Wealth	Deviation of household’s wealth from the mean wealth in the country
	Age	Discrete variable – age of a respondent
	Marital status	Dummy variable 1 – for married households and registered partnerships 0 – otherwise
	Gender	Dummy variable 1 – male 0 – female
	Education	Dummy variable 1 – if a respondent has strictly more than 9 years of education 0 – if a respondent has 9 or less years of education

4.3. Final model specification

When all dependent, independent and control variables are constructed and selected, the main model is formulated as follows:

$$P(stockholding_i = 1|Country_i, Health_i, Control_i) = \tag{14}$$

$$= G\left(\beta_0 + Country_i\beta_{counry} + Health_i\beta_{health} + Control_i\beta_{control}\right)$$

where $Country_i$ is the matrix of dimension (1×13) of the dummy variables for each of the country excluding Germany (it is chosen as a reference country):

$$Country_i = [Austria \quad \dots \quad Switzerland] \tag{15}$$

$Health_i$ is the matrix of dimension (1×3) of the health variables such as the perceived health status, limitations in mobility and mental health:

$$Health_i = [Self\text{–}assessed\ health \quad Mobility \quad Mental\ health] \tag{16}$$

$Control_i$ is the matrix of dimension (1×5) of the control variables:

$$Control_i = [Gender \quad Age \quad Wealth \quad Education \quad Marital\ status] \tag{17}$$

$\beta_0, \beta_{country}, \beta_{health}, \beta_{control}$ are the vectors of coefficients for the explanatory variables.

To ensure that country effects are significant the Wald test is performed. The Wald test is a method to test the significance of independent variables. If several explanatory variables (in our case, country dummy variables) are jointly not equal to zero, we conclude that the parameters associated with these variables are significant (Brooks, 2008). Therefore, these variables should be included in the model.

The model specification as presented above allows us to assess how the probability of direct and total stockholding of a household is affected by its health status, controlling for the

influences of other factors. We would like to emphasize that the tested hypothesis is that healthier households are more likely to participate in stock markets than less healthier ones. The results of our research are presented and discussed in the next chapter.

5. Empirical results and analysis

5.1. Descriptive statistics

In the previous chapter we described the data used for the research. In this section we present the obtained empirical results. Firstly, we provide the readers with the descriptive statistics of the variables relevant to our study. From Table 1 useful insights into the used data are derived.

Table 1: Descriptive statistics for the data

The table presents the descriptive statistics of the data set. Total (direct) stock market participation is the dummy variable that takes the value of one if a household has total (direct) stockholdings. Self health 1 is the dummy variable that takes the value of one if a household assesses its health as "fair" or "poor" and zero if a household assesses its health as "excellent", "very good" or "good". Income is the average monthly after-tax income of a household. Age is the discrete variable that shows age of a respondent. Male (female) is the dummy variable that takes the value of one if a respondent is male (female). Marital status is the dummy variable that takes value "1" if a respondent is married or in a registered partnership. Years of education is the discrete variable that represents a number of years in the full time education for each respondent. A specific country is the dummy variable that takes the value of one if a respondent is from the particular country this dummy variable is for and the value of zero otherwise.

Variable	Mean	SD
Total stock market participation	0,234	0,424
Direct stock market participation	0,156	0,363
Self health 1	0,348	0,476
Income	2050,84	1695,85
Age	64,210	14,778
Male	0,443	0,497
Female	0,557	0,497
Marital status	0,728	0,445
Years of education	9,986	4,595
Country:		
Austria	0,0390	0,1935
Germany	0,0746	0,2628
Sweden	0,0798	0,2709
Netherlands	0,0773	0,2671
Spain	0,0647	0,2461
Italy	0,0867	0,2814
France	0,0862	0,2807
Denmark	0,0760	0,2650
Greece	0,0942	0,2922
Switzerland	0,0425	0,2017
Belgium	0,0921	0,2891
Czech Republic	0,0822	0,2747
Poland	0,0717	0,2580
Ireland	0,0330	0,1785

It is shown in Table 1 that 23,4% of all households participate in stock markets by holding any risky assets - stocks and/or shares of mutual funds, managed investment accounts or IRAs (total stock market participation). 15,6% of households directly hold any stocks in their portfolios (direct stock market participation). Statistics of the constructed dummy variable for the self-assessed health status (self health 1) indicates that 34.8% of all respondents consider their health as "poor" or "fair". The average monthly income of a household is 2051 euros that results in the average annual income of 24 612 euros. However, it should be noted that significant variation in income is observed among households. The average respondent is 64 years old and has approximately 10 years of education. The largest share of respondents (50,4%) is from 50 to 64 years old (see Figure 1). The age groups of 65 to 74 years old and of 75 and above years old are approximately equally represented in the survey.

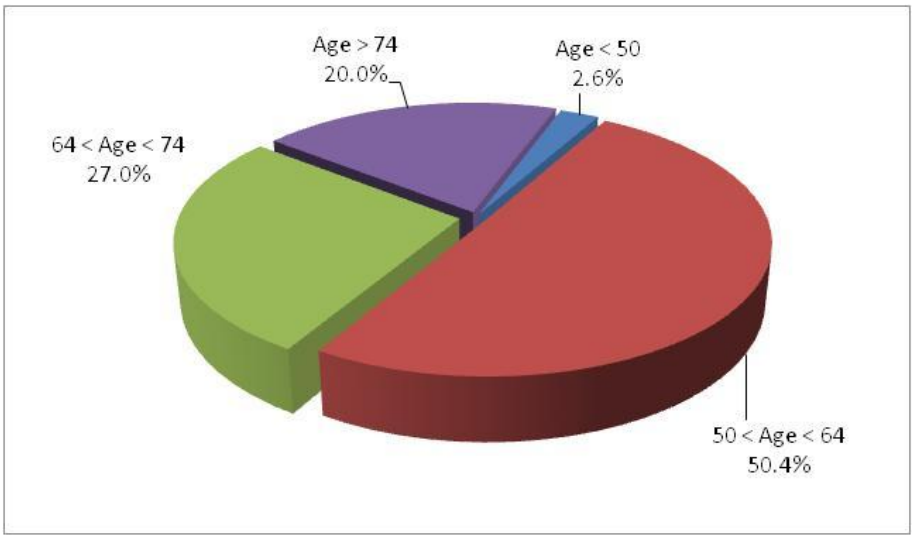


Figure 1: Age of the SHARE respondents
The figure presents the age of the SHARE respondents.

