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What drives the association between health and portfolio choice?

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Abstract

There is a persistent association between health and portfolio choice, but hardly anything is known about the underlying sources of heterogeneity: what makes healthier individuals hold more risky assets? This paper uses rich Dutch longitudinal data to take into account and explain unobserved heterogeneity in the association between health and portfolio choice. We show that the association largely reflects unobserved heterogeneity, which is driven partly by behavioural variables. Yet even when adding an extensive set of behavioural variables including risk aversion, stock aversion, loss aversion, time preferences, and mental accounting, the association between health and portfolio choice does not completely vanish.

JEL Classification*:* C23, D14, G11, I19

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1. Introduction

Population ageing imposes severe challenges of financial sustainability on both the pension system and the health care system. The recent financial crisis has only exacerbated these challenges. Policy responses in the pension system involve a shift from defined benefit (DB) to defined contribution (DC) schemes, and are likely to increase reliance on individual retirement accounts and savings. In the health care sector, individuals will become more and more responsible for financing their own health care expenditures, by increased co-payments and by restrictions on health care services that are publicly financed (Atella et al., 2012). These trends imply that financial assets become increasingly important, arguably even crucial, for the financial security of households to finance consumption and to protect against financial risks associated with illness or widowhood. It is no surprise then that there has been a growing attention for household and individual portfolio choices over the last years.

The literature now quite generally assumes that background risks – risks that are uninsurable – are important determinants of portfolio decisions, and partly explain why households tend to invest less in risky assets than what would be predicted by traditional portfolio choice models (Markowitz, 1952). Individuals facing higher background risk tend to avoid other risks including stock market risk (Pratt and Zeckhauser, 1987, Eeckhoudt et al., 1996), commonly referred to as "temperance" (Kimball, 1991).

Given increased life expectancy and restrictions on health insurance coverage, background risk deriving from individual health status is becoming increasingly important (Campbell, 2006). Although life and health insurance are widely available, these markets are far from perfect (Atella et al., 2012). Individuals are generally not able to dynamically insure against future health shocks and medical expenditure risk (Goldman and Maestas, 2013, Edwards, 2008). This implies that health status and future health risks are an important source of background risk that may influence portfolio decisions (Edwards, 2008). Ill health may involve both direct costs in terms of health care expenses, but also indirect costs pertaining to reduced labor productivity, and possibly supply. Additionally, sudden illness may lead to a revision of subjective life expectancy (Campbell, 2006) and a revision of investment and savings plans (Smith and Love, 2010).

The literature has uniformly established an association between health and portfolio choice, with healthier individuals holding more risky assets. Since this finding is in line with the theory that healthier individuals face less background risk, it is tempting to attribute the association to a causal effect of health on portfolio choice. Yet, so far the literature is divided with respect to whether the reported association indeed represents causality or rather reflects unobserved heterogeneity. After all, numerous factors including household income, time preference, and risk-aversion will affect both portfolio choices and health investments, potentially producing a spurious association between health and portfolio choice.

In this paper we use detailed longitudinal data from the Dutch DNB household survey that allow us to compare OLS and Fixed Effects regression models to distinguish causality from heterogeneity. An additional advantage of the data is that it covers, next to the usual health measures, a detailed set of behavioral measures including risk aversion and time preference, which allows us to assess to what extent these factors contribute to unobserved heterogeneity in the association between health and portfolio choice.

The results show that overall there is a positive, but relatively weak, relationship between health and portfolio choice in the Netherlands, in line with the findings of Atella et al. (2012). Our results further suggest that the association between health and portfolio choice reflects heterogeneity rather than a causal effect of health on portfolio choice or vice versa. Individual preferences such as risk, stock, and loss aversion, mental accounting, and one's position relative to others significantly, yet only partly, drive the association between health and portfolio choice.

2. Related Literature

The relationship between income or wealth and health has long interested economists and other social scientists (Ettner, 1996, Meer et al., 2003, van Kippersluis et al., 2009). In contrast, there is only a small – but recently growing – literature on the relationship between health and portfolio choice, which is almost exclusively based upon the US Health and Retirement Study (HRS). The seminal study by Rosen and Wu (2004) estimates the association between self-reported health and (i) the probabilities of holding different types of financial asset and (ii) the share of risky assets in total financial assets. They find a positive association between health and both types of outcomes, even after controlling for measures of risk aversion, planning horizon, subjective life expectancy, optimism, bequest motives, and health insurance.

Two distinct, yet related, lines of research followed upon the work of Rosen and Wu (2004). The first series of studies assumes there is indeed an effect running from health to portfolio choice and uses the HRS to scrutinize the mechanisms through which the effect of health on portfolio choice operates. Berkowitz and Qiu (2006), for example, argue that the effect may be explained by the impact that a *health shock* has on the level of financial wealth. Edwards (2008) finds the effect of health status on portfolio choice to become insignificant once *future health risks* are taken into account. Coile and Milligan (2009) find that the association between health and portfolio choice is generally larger for individuals who have health impairments and difficulties with managing their finances. Cardak and Wilkins (2009), using the Australian HILDA survey, find that health primarily affects risky asset holdings through some proxies for risk and time preferences and that health is not a significant determinant of portfolio choice for retired households, possibly reflecting protection against ill health in Australia's National Health System (NHS). This result is confirmed by the study of Atella et al. (2012), who, using the European SHARE survey, show that, across ten European countries, health status and future health risks influence portfolio choices mainly in countries that do not have an NHS.