72,8% of all households are married, living with the spouse, or are in a registered partnership. Respondents of the survey are almost equally split between genders - 44% of respondents are males and 56% are females. Countries are represented nearly evenly in the survey, since the share of each country varies from 3% to 9%. Figure 2 (see the next page) shows the considerable differences in total and direct stock market participation across the

countries covered in the survey. Total stockholding always exceeds direct stockholding, since it is possible to participate in stock markets through certain types of mutual funds, managed investment accounts and IRAs.

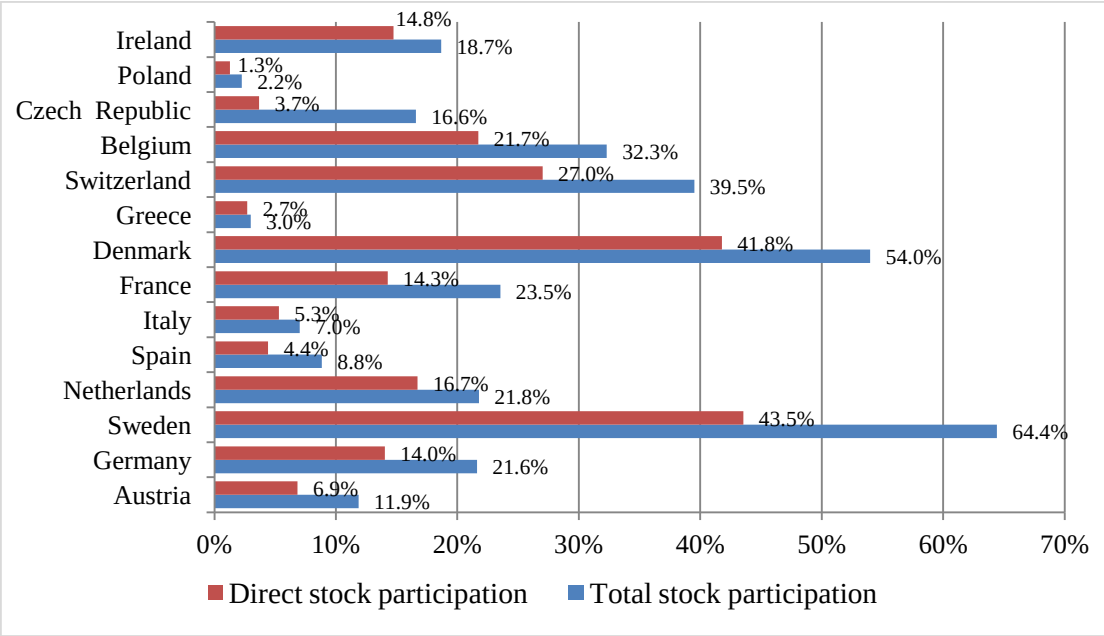


Figure 2: Total and direct stock market participation in the SHARE countries
The figure presents the percentage of households with total and direct stockholdings in each of the SHARE countries.

The highest direct and total stock market participation is observed in Scandinavian countries (in Sweden and Denmark, total stockholding exceeds 50%) and such developed Western European countries as Switzerland and Belgium. The lowest share of households holding risky assets is in Poland and in Southern European countries as Spain, Italy and Greece. Atella, Brunetti and Maestas (2012) argue that heterogeneity in portfolio composition can be explained by the differences in health care systems (mainly, the level of protection of systems). However, the protectiveness of the health care system is highly affected by the overall economic development in the country. The SHARE reveals significant differences in income adequacy across countries (the SHARE brochure) and shows that the lowest level of stock market participation is in the countries with the least adequate income. As a result, both significant wealth and country effects in the portfolio choice decisions are observed.

5.2. Results and analysis

We estimate two regressions as it is specified in Equation 14 for both total and direct stock market participation as the dependent variable. We control for country effects in the model and choose Germany as the reference country. The obtained results are presented in Table 2 below.

Table 2: Empirical results of the model

This table presents the results of models where both total and direct stock market participation are the dependent variables. The constructed explanatory health variables are the self-assessed health status with the range from 0 to 2 (if the variable takes value "0", a household clearly assesses its health status as "good", "1" – unclear assessment of the health status, "2" – the health status is clearly assessed as "bad"), the number of mobility limitations and the number of mental health problems faced by a household. The models control for gender (the dummy variable takes value "1" for a male and "0" for a female), age of a respondent, wealth (estimated as a deviation from the country's average income), education (the dummy variable takes value "1" if a respondent has strictly more than nine years of education and "0" if a respondent has nine or less years of education), marital status (the dummy variable takes value "1" for a household that is married or in a registered partnership) as well as country specific characteristics (13 country dummy variables, Germany is the reference country).

Variable/Dependent variable	Total stock participation	Direct stock participation
1	2	3
Constant	**-0,3197***	**-1,3434*** **
	(0,1641)	*(0,1834)*
Austria	**0,0855**	**0,0287**
	(0,2296)	*(0,2535)*
Belgium	**-0,0382**	**-0,1118**
	(0,1282)	*(0,1447)*
Czech Republic	**0,0194**	**-0,5997*** **
	(0,0838)	*(0,1018)*
Denmark	**1,2585*** **	**1,1088*** **
	(0,0902)	*(0,0952)*
France	**0,2269** **	**0,1161**
	(0,0973)	*(0,1069)*
Greece	**-0,5938*** **	**-0,3695*** **
	(0,1268)	*(0,1322)*
Ireland	**0,0329**	**0,0802**
	(0,0989)	*(0,1062)*
Italy	**-0,2866** **	**-0,1720**
	(0,1156)	*(0,1233)*
Netherlands	**0,0553**	**0,1288**
	(0,0985)	*(0,1056)*
Poland	**-1,0936*** **	**-1,0987*** **
	(0,1095)	*(0,1280)*
Spain	**-0,3018***	**-0,6071*** **
	(0,1366)	*(0,1786)*
Sweden	**1,3198*** **	**0,9656*** **
	(0,0947)	*(0,0982)*
Switzerland	**0,7405*** **	**0,4993*** **
	(0,0989)	*(0,1065)*
Self –assessed health	**-0,0926*** **	**-0,0602***
	(0,0321)	*(0,0374)*

Table 2, continued: Empirical results of the model

Mental health	**-0,0069**	**0,0013**
	(0,0105)	*(0,0120)*
Mobility	**-0,0487*** **	**-0,0328** **
	(0,0130)	*(0,0146)*
Gender	**0,1693*** **	**0,1741*** **
	(0,0388)	*(0,0433)*
Age	**-0,0157*** **	**-0,0044* **
	(0,0021)	*(0,0023)*
Wealth	**0,1063*** **	**0,0858*** **
	(0,0172)	*(0,0217)*
Education	**0,3659*** **	**0,3463*** **
	(0,0439)	*(0,0490)*
Marital status	**0,1936*** **	**0,2580*** **
	(0,0410)	*(0,0474)*
McFadden R-squared	**0,2612**	**0,2386**