The second line of research doubts the robustness of the findings by Rosen and Wu (2004) and subsequent studies, questioning whether unobserved heterogeneity is properly taken into account. Smith and Love (2010) use the HRS and conclude that most of the effect of health on portfolio choice disappears after adequately controlling for unobserved heterogeneity. Only some effect is observed for married couples in the lowest health category. Fan and Zhao (2009) use the US New Beneficiary Survey in 1982 and 1991 and fixed effects models to conclude that the effect of health on portfolio choice reflects heterogeneity rather than causality. Yet, adverse health shocks that impede physical functioning such as a stroke or heart attack do lead to less risky portfolio choices, probably through future health risks.

Our reading of the literature is that while a serious *health shock* may lead individuals to move towards safer assets, the association between *health status* and portfolio choice seems largely driven by unobserved heterogeneity. Main limitation of the literature is that even though fixed effects models suggest that fixed, unobserved factors account for the association between health status and portfolio choice, it is unknown what these factors are. Most of the relevant factors such as time preference or risk aversion are constructs that are usually not, or only imperfectly, measured in the existing literature.

Our data covers many variables measuring individual preferences, such as aversion to risk and stocks, and time preferences, among many others, permitting to investigate whether these typically unobserved individual preferences are responsible for the association between health and portfolio choice. Hence, the main contribution of this paper is to help lifting the lid on unobserved heterogeneity in the association between health and portfolio choice.

3. Data and Methods

3.1 Data

This paper uses the Dutch DNB Household survey. The survey has been set up to investigate the wealth and asset formation of Dutch households, and as such provides ideal data to investigate the portfolio choices of individuals. The data forms a panel in the sense that individuals are followed for several years. Additional advantage of the data is that it covers, next to the usual health measures, a rich set of measures for risk aversion, time preference, and other individual characteristics and preferences.

We exclude individuals with an age below 50 for comparison with other studies on the association between health and portfolio choice, and since holding risky assets is rare below this age. Table 1 provides definitions of all variables used in the analysis, and the online Appendix gives background information on the questions used to create the behavioral variables.

Dependent variables – Portfolio choice

Following Rosen and Wu (2004), two dependent variables are used. The first dependent variable is a binary indicator that measures whether an individual holds any risky assets, and the second measures the share of risky assets over total financial assets. The DNB Household survey includes many variables with multiple components on main assets, debt and mortgages.

We follow the definition used by Noussair et al. (2013) to classify the following assets as risky: growth funds, mutual funds or mutual fund accounts, bonds or mortgage bonds as well as stocks and shares. Assets classified as safe are: checking accounts, savings or deposit accounts, deposit books, savings certificates, single premium annuity insurance policies and savings or endowment insurance policies. Table 2 shows that 34 percent of the sample (sample 4) holds risky assets, and the average share of risky assets over total financial assets is 15 percent.

Independent variable – Health status

The independent variable of interest is health status. In the DNB Household Survey, a self-assessed health measure is available which covers the range from very good to poor on a five point scale. A dummy for being in each state is created and employed in the analysis. Table 2 shows that 75 percent of the sample reports being in good or very good health.

Socio-demographic controls

The dataset includes important control variables which have already been used in previous research: age, age-squared, gender[1], marital status, whether the individual is the person most involved with the financial administration of the household, whether the individual has health insurance, size of the household, degree of urbanization, region, education, employment status, household income, and wave dummies. Household income is aggregate net income of all household members after deduction of taxes and social insurance premiums over the past 12 months in categories ranging from 1 (less than €10,000) to 6 (more than €75,000). The first lag of household income is employed in the estimations to reduce the problem of potential reverse causation.

The highest completed education level has been coded into the following categories: primary education, lower secondary education, higher secondary education, lower vocational education, higher vocational education and university education.[2]

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[1] One individual (five observations) has been dropped due to a change in gender, which is assumed to be misreporting.

[2] Some individuals report a decrease in highest education over time. This is likely to be a reporting error, possibly due to changes in the education system, and therefore these cases have been re-coded to their previous education level. This affected 2,831 observations or about 9% of the sample. Another 16% of the sample report an increase in their highest education, which seems surprising given that the sample is older than 50. However, since an increase is not impossible, these have not been re-coded.

Table 2 shows that the fraction of males in our sample is 68 percent, and the average age is around 64 (minimum age is 50 by definition; the oldest individual in the sample is 94). 75 percent of the sample is married, and 46 percent has retired.

Behavioral controls

The DNB Household Survey offers a wide range of variables on time and risk preferences as well as further behavioral variables which potentially affect the association between health and portfolio choice. These control variables are important for this research, but unfortunately they are not available in all waves. The behavioral controls are described in the order of their availability from most available to least available. The first set of the controls is available in all waves (1995-2013), the second set from 1995 to 2007, in 2009, and in 2011, the third set runs from 1996 to 2007 and from 2009 to 2011, and the fourth set is available from 1997 to 2002.

The first set covers variables related to risk, loss and stock aversion, as well as mental accounting. These variables are available in all waves. Risk aversion is based on the statement: "I think it is more important to have safe investments and guaranteed returns, than to take risk to have a chance to get the highest possible returns". The individual then agrees or disagrees with the statement on a scale from 1 (totally disagree) to 7 (totally agree). Loss and stock aversion are based on statements judged on the same scale. We define *stock aversion* as the answer to the statement: "I would never consider investments in shares because this is too risky". Loss aversion is based on the statement: "I am prepared to take the risk to lose money, when there is also a chance to gain money", where the scale is reversed, so that "totally disagree" is assigned a score of 7. Thaler (1980) defined mental accounting to be the irrational behavior of individuals to treat different subsets of their money differently, despite the fact that they are perfectly substitutable. In line with Thaler's definition, our mental accounting variable is based on a question whether the individual puts aside money for particular purposes where holidays, clothing, and rent are given as examples. If the individual puts aside money it is coded as mental accounting independently of whether he/she puts it on a separate bank account, hides it in his/her house or any other way.

The second set of behavioral controls consists of three variables concerning the social environment. All three social environment variables are based on questions concerning the individual's situation compared to that of others, with response scales ranging from 1 (totally disagree) to 7 (totally agree). The first variable (social comparison) is the average of the score on five questions related to whether the individual considers him/herself better off in financial terms than individuals in his/her environment. For details, see the Online Appendix. The second question (saving environment) asks whether most people in the individual's environment save money, representing the saving behavior in the individual's environment. The third question (reduction in expenditure) asks whether the individual's household could reduce expenditure by 5% without problems if necessary. These variables are available from 1995 to 2007; from 2007 onwards they were only asked bi-annually and are therefore also available in 2009, 2011, and 2013.

The third set covers a variable on myopic behavior. This variable is available in all waves except 1995 and 2008. Myopia refers to the tendency of individuals to focus on the short term at the expense of the long term. Our variable is the average of the score on eleven questions where the individual rates, on a scale from 1 (extremely uncharacteristic) to 7 (extremely characteristic), how close he/she agrees with statements relating pay-offs in the present and the future.

The fourth set of variables measure time preferences. These variables estimate the two parameters of the quasi-hyperbolic discounting function according to which an individual evaluates an income stream $(x_0, x_1, x_2, \dots, x_t)$ by

$$V(x_0, x_1, x_2, \dots, x_t) = u(x_0) + \beta \sum_{t=1}^{\infty} \delta^t u(x_t),$$

where x_k denotes income to be received in period k (Laibson, 1997).

Quasi-hyperbolic discounting reflects present-biased time preferences. If β were equal to one, the individual would discount the future at a constant rate, and δ would be the standard discount factor used to distinguish between subsequent periods. The present-bias parameter β can be viewed as an extra discount applied to the whole future, to distinguish the present from any future period. Sixteen time-preference questions yielded eight estimates of β and eight estimates of δ for each individual, where we assumed linear utility $u(x) = x$. The variables Beta and Delta are the averages of the estimates of β and δ, respectively. These variables are available from 1997 to 2002.

After dropping individuals below 50 a panel of 543 remains for the sample in which all variables are available running from 1997 to 2002. The sample with only the first set of behavioral controls (risk, stock, and loss aversion, and mental accounting) has 7,151 observations and runs from 1995 to 2013.

Table 2 provides descriptive statistics for all variables used in the estimation to show whether the means of key variables differ between samples. Apart from slight differences between the smallest sample including time preferences and the other samples, overall the samples are comparable.

3.2 Methods

First, the association between portfolio choice and health is established using a pooled OLS regression, before it is scrutinized by a number of standard control variables derived from the literature. Both the binary indicator whether the individual holds any risky assets and the share of risky over total financial assets are used as dependent variables with self-assessed health as the independent variable of interest. The second step is to include individual fixed effects, to investigate whether, as in the literature, the association disappears when controlling for unobserved heterogeneity.

The remaining steps go beyond the literature by exploring unobserved heterogeneity in the health-portfolio choice association in more detail. We do so in two separate ways in steps 3 and 4. The third step introduces the behavioral variables into the pooled OLS regression to explore whether we can reproduce the fixed effects results by running a pooled OLS regression including behavioral variables that were so far unobserved in the literature and would normally be captured in the fixed effect. Including those variables in the pooled OLS regressions allows gauging whether these behavioral concepts are responsible for the association between portfolio choice and health. A complication is that these variables are not all available for the same number of waves, which we will take into account by using consistent samples when comparing across models. In the estimation models all behavioral variables are lagged to ensure they were determined before portfolio choice in the current period.

The second way of exploring unobserved heterogeneity, and our fourth step, is an auxiliary regression. During step two, the fixed effect was extracted.[3] We determine whether the average levels of the behavioral variables are determinants of this individual specific fixed effect using pooled OLS, to directly investigate whether our behavioral variables contribute to unobserved heterogeneity.

4. Results

Table 3 shows that the Dutch data roughly follows the pattern observed in US data. An association between health and portfolio choice exists, with the people reporting their health to be "excellent" or "good" significantly holding more risky assets compared to those in fair health. The point estimates indicate that those in excellent self-reported health are 12 percentage points

[3] Stata implements the fixed effect model by subtracting the individual mean over all waves and adding the overall mean. Hence, when extracting the individual specific intercept from models in Stata, the result is the deviation from the overall mean.

more likely to hold any risky assets, and have a 5 percentage point higher share of risky assets over total financial assets, compared to those in fair health (see columns 1 and 2). After introduction of a basic set of demographic and socioeconomic control variables the association becomes smaller for both outcome measures, but is still statistically significant (see columns 3 and 4). This is a first indication that the association between health and portfolio choice at least partly reflects the influence of variables associated with both health and portfolio choice.[4]

Exploiting the panel dimension via a fixed effect model (bottom of table 3) leads to a vanishing of the association for both outcomes,[5] in line with results presented by Fan and Zhao (2009) and Smith and Love (2010), which suggests that the association between health and portfolio choice is further influenced by some unobserved time-invariant variables. In the remainder, we will investigate whether our dataset includes some of these (time-invariant) variables affecting health and portfolio choice.