Germany is a reference country.
Standard deviations are given in the parentheses
* - coefficient is significant at 10%
** - coefficient is significant at 5%
*** - coefficient is significant at 1%

Estimating the effects of health variables on the probability of total stockholding, we obtain the results that are consistent with background theories and previous empirical studies (Love and Smith, 2010, Tousasaint-Comeau and Hartley, 2009, Atella, Brunetti and Maestas, 2012, Edwards, 2005). Total stock market participation is decreasing in the self-assessed health status and the number of mobility limitations. The worse self-assessed health status and a larger number of restrictions in mobility imply the lower probability of stock market participation. Both coefficients are statistically significant. The health effects on the portfolio choice are captured better in the model with total stockholding as the dependent variable, since total stock market participation by definition covers a wider range of risky assets that can compose a portfolio of a household.

For the model with direct stockholding as a dependent variable, we obtain the statistically significant results indicating that the probability of direct stock market participation decreases when mobility becomes more limited. The coefficient for the self-assessed health status has a

negative sign, which is consistent with theory and is almost significant at the 10% significance level. Again, we can conclude that households with less mobility limitations and better self-assessed health condition are more likely to hold risky assets

Bogan and Fertig (2012) find that mental health has significant effects on portfolio choice of households in the USA and mental illnesses are associated with a reduction in risk-taking. The coefficients for mental health in our estimations conducted on the European data are not significant. Therefore, there is no evidence in our work that mental health affects households' stockholding decisions.

Coefficients of control variables are significant and exhibit expected signs in both models. In line with other researchers, our results support the hypothesis that the probability of stock market participation is increasing in wealth. The probability of stockholding decreases when a household ages as it is stated by the life-cycle theory. We find the gender differences in portfolio allocation indicating that males are more likely to hold risky assets than females. Consistent with the findings of Atella, Brunetti and Maestas (2012) and Bertocchi, Brunetti and Torricelli (2011) we conclude that the probability of total and direct stock market participation is higher for married households than for single ones. Thus, marriage serves as a sort of a safe asset for a household. Finally, our results indicate that the probability of stock market participation is higher for more educated agents, supporting arguments presented by Christelis (2010) that holding of stocks requires additional knowledge and experience.

Country specific effects are observed in our research as well. We can see that the probability of total stockholding is higher for citizens of Denmark, France, Sweden and Switzerland in comparison to Germany. On the other hand, citizens of Greece, Italy, Poland and Spain are less likely to participate in stock markets than German households. The highest positive coefficients that are significant at the 1% significance level are for Sweden and Denmark,

thus Swedish and Danish households are most likely to participate in stock markets. It can be explained, for instance, by the fact that these courtiers are known for highly protective social and health care systems (Atella, Brunetti and Maestas, 2012) in comparison to other countries in the SHARE.

To ensure the significance of country effects the Wald-test is performed. We test the hypothesis that coefficients for country dummy variables are jointly equal to zero. Table 3 reports that the p-values are less than one percentage for both models. Therefore, we can conclude that country effects are significant in our study.

Table 3: Wald-test for the significance of country effects

Model	F-statistic		
	Value	Df	Probability
Model for total stock market participation	90.77032	(13, 7767)	0.0000
Model for direct stock market participation	67.91025	(13, 7767)	0.0000

Coefficients in the main models provide us with an understanding of the direction and significance of the relationship between health and decisions of stockholding. In order to assess how the probability of stock market participation changes, while health variables transit from one value to another, marginal effects on the probability of total stockholding are estimated. We choose the model with total stock market participation, since such specification captures the influence of health in a more natural way than the direct stockholding model, because of considering stock market participation through mutual funds, managed investment accounts or IRAs. Partial effects of the explanatory variables are calculated as it is stated in chapter 4. The obtained results for the marginal effects of the significant health variables are presented in the following tables.

Table 4: Change in the probability of total stockholding for the transition in the self-assessed health variable

	Transition of self-assessed health from 0 (“good”) to1 (“unclear”)	Transition of self-assessed health from 1 (“unclear”)to 2 (“bad”)
Germany	-2,46%	-2,25%
Austria	-2,64%	-2,44%
Belgium	-2,37%	-2,16%
Czech Republic	-2,50%	-2,29%
Denmark	-3,47%	-3,57%
France	-2,94%	-2,75%
Greece	-1,20%	-1,04%
Ireland	-2,53%	-2,32%
Italy	-1,82%	-1,62%
Netherlands	-2,58%	-2,37%
Poland	-0,50%	-0,42%
Spain	-1,79%	-1,59%
Sweden	-3,39%	-3,51%
Switzerland	-3,64%	-3,57%

In Table 4 we can see how the probability of total stock market participation diminishes for different countries when the perceived health condition worsens. For instance, in Germany the probability of total stockholding is about 2.46% lower for those households who cannot clearly state their perceived health condition (value of 1) in comparison to households who clearly assess their health status as “good” (value of 0). When self-assessed health deteriorates further and household’s assessment changes from the “unclear” health condition (value of 1) to the clear “bad” one (value of 2), the marginal effect on the probability of total stockholding is -2.25% that means that the probability of stock market participation becomes 2.25% lower. For the other countries these effects are similar. Worsening of the perceived health status lowers the probability of holding risky assets. The graphical representation of the changes in probability of stockholding affected by the change in self-assessed health is presented in Appendix 2.