[Table 3 – about here]

Table 4 presents pooled OLS results for the dependent variable whether the individual holds any risky assets, now gradually adding our behavioral control variables. In column (1) we reproduce the association between health and portfolio including the basic set of demographic control variables from column 3 of Table 3. Column 2 adds the behavioral control variables relating to risk aversion, stock aversion, loss aversion, and mental accounting. This leads to a reduction in the size of the association between self-reported health and possessing any risky assets. Yet, adding these behavioral variables does not fully dissolve the association between "excellent" or

[4] Coefficients for control variables are not reported, but are available upon request.

[5] Only for holding any risky assets, in the Fixed Effects model without any control variables, the association is statistically significant at 5% for the self-reported health value "Good". Yet, the coefficient becomes statistically insignificant as soon as we control for age, and the point estimate of the FE regression (0.0302) is less than half of the OLS coefficient (0.0666).

"good" self-assessed health and holding any risky assets. As expected, aversion to losses and stocks leads to a reduced probability of holding any risky assets. Interestingly, conditional on stock and loss aversion, risk aversion is positively associated with holding any risky assets. These results are counter-intuitive and multicollinearity has been explored as a reason. The correlation between the aversion measures varies between 0.21 (risk aversion and loss aversion) to 0.45 (stock aversion and loss aversion). The variance inflation factor for all measures is below 2, which does indicate some multicollinearity. However, a variance inflation factor of 2 is usually not considered a problem (Heij et al., 2004).

When including the social environment variables, the sample size drops from 7,151 to 4,188. Interestingly, the association between self-reported health and portfolio choice seems slightly stronger in this sample (compare column 2 and column 3), although we cannot reject equivalence of the coefficients. More importantly, when comparing columns 3 and 4 of Table 4, adding social environment variables hardly changes the association between self-reported health and holding any risky assets. The variables related to social environment are insignificant, except social comparison which has a positive effect on holding risky assets, indicating that people, who consider themselves to be better off than their peers, are more likely to hold any risky assets.

Adding the variable related to myopic behavior further reduces the sample to 3,546 observations. While individuals who are more myopic are less likely to hold any risky assets, myopic behavior does not seem to contribute to the observed health-portfolio choice association (compare columns 5 and 6 of Table 5).

Finally, we include the time preference variables in columns 7 and 8 of Table 5, which leads to a drastic reduction in sample size, leaving only 543 observations. Even in this smaller sample an association between health and portfolio choice exists. The size of the association seems to decrease somewhat due to the addition of our time preference variables 'Beta' and 'Delta', but the small sample size precludes drawing strong conclusions from this exercise. Moreover, the coefficients on Beta and Delta do not differ significantly from zero.

For the share of risky assets over total financial assets, adding behavioral control variables to the model does not qualitatively change our results compared to the case in which we only included a basic set of control variables (see Table 5). When comparing consecutive columns (thereby keeping the sample size constant), the coefficients for the self-reported health dummies show very little change, suggesting that our behavioral control variables explain little of the association between self-reported health and the share of risky assets over total financial assets.[6]

This does not mean that the behavioral variables do not influence the share of risky assets over total financial assets. In fact, both stock and loss aversions are significant in all models and reduce the extent of risky asset ownership. Social comparison is also significant when added to the model, implying that being better off than one's peers increases the extent of risky asset ownership. Myopia is also significant, where being more short-sighted is associated with a lower extent of risky asset ownership.

[Table 5 – about here]

The pooled OLS results discussed above suggest that our behavioral variables cannot fully explain the unobserved heterogeneity that seems to be driving the association between health and portfolio choice. An alternative, and more direct, way of investigating what drives unobserved heterogeneity is to use the individual fixed effects extracted from the regressions in columns 7 and 8 in Table 3 as dependent variable and regress the fixed effects on the mean of the

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[6] Interestingly, the association between self-assessed health and portfolio choice is much stronger in the final, smallest sample which includes time preference variables. Nonetheless, addition of the time preference variables does not affect the association, such that even in this selective sample the conclusion that time preference variables do not significantly affect the association between health and portfolio choice can be drawn.

behavioral variables. The extracted individual fixed effect reflects whether a certain individual exhibits above average intrinsic traits to own risky assets or to own a higher share of risky assets (Table 6).

The auxiliary regressions in Table 6 show that most of our behavioral variables are strongly associated with the time-invariant fixed effects. Stock and loss aversion are associated with a lower fixed effect, which suggests that aversion to stocks and aversions to losses are traits that make individuals invest less in risky assets. As before, conditional on stock and loss aversion, risk aversion is positively correlated to investments in risky assets. Mental accounting reduces the extent of ownership except in the smallest sample. The coefficients for short-run and long-run discount factor are very large and statistically significant (with one exception), providing tentative evidence that time preference is an important contributor to intrinsic preferences that determine stock-ownership.