Table 5: Change in the probability of total stockholding for transitions in limitations in mobility

	Change in the number of limitations in mobility									
	From 0 to 1	**From 1 to 2**	**From 2 to 3**	**From 3 to 4**	**From 4 to 5**	**From 5 to 6**	**From 6 to 7**	**From 7 to 8**	**From 8 to 9**	**From 9 to 10**
Germany	-1.34%	-1,28%	-1,23%	-1,17%	-1,11%	-1,06%	-1,00%	-0,94%	-0,89%	-0,84%
Austria	-1.44%	-1,38%	-1,33%	-1,27%	-1,21%	-1,16%	-1,10%	-1,04%	-0,99%	-0,93%
Belgium	-1.30%	-1,24%	-1,18%	-1,13%	-1,07%	-1,01%	-0,96%	-0,90%	-0,85%	-0,79%
Czech Republic	-1.36%	-1,31%	-1,25%	-1,19%	-1,14%	-1,08%	-1,02%	-0,97%	-0,91%	-0,86%
Denmark	-1.79%	-1,83%	-1,86%	-1,88%	-1,90%	-1,92%	-1,93%	-1,94%	-1,94%	-1,94%
France	-1.59%	-1,54%	-1,49%	-1,43%	-1,38%	-1,32%	-1,27%	-1,21%	-1,15%	-1,09%
Greece	-0.67%	-0,63%	-0,58%	-0,54%	-0,50%	-0,46%	-0,42%	-0,39%	-0,35%	-0,32%
Ireland	-1.38%	-1,32%	-1,27%	-1,21%	-1,15%	-1,09%	-1,04%	-0,98%	-0,93%	-0,87%
Italy	-1.01%	-0,95%	-0,90%	-0,84%	-0,79%	-0,74%	-0,69%	-0,64%	-0,60%	-0,55%
Netherlands	-1.40%	-1,35%	-1,29%	-1,24%	-1,18%	-1,12%	-1,06%	-1,01%	-0,95%	-0,90%
Poland	-0.29%	-0,26%	-0,24%	-0,21%	-0,19%	-0,17%	-0,16%	-0,14%	-0,12%	-0,11%
Spain	-0.99%	-0,93%	-0,88%	-0,83%	-0,77%	-0,72%	-0,67%	-0,63%	-0,58%	-6,65%
Sweden	-1.75%	-1,78%	-1,82%	-1,85%	-1,88%	-1,90%	-1,91%	-1,93%	-1,94%	-1,94%
Switzerland	-1.93%	-1,91%	-1,90%	-1,87%	-1,85%	-1,82%	-1,78%	-1,75%	-1,71%	-1,66%

It is shown in Table 5 that the probability of stock market participation decreases when the number of mobility limitations increases. The strongest negative effect on the probability for all countries, except Sweden and Denmark, is observed at the first transitions when the number of mobility limitations changes from zero to one. Therefore, the absolute value of the marginal effects is decreasing for almost all countries. For Sweden and Denmark the absolute value of the marginal effects increases when the number of mobility limitations grows. Both increasing and decreasing absolute values of the marginal effects are consistent with the tested hypothesis, since the probability of stockholding falls when health deteriorates. The differences are resulted entirely from the specificity of the cumulative distribution function of a standard normally distributed random variable (its convex and concave parts), which is used in the probit model and the fact that the highest probability of stockholding is observed for Danish and Swedish households. Graphical results of the change in the probability of total

stock market participation with respect to the change in mobility limitations can be found in Appendix 3.

The marginal effects for the mental health variable are not presented, since no significant coefficients were obtained in our investigation. Thus no clear conclusions regarding the influence of mental health on the decision of stockholding can be derived.

The results obtained in this work are in line with theory and previous research. Deterioration of the perceived health condition as well as an increase in mobility limitations lowers the probability of direct and total stockholding. However, we do not find evidence that mental health influences the stockholding decision.

6. Conclusions

There are a number of theories and concepts such as the life-cycle theory, precautionary saving and risk-vulnerability concepts, and a multi-period model with the presence of background risk factors that provide the foundations for the investigation of the relationship between health and portfolio allocation. Moreover, empirical evidence of the influences of health factors on the decisions of stock market participation is widely presented in the scientific world. In line with theory and empirical evidence, we present obtained results of the research dedicated to studying the health status effects on the households' participation in the stock market.

Using the SHARE database, spanning fourteen European countries, we adopt the probit model and investigate how health factors affect both households' direct stockholdings and total stockholdings. The total stockholdings additionally include participation in the stock market through mutual funds, managed investments accounts and individual retirement accounts. Comparing our study to other papers, we create a wide range of health variables and based on correlation matrix analysis we choose our own set of constructed health factors. The chosen variables are the self-assessed health condition, mobility limitations and mental health. Proceeding with the estimation of households' likelihood of stockholding affected by the set of the health variables, we control for the influences of age, wealth, gender, marital status, education as well as country specific characteristics.

Obtained results support our hypothesis, even after controlling for influences of other variables. Thus, we can conclude that healthy households are more likely to hold risky assets than unhealthy ones. Stronger evidence is observed in the model for the likelihood of total stockholding. In this model, we obtain significant coefficients for the perceived health status and mobility limitations, which proves that worsening of self-assessed health and an increase

in the number of mobility limitations indeed lower the probability of the total stockholding. The estimations of the marginal effects on the probability of the total stockholding and its graphical representation are presented in our study as well. Country effects are significant in our models and indicate that the highest probability of total stockholding is observed in Sweden and Denmark. From our point of view, it can be explained by the fact that these Scandinavian countries, because of their highly developed social and health care systems, are distinguished from other European countries. In our research, we do not find evidence that mental health affects the households' decisions of participation in the stock market. However, we believe that influences of mental health on holding risky assets should be investigated further.

Other attractive areas for further research can be based on the estimation of health effects on the households' stockholding using panel data. Moreover, the research of the relationship between health and stock market participation should be further controlled for the influences of other factors, such as religion, bequest motives as well as social and biological factors. Besides investigating the influences of health factors on stockholding for older people, younger households can be considered as well.

References

Ameriks, John and Zeldes, Stephen P., “How Do Household Portfolio Shares Vary With Age?” *Working paper,* Columbia University, Graduate School of Business (2004)

Atella, Vincenzo, Brunetti, Marianna and Maestas, Nicole, “Household Portfolio Choices, Health status and Health Care Systems: A cross-country analysis based on SHARE.” *Journal of Banking and Finance* 36 (2012): 1320–1335

Berkowitz, Michael K. and Qiu, Jiaping, "A further look at household portfolio choice and health status." J*ournal of Banking & Finance*, vol. 30(4), (April 2006): 1201-1217

Bertocchi, Graziella, Brunetti, Marianna and Torricelli, Costanza, “Marriage and other risky assets: A portfolio approach.” *Journal of Banking & Finance*, vol. 35(11) (November 2011): 2902-2915

Bogan, Vicki L. and Fertig, Angela R., “Portfolio Choice and Mental Health.” *Review of Finance, Forthcoming* (2012). Available online: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1507190 (Accessed on May 12, 2012)

Brooks, Chris. *Introductory Econometrics for Finance*. 2nd ed. Cambridge University Press, 2008

Carroll, Christopher D. and Kimball, Miles S., “Precautionary Saving and Precautionary Wealth.” *Economics Working Paper Archive 530*, The Johns Hopkins University, Department of Economics (2006)

Christelis, Dimitris, Jappelli, Tullio and Padula, Mario, “Cognitive abilities and portfolio choice." *European Economic Review*, vol. 54(1), (January 2010): 18-38

Christelis, Dimitrios, Jappelli, Tullio and Padula, Mario, “Wealth and Portfolio Composition.” *CSEF Working Papers 132*, Centre for Studies in Economics and Finance (CSEF), University of Naples, Italy (2005)

Coile, Courtney and Milligan, Kevin, “What Happens to Household Portfolios After Retirement.” *Issues in Brief* ib2006-56, Center for Retirement Research (Nov 2006)

Delavande, Adeline and Rohwedder, Susann, “Individuals' Uncertainty about Future Social Security Benefits and Portfolio Choice.” *Working Papers 782, RAND Corporation Publications Department* (2010)

Edwards, R.D., “Health risk and portfolio choice.” (2005) Available online: http://qcpages.qc.edu/~redwards/Papers/edwards-hr-jbes-final.pdf (Accessed on March 5, 2012)

Edwards, Ryan D., “Health risk and portfolio choice.” *Journal of Business & Economic Statistics* 26 (4) (2008): 472–485

Fan, Elliott and Zhao, Ruoyun, “Health status and portfolio choice: Causality or heterogeneity?" *Journal of Banking & Finance*, vol. 33(6), (June 2009): 1079-1088

Fisher, Irving. *The Theory of Interest*. New York: Macmillan (1930)

Fisher, Malcoln R., “Exploration in savings behaviour.” *Oxford University Institute of Statistics Bulletin* 18 (1956): 201-277

Friedman, Milton. *A Theory of the Consumption Function.* Princeton: Princeton University Press (1957)

Gollier, Christian and Pratt, John W, “Risk Vulnerability and the Tempering Effect of Background Risk.” *Econometrica*, Econometric Society, vol. 64(5) (September 1996): 1109-112

Geyer, Alois. *Basic Financial Econometrics Lecture Notes.* Vienna Graduate School of Finance, March 11, 2010

Greene,William. *Econometric Analysis.* 5th ed. Prentice-Hall, Upper Saddle River, NJ, 2003

Heaton, John and Lucas, Deborah J., “Evaluating the Effects of Incomplete Markets on Risk Sharing and Asset Pricing.” *Journal of Political Economy*, University of Chicago Press, vol. 104(3) (June 1996): 443-487

Heaton, John and Lucas, Deborah, “Portfolio Choice in the Presence of Background Risk.” *Economic Journal, Royal Economic Society* vol. 110(460) (January 2000): 1-26

Harrod, Roy. *Towards a Dynamic Economics*. London: Macmillan. (1948)

Hochguertel, Stefan, "Precautionary motives and portfolio decisions." *Journal of Applied Econometrics*, vol. 18(1) (2003): 61-77

Kimball, Miles S., "Precautionary Saving in the Small and in the Large." *Econometrica*, Econometric Society, vol. 58(1) (January 1990): 53-73

Kimball, Miles S., "Standard Risk Aversion." *Econometrica*, Econometric Society, vol. 61(3) (May 1993): 589-611

King, Mervyn, "The Economics of Saving: A Survey of Recent Contributions." In Frontiers of Economics. Edited by K. Arrow and S. Houkapohja. New York: Basil Blackwell (1985): 227–294

Kliger, Doron and Levy, Ori, “Theories of choice under risk: Insights from financial markets.” *Journal of Economic Behavior & Organization*, vol. 71(2) (August 2009): 330-346

Leland, Hayne E., “Saving and Uncertainty: The Precautionary Demand for Saving.” *Quarterly Journal of Economics* 82 (1968): 465-473

Love, David A., and Paul A. Smith, "Does Health Affect Portfolio Choice?" *Health Economics*, vol. 19, no. 12 (2010): 1441-1460.

Love, David A., “The Effects of Marital Status and Children on Savings and Portfolio Choice." *Review of Financial Studies*, Oxford University Press for Society for Financial Studies, vol. 23(1) (January 2010): 385-432

Merton, Robert C., "Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case." *The Review of Economics and Statistics*. MIT Press, Vol. 51 No. 3, (August 1969): 247-257.

Modigliani, Franco and Brumberg Richard, “Utility analysis and the consumption function: An interpretation of cross-section data (1954).” Collected papers of Franco Modogliani (2005): 3-46

Qiu, Jiaping “Precautionary Savings and Health Insurance: A Portfolio Choice Perspective.”(2005) Available online: http://www.business.mcmaster.ca/finance/jiaping/paper/portfolioinsurance.pdf (accessed April 15, 2012)

Rosen, Harvey S. and Wu, Stephen, “Portfolio choice and health status." *Journal of Financial Economics*, vol. 72(3) (June 2004): 457-484

Sandmo, Agnar, “The Effect of Uncertainty on Saving Decisions.” *Review of Economic Studies* 37 (1970):353-360

SHARE. Questionnaire Wave 2. Version 2006-09-21. Available online: http://share-dev.mpisoc.mpg.de/fileadmin/pdf_questionnaire_wave_2/country_specific_questionnaire/Generic_version_english/Generic_Share_w2_Questionnaire.pdf (accessed May 24, 2012)

SHARE. Release Guide. (May 24th 2011). Available online: http://www.share-project.org/fileadmin/pdf_documentation/SHARE_release_guide.pdf (accessed on May 24, 2012)

SHARE. Tackling the Demographic Challenge. SHARE brochure. Available online: http://www.share-project.org/fileadmin/SHARE_Brochure/share_broschuere_web_final.pdf (accessed May 9, 2012)

Smith, James P., "Healthy Bodies and Thick Wallets: The Dual Relation between Health and Economic Status." *Journal of Economic Perspectives, American Economic Association* vol. 13(2) (Spring. 1999): 145-166

Toussaint-Comeau, Maude and Hartley, Jonathan, ”Health and the Savings of Insured versus Uninsured, Working-Age Households in the U.S.” *Chicago Fed Working Paper Series* WP 2009-23 (November 2009)

Wooldridge, Jeffrey. *Introductory Econometrics: A Modern Approach*. 2nd revised edition. South Western Educational Publishing, 2002

Wu, Stephen, "The Effects of Health Events on the Economic Status of Married Couples." *Journal of Human Resources*, vol. 38 No. 1 (2003): 219– 230

Yogo, Motohiro,”Portfolio Choice in Retirement: Health Risk and the Demand for Annuities, Housing, and Risky Assets." *NBER Working Papers* 15307, National Bureau of Economic Research, Inc (2009)