[Table 6 – about here]

5. Conclusion

Given increased life expectancy, reduced health insurance coverage and other policy responses to tight budgets, individuals become increasingly responsible for protecting against financial risks such as sudden severe illness. Deteriorating health status and future health risks provide an important source of background risk, where ill health may involve both direct costs in terms of health care expenses, but also indirect costs pertaining to reduced labor productivity, and possibly supply. Given imperfect insurance markets and reduced health insurance coverage, it is vital to thoroughly understand the association between health and portfolio choice. The literature so far was divided on the question whether there is a causal relationship between health and portfolio choice, or whether the association reflects unobserved heterogeneity.

This paper contributes to this debate by exploiting rich Dutch longitudinal data to distinguish between these two hypotheses. Our results show that in the Netherlands, as in other countries, there is a clear association between health and portfolio choice, with healthier individuals holding more risky assets compared to their unhealthy peers. Fixed effects analyses, however, show that this association between health and portfolio choice does not derive from a causal effect of health on portfolio choice or vice versa. This suggests that time-invariant individual traits are responsible for the association, measures of which are typically unobserved in existing survey data. The DNB Household Survey that is employed in this paper does capture many of those hard-to-measure individual preferences and characteristics, and employing these is the main contribution of this paper.

Our variables measuring risk aversion, loss aversion, stock aversion, myopic behavior, and time preferences are all identified as relevant determinants of portfolio choice. Moreover, all of these behavioral variables also contribute to unobserved heterogeneity, as they are strongly associated with the individual fixed effects extracted from the portfolio choice regressions. Given that the association between health and portfolio choice vanishes upon including individual fixed effects, this suggests that these factors partly drive the relationship between health and portfolio choice.

Nevertheless, directly including our behavioral variables in a pooled OLS regression of portfolio choice on self-assessed health does not strongly affect the association between health and portfolio choice. In other words, the association between self-assessed health and holding any risky assets still remains after controlling for an extensive set of behavioral factors including risk, loss, and stock aversion, time preference, and myopic behavior. This implies that there must be other unobserved variables that contribute to the association between health and portfolio choice. An important candidate is cognitive ability, which unfortunately is not available in our data, but has been linked to both portfolio choice (Christelis, 2010), as well as health outcomes (Deary, 2008).

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Tables

Table 1 – Definitions of variables used

Variable name	Definition
Any risky assets	=1 if risky assets > 0
Share of risky assets	Risky assets / (risky assets + safe assets)
Self-assessed health	5 point scale of self-assessed health ranging from Very Good (1) to Poor (5)
Age	Age in years
Age-squared	Age in years squared
Gender	=0 being female, =1 being male.
Marital status	Dummies for each of the following: married with community of property, married with marriage settlement, divorced, living together, widowed, never married
Main financial decision maker	=1 if the respondent is the person most involved with the financial administration of the household
Insured	=1 if the respondent has health insurance
Household size	Split up into seven dummies for household sizes of 1 to 6, or >6
Urbanization	Split up into dummies for degree of urbanization: 1 equals very high and 5 very low degree of urbanization
Region	Dummies for the regions: Amsterdam, Rotterdam, The Hague; other West parts; North; East; South
Education	Nine dummies capturing the following education levels: special education, kindergarten and primary, pre-vocational, pre-university, senior vocational or apprenticeship, vocational colleges, university
Employment Status	Dummies for employed, unemployed, housekeeping, studying, retired
Household income	Dummies for household income: below €10,000; between € 10,000 and € 14,000; between € 14,000 and € 22,000; between € 22,000 and € 40,000; between € 40,000 and € 75,000 and € 75,000 or more
Wave	Dummies for each covered in the respective sample
Risk aversion	Risk aversion index, ranging from 1 to 7; a higher category indicating more risk aversion
Stock aversion	Stock aversion index, ranging from 1 to 7; a higher category indicating more stock aversion
Loss aversion	Loss aversion index, ranging from 1 to 7; a higher category indicating more loss aversion
Mental Accounting	=1 if the respondent uses mental accounting
Social comparison	Index of social comparison on a range from 1 to 7, where higher numbers indicate the individual being better off than his/her peers
Saving environment	Index ranging from 1 to 7, where higher numbers indicate an environment where individuals save money for the future
Reduction in expenditure	Index ranging from 1 to 7, where higher numbers show the ability to reduce expenditure by 5% without problems
Myopia	Index ranging from 1 to 7, where higher numbers indicate more myopic behavior
Beta	Present-bias parameter β of quasi-hyperbolic discounting
Delta	Discount factor δ of quasi-hyperbolic discounting