Appendices

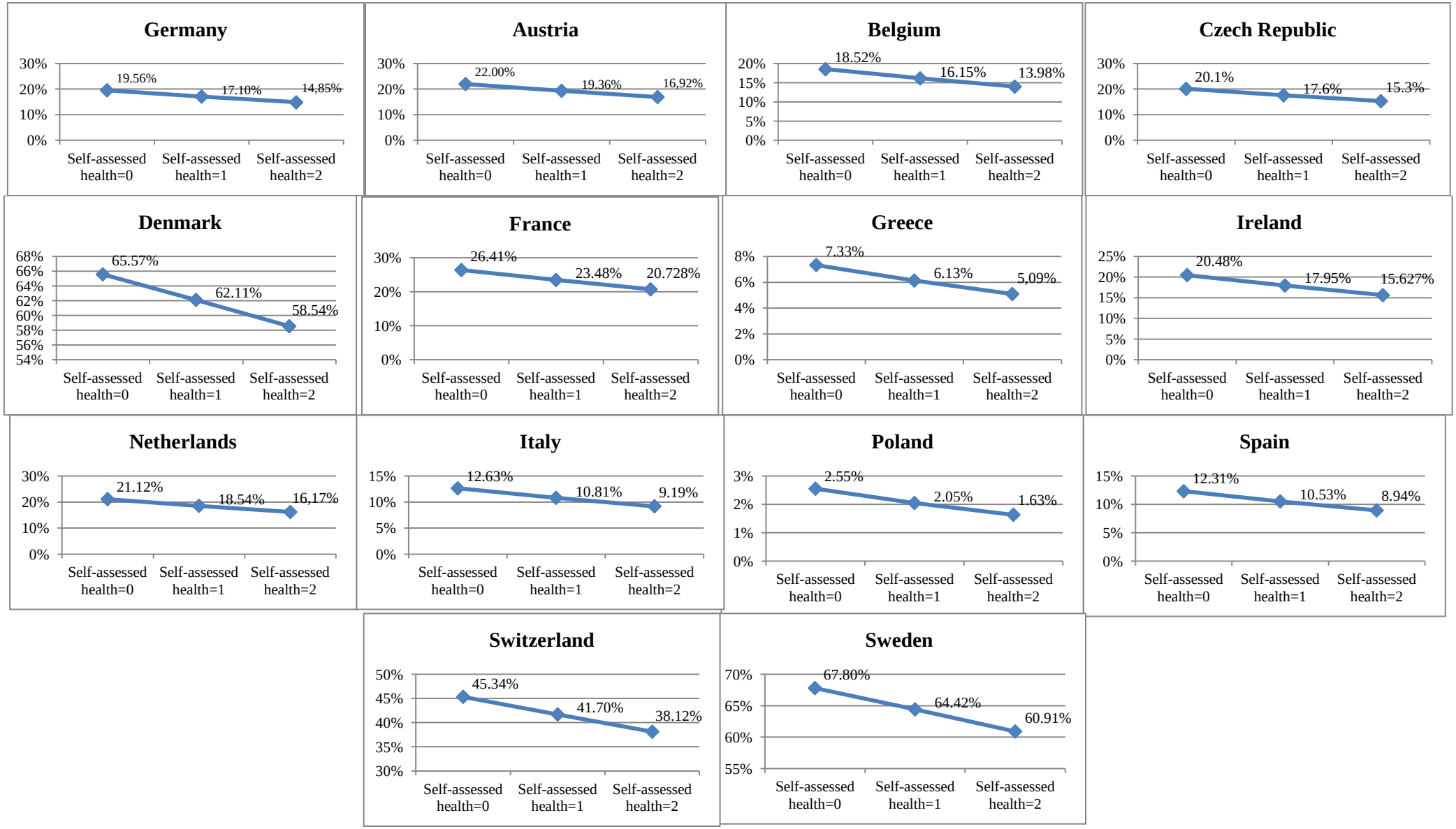
Appendix 1: Correlation matrix for all constructed health variables

	Self health 1	Self health 2	Self-assessed health	Chronic illnesses	Chronic illnesses 2	Symptoms	Symptoms 2	Mobility	Mobility 2	Limitations of daily activity	Limitations of daily activity 2	Limitations of instrumental activity	Limitations of instrumental activity 2	Mental health	Mental health 2
Self health 1	1.000	-0.612	0.884	0.463	0.399	0.489	0.419	0.507	0.453	0.285	0.315	0.323	0.355	0.406	0.325
Self health 2	-0.612	1.000	-0.803	-0.496	-0.410	-0.546	-0.453	-0.627	-0.513	-0.421	-0.406	-0.470	-0.454	-0.452	-0.346
Self-assessed health	0.884	-0.803	1.000	0.454	0.377	0.522	0.417	0.549	0.466	0.316	0.344	0.387	0.433	0.448	0.382
Limited activity	0.519	-0.542	0.509	0.447	0.389	0.485	0.435	0.510	0.476	0.275	0.312	0.322	0.369	0.347	0.271
Chronic illnesses	0.463	-0.496	0.454	1.000	0.795	0.600	0.458	0.502	0.446	0.276	0.305	0.314	0.348	0.341	0.264
Chronic illnesses 2	0.399	-0.410	0.377	0.795	1.000	0.461	0.424	0.401	0.391	0.183	0.224	0.219	0.269	0.270	0.214
Symptoms	0.489	-0.546	0.522	0.600	0.461	1.000	0.746	0.622	0.525	0.356	0.391	0.396	0.435	0.516	0.407
Symptoms 2	0.419	-0.453	0.417	0.458	0.424	0.746	1.000	0.471	0.459	0.215	0.264	0.261	0.324	0.414	0.336
Mobility	0.507	-0.627	0.549	0.502	0.401	0.622	0.471	1.000	0.779	0.588	0.577	0.625	0.613	0.453	0.348
Mobility 2	0.453	-0.513	0.466	0.446	0.391	0.525	0.459	0.779	1.000	0.290	0.382	0.354	0.453	0.362	0.292
Limitations of daily activity	0.285	-0.421	0.316	0.276	0.183	0.356	0.215	0.588	0.290	1.000	0.796	0.721	0.482	0.296	0.211
Limitations of daily activity 2	0.315	-0.406	0.344	0.305	0.224	0.391	0.264	0.577	0.382	0.796	1.000	0.578	0.495	0.301	0.235
Limitations of instrumental activity	0.323	-0.470	0.387	0.314	0.219	0.396	0.261	0.625	0.354	0.721	0.578	1.000	0.757	0.348	0.249
Limitations of instrumental activity 2	0.355	-0.454	0.433	0.348	0.269	0.435	0.324	0.613	0.453	0.482	0.495	0.757	1.000	0.346	0.272
Mental health	0.406	-0.452	0.448	0.341	0.270	0.516	0.414	0.453	0.362	0.296	0.301	0.348	0.346	1.000	0.777
Mental health 2	0.325	-0.346	0.382	0.264	0.214	0.407	0.336	0.348	0.292	0.211	0.235	0.249	0.272	0.777	1.000