Table 2: Means of variables used per sample

Variable name	Sample 4 N=7,151	Sample 3 N=4,188	Sample 2 N=3,546	Sample 1 N=543
Any risky assets	0.34	0.34	0.35	0.42
Share of risky assets	0.15	0.15	0.15	0.20
Self-assessed health				
Very Good	0.12	0.11	0.11	0.12
Good	0.63	0.63	0.63	0.61
Fair	0.20	0.21	0.21	0.21
Not so good	0.04	0.04	0.04	0.04
Poor	0.01	0.01	0.01	0.01
Age	64.06	63.72	63.34	61.77
Age-squared	4177.14	4133.89	4085.48	3882.74
Gender	0.68	0.68	0.68	0.73
Marital Status				
Married (community of prop.)	0.67	0.67	0.67	0.65
Married (with settlement)	0.08	0.08	0.08	0.08
Divorced	0.07	0.07	0.07	0.08
Living together	0.03	0.03	0.03	0.04
Widowed	0.08	0.07	0.07	0.07
Never married	0.08	0.08	0.08	0.08
Main financial decision maker	0.80	0.80	0.80	0.83
Insured	1.00	1.00	1.00	1.00
Household size				
1	0.21	0.21	0.21	0.21
2	0.65	0.64	0.64	0.63
3	0.07	0.06	0.06	0.08
4	0.05	0.06	0.06	0.06
5	0.02	0.02	0.02	0.02
6	0.00	0.00	0.00	0.01
>6	0.00	0.00	0.00	0.00
Urbanization				
Very high degree	0.14	0.15	0.15	0.16
High degree	0.26	0.25	0.25	0.24
Moderate degree	0.22	0.22	0.22	0.23
Low degree	0.22	0.21	0.21	0.19
Very low degree	0.16	0.17	0.17	0.18
Region				
Amsterdam, Rotterdam, The Hague	0.16	0.17	0.17	0.15
Other West parts	0.30	0.29	0.29	0.31
North	0.11	0.11	0.11	0.08
East	0.18	0.18	0.18	0.22
South	0.25	0.25	0.25	0.24

Continued on the next page

Education				
Primary Education	0.03	0.03	0.03	0.02
Lower Secondary Education	0.22	0.23	0.22	0.15
Higher Secondary Education	0.13	0.14	0.14	0.14
Lower Vocational Education	0.21	0.22	0.23	0.31
Higher Vocational Education	0.28	0.27	0.26	0.27
University Education	0.13	0.12	0.12	0.10
Employment Status				
Working	0.32	0.33	0.34	0.38
Unemployed	0.02	0.02	0.02	0.01
Housekeeping	0.10	0.10	0.10	0.09
Studying	0.00	0.00	0.00	0.00
Retired	0.46	0.44	0.43	0.37
Household income				
less than € 10,000	0.00	0.00	0.00	0.00
between € 10,000 and € 14,000	0.02	0.01	0.01	0.04
between € 14,000 and € 22,000	0.10	0.08	0.08	0.14
between € 22,000 and € 40,000	0.30	0.26	0.28	0.40
between € 40,000 and € 75,000	0.43	0.47	0.46	0.31
€ 75,000 or more	0.15	0.18	0.17	0.11
Risk aversion	5.28	5.20	5.20	5.32
Stock aversion	4.57	4.55	4.49	4.24
Loss aversion	5.56	5.53	5.51	5.18
Mental Accounting	0.31	0.30	0.31	0.28
Social comparison		3.95	3.95	4.11
Saving environment		4.19	4.20	4.35
Reduction in expenditure		4.86	4.86	5.21
Myopia			3.97	3.89
Beta				0.99
Delta				1.00

Table 3: Association between portfolio choice and health before and after introducing a fixed effect

	OLS without further control variables		OLS with further control variables	
	Holding of any risky assets N=7,151	Share of risky assets N=7,151	Holding of any risky assets N=7,151	Share of risky assets N=7,151
Column	1	2	3	4
Self-assessed health				
Very good	0.1240***	0.0500**	0.0770**	0.0305*
Good	0.0666***	0.0244*	0.0400*	0.0140
Not so good	0.0143	0.0397	0.0125	0.0288
Poor	-0.0078	-0.0462	0.0333	-0.0341
Constant	0.2805***	0.1253***	0.2448	0.6585**
	FE without further control variables		FE with further control variables	
	Holding of any risky assets N=7,151	Share of risky assets N=7,151	Holding of any risky assets N=7,151	Share of risky assets N=7,151
Column	5	6	7	8
Self-assessed health				
Very good	0.0375	0.0190	0.0241	0.0146
Good	0.0302**	0.0139	0.0198	0.0101
Not so good	-0.0065	0.0084	0.0128	0.0130
Poor	-0.1207*	-0.0025	-0.0984	-0.0013
Constant	0.3153***	0.1365***	0.6255	1.4842**

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The regressions in columns 3 and 4 control for age, age-squared, marital status, financial responsibility, insurance, household size, degree of urbanization, region, education, employment status, household income and wave dummies (results for control variables available upon request). The omitted category for self-assessed health is "Fair".

Table 4: Pooled-OLS with added behavioral controls for the dependent variable holding any risky assets

	Any risky assets N=7,151	Any risky assets N=7,151	Any risky assets N=4,188	Any risky assets N=4,188	Any risky assets N=3,546	Any risky assets N=3,546	Any risky assets N=543	Any risky assets N=543
Sample	Sample 4		Sample 3		Sample 2		Sample 1	
Column	1	2	3	4	5	6	7	8
Self-assessed health								
Very good	0.0770**	0.0546*	0.0825**	0.0753**	0.0690*	0.0649*	0.1451*	0.1188
Good	0.0400*	0.0386**	0.0561***	0.0517**	0.0545**	0.0539**	0.1113**	0.1001*
Not so good	0.0125	0.0273	0.0834*	0.0819*	0.0740	0.0700	0.0477	0.0547
Poor	0.0333	0.0344	0.0433	0.0462	0.0328	0.0358	0.1764	0.2280
Risk Aversion		0.0238***	0.0254***	0.0223***	0.0277***	0.0218***	0.0139	0.0027
Stock Aversion		-0.0808***	-0.0825***	-0.0810***	-0.0821***	-0.0783***	-0.0772***	-0.0687***
Loss Aversion		-0.0539***	-0.0525***	-0.0488***	-0.0515***	-0.0457***	-0.0446***	-0.0322**
Mental Accounting		-0.0208	-0.0260	-0.0251	-0.0248	-0.0272	-0.0103	0.0007
Social Comparison				0.0276***		0.0346***		0.0680***
Saving environment				0.0090		0.0049		0.0337**
Reduction in expenditure				0.0038		0.0064		0.0107
Myopia						-0.0417***		-0.0384
Beta								0.4834
Delta								-0.2081
Constant	0.2448	0.5800	0.9240*	0.7440	0.8306	0.8726	0.0363	-1.1313

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Controls not shown are: age, age-squared, marital status, financial responsibility, insurance, household size, degree of urbanization, region, education, employment status, household income and wave dummies (results for control variables available upon request). The omitted category for self-assessed health is "Fair".

Table 5: Pooled-OLS with added behavioral controls for the dependent variable share of risky assets

	Share risky assets N=7,151	Share risky assets N=7,151	Share risky assets N=4,188	Share risky assets N=4,188	Share risky assets N=3,546	Share risky assets N=3,546	Share risky assets N=543	Share risky assets N=543
Sample	Sample 4		Sample 3		Sample 2		Sample 1	
Column	1	2	3	4	5	6	7	8
Self-assessed health								
Very good	0.0305*	0.0188	0.0218	0.0207	0.0152	0.0170	0.1207***	0.1095**
Good	0.0140	0.0135	0.0163	0.0153	0.0128	0.0145	0.0769**	0.0692**
Not so good	0.0288	0.0351	0.0755**	0.0745**	0.0717*	0.0701*	0.1120	0.1165
Poor	-0.0341	-0.0343	-0.0284	-0.0317	-0.0325	-0.0369	0.1010	0.1161
Risk Aversion		0.0072***	0.0096***	0.0088***	0.0096***	0.0078**	0.0106	0.0062
Stock Aversion		-0.0415***	-0.0412***	-0.0402***	-0.0415***	-0.0394***	-0.0503***	-0.0452***
Loss Aversion		-0.0279***	-0.0268***	-0.0254***	-0.0250***	-0.0227***	-0.0368***	-0.0314***
Mental Accounting		-0.0194**	-0.0157	-0.0148	-0.0134	-0.0140	-0.0046	-0.0032
Social Comparison				0.0205***		0.0227***		0.0369**
Saving environment				-0.0031		-0.0062		0.0024
Reduction in expenditure				-0.0020		-0.0016		0.0043
Myopia						-0.0224***		-0.0391**
Beta								-0.0789
Delta								-1.5408
Constant	0.6585**	0.8590***	1.3223***	1.2265***	1.3275***	1.3541***	1.5133*	2.7035

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Controls not shown are: age, age-squared, marital status, financial responsibility, insurance, household size, degree of urbanization, region, education, employment status, household income and wave dummies (results for control variables available upon request). The omitted category for self-assessed health is "Fair".

Table 6: Results for regressing the fixed effects (extracted from fixed effect model) on behavioral controls

			Dependent Variable: Fixed effect of holding any risky assets				
	N=7,151	N=4,188	N=4,188	N=3,546	N=3,546	N=543	N=543
Sample	Sample 4	Sample 3		Sample 2		Sample 1	
Column	1	2	3	4	5	6	7
Risk Aversion	0.0371***	0.0324***	0.0281***	0.0344***	0.0282***	0.0254	0.0170
Stock Aversion	-0.0845***	-0.0808***	-0.0778***	-0.0813***	-0.0761***	-0.0935***	-0.0865***
Loss Aversion	-0.0652***	-0.0628***	-0.0576***	-0.0606***	-0.0533***	-0.0282*	-0.0204
Mental Accounting	-0.0672***	-0.0702***	-0.0641***	-0.0684***	-0.0636***	-0.0497	-0.0325
Social Comparison			0.0319***		0.0385***		0.0610**
Saving environment			-0.0046		-0.0115		0.0390**
Reduction in expenditure			0.0137**		0.0154**		-0.0001
Myopia					-0.0307*		0.0042
Beta							1.4841***
Delta							7.4639**
Constant	0.5729***	0.5512***	0.3582***	0.5332***	0.4424***	0.5017***	-8.8534**
			Dependent Variable: Fixed effect of share risky assets				
	N=7,151	N=4,188	N=4,188	N=3,546	N=3,546	N=543	N=543
Sample	Sample 4	Sample 3		Sample 2		Sample 1	
Column	1	2	3	4	5	6	7
Risk Aversion	0.0146***	0.0126***	0.0114***	0.0136***	0.0121***	0.0147	0.0134
Stock Aversion	-0.0438***	-0.0402***	-0.0384***	-0.0410***	-0.0386***	-0.0556***	-0.0524***
Loss Aversion	-0.0349***	-0.0344***	-0.0324***	-0.0333***	-0.0309***	-0.0247***	-0.0226**
Mental Accounting	-0.0469***	-0.0447***	-0.0412***	-0.0451***	-0.0416***	-0.0377	-0.0310
Social Comparison			0.0236***		0.0261***		0.0403***
Saving environment			-0.0102**		-0.0145***		0.0079
Reduction in expenditure			0.0021		0.0026		-0.0115
Myopia					-0.0094		0.0028
Beta							0.5898**
Delta							3.3665
Constant	0.3312***	0.3113***	0.2375***	0.3067***	0.2704***	0.3349***	-3.7690*

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable is the fixed effect extracted from the regressions in columns 3 and 4 in the bottom of Table 3.