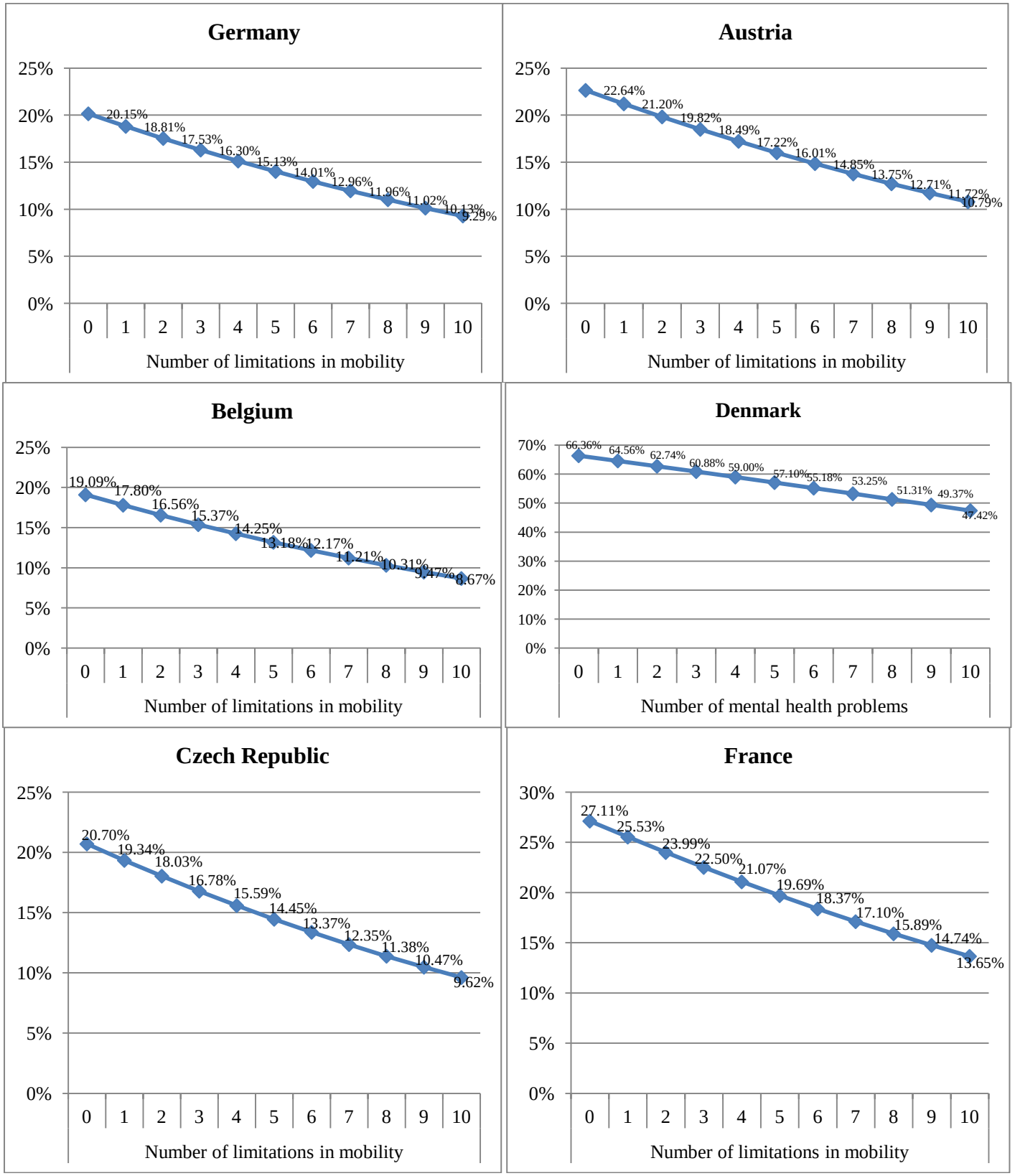
absolute of correlation is above 0.7

absolute value of correlation in between 0.5 and 0.7

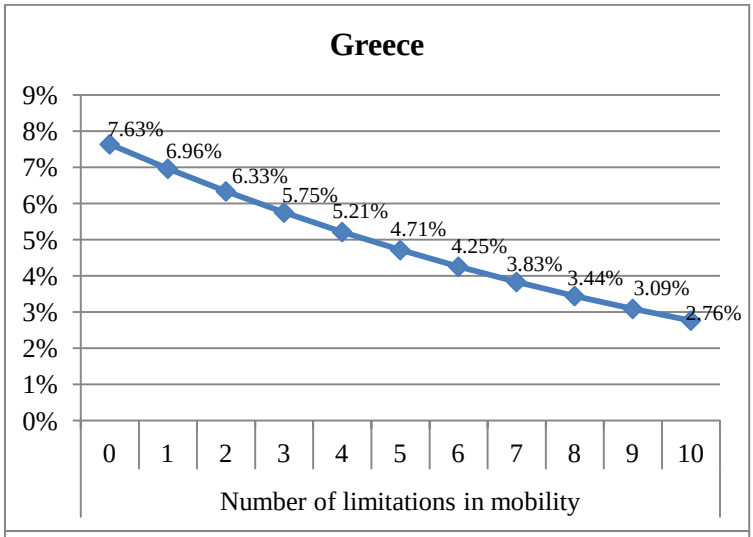
Appendix 2: Probability of total stock market participation with respect to the changes in the self-assessed health condition

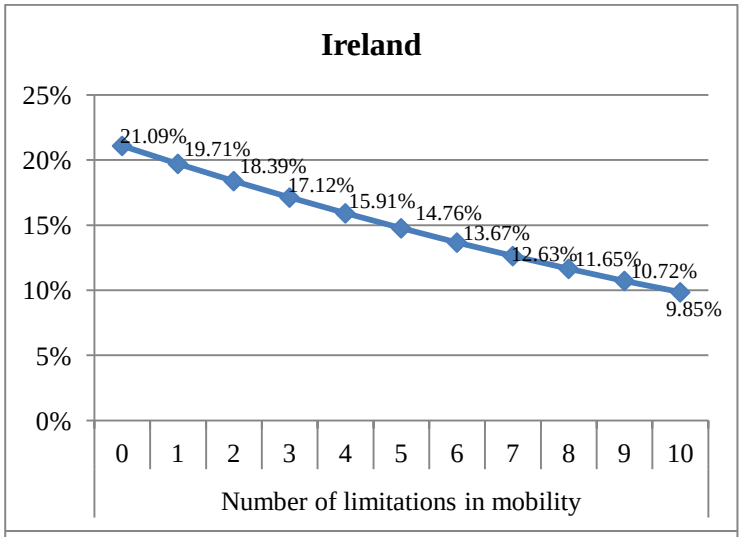


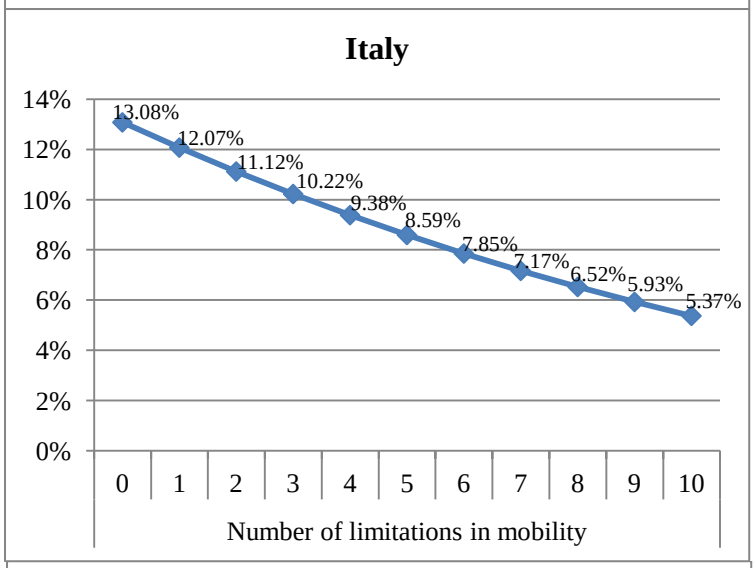
Appendix 3: Probability of total stock market participation with respect to the changes in the number of mobility limitations

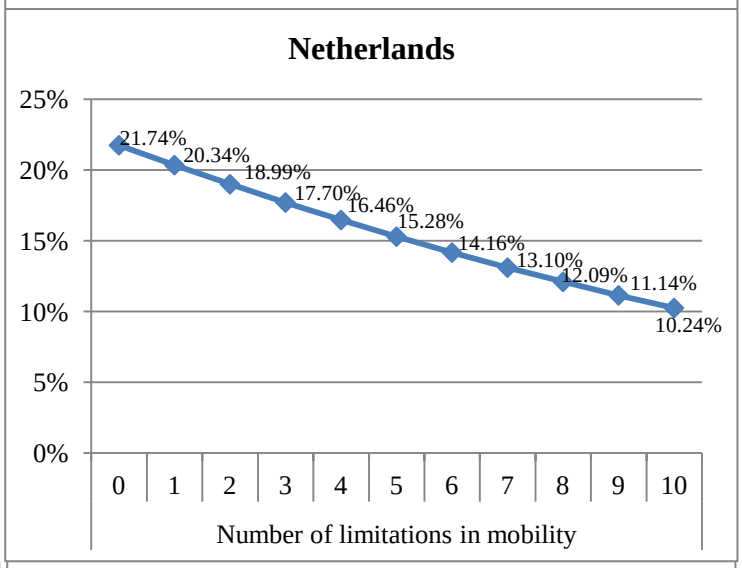


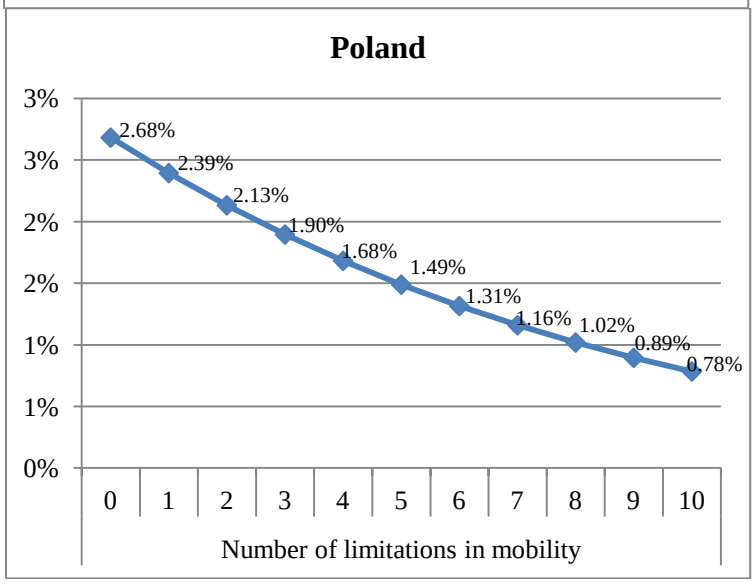
Appendix 3, continued: Probability of total stock market participation with respect to the changes in the number of mobility limitations

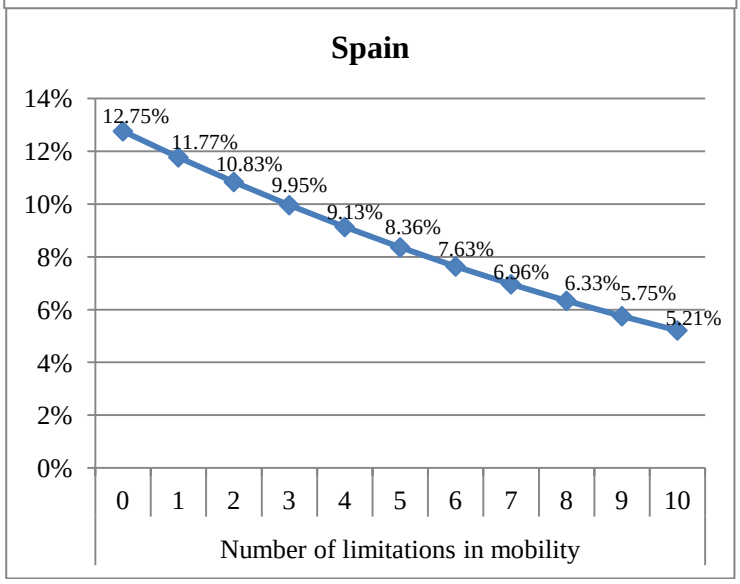












Appendix 3, continued: Probability of total stock market participation with respect to the changes in the number of mobility limitations