Online Appendix – Creation of behavioral control variables

This appendix outlines the definitions of the behavioral control variables. For each variable first the survey questions used are presented and then the definition of the variable is given.

Risk aversion:

The measure of risk aversion was created using the following statement to which the individual agreed or disagreed on a scale from 1 (totally disagree) to 7 (totally agree). The statement was: ”I think it is more important to have safe investments and guaranteed returns, than to take a risk to have a chance to get the highest possible returns.”. The responses were cleaned dropping missing variables and responses outside the range of 1 to 7.

Loss aversion:

The measure of loss aversion was created using the following statement to which the individual agreed or disagreed on a scale from 1 (totally agree) to 7 (totally disagree). The statement was: “I am prepared to take the risk to lose money, when there is also a chance to gain money.”. The responses were cleaned dropping missing variables and responses outside the range of 1 to 7.

Stock aversion:

The measure of stock aversion was created using the following statement to which the individual agreed or disagreed on a scale from 1 (totally disagree) to 7 (totally agree). The statement was: ”I would never consider investments in shares because I find this too risky.”. The responses were cleaned dropping missing variables and responses outside the range of 1 to 7.

Mental accounting:

Mental accounting is a dummy variable based on answering the following question positively: “Do you put money aside for particular purposes (holidays, clothes, rent etc.) frequently, in order to reserve separate amounts for different expenditures? For example, by depositing money into separate bank or giro accounts, or by putting money in separate envelopes or jars.”. The possible answers were: no (1), separate bank or giro accounts (2), separate envelopes or jars/boxes, or in another way in your own house (3), other ways (4). All positive replies (2-4) were coded as mental accounting and no (1) was coded as no mental accounting.

Social comparison:

The social comparison variable is based on five statements to which the individual agreed or disagreed on a scale from 1 to 7, with 1 being totally disagree and 7 being totally agree. The statements were:

- Compared to others in my environment, I am better off.
- I think I have more assets than others in my environment.
- Other people in my environment have more money to spend than I.
- If I compare myself with my friends, I think in general I am financially better off.
- I can spend more on durable consumer goods than others in my environment.

The variable capturing social comparison is the average of the responses to these statements. However, before averaging the responses the third statement is inversed as the statement is negatively phrased.

Saving environment

The saving environment variable is based on a statement to which the individual agreed or disagreed on a scale from 1 (totally disagree) to 7 (totally agree). The statement was: "Most people in my environment are saving money".

Reduction in expenditure

The reduction in expenditure variable is based on a statement to which the individual agreed or disagreed on a scale from 1 (totally disagree) to 7 (totally agree). The statement was: "If necessary, we/I can reduce our/my household's expenditures by 5% without a problem".

Myopia

The variable on myopia is based on eleven statements, which the individual judges as characteristic of him/herself or not, the scale is from 1 (extremely uncharacteristic) to 7 (extremely characteristic). The statements are:

1. I think about how things can change in the future, and try to influence those things in my everyday life.
2. I often work on things that will only pay off in a couple of years.
3. I am only concerned about the present, because I trust that things will work themselves out in the future.
4. With everything I do, I am only concerned about the immediate consequences (say a period of a couple of days or weeks).
5. Whether something is convenient for me or not, to a large extent determines the decisions that I take or the actions that I undertake.
6. I am ready to sacrifice my well-being in the present to achieve certain results in the future.
7. I think it is important to take warnings about negative consequences of my acts seriously, even if these negative consequences would only occur in the distant future.
8. I think it is more important to work on things that have important consequences in the future, than to work on things that have immediate but less important consequences.
9. In general, I ignore warnings about future problems because I think these problems will be solved before they get critical.
10. I think there is no need to sacrifice things now for problems that lie in the future, because it will always be possible to solve these future problems later.
11. I only respond to urgent problems, trusting that problems that come up later can be solved in a later stage.

The variable Myopia is the average of the responses to these statements, but before averaging the responses to statement 1,2,6,7, and 8 are reverse coded to ensure that larger scores indicate more focus on the present and less on the future.

Delta

Delta represents δ in the quasi-hyperbolic discount function

$$V(x_0, x_1, x_2, \dots, x_t) = u(x_0) + \beta \sum_{t=1}^{\infty} \delta^t u(x_t),$$

where we assume linear utility $u(x) = x$. Delta is calculated using the following questions:

1. Imagine you win a prize of Dfl. 1000 (€ 454) in the National Lottery. The prize has to be paid out today. Imagine, however, that the lottery asks if you are prepared to wait THREE MONTHS before you get the prize. There is no risk involved in this wait.
   How much extra money would you ask to receive AT LEAST to compensate for the waiting term of three months?
2. Now imagine that the National Lottery asks if you are prepared to wait A YEAR before you get the prize of Dfl. 1000 (€ 454). There is no risk involved in this wait.
   How much extra money would you ask to receive AT LEAST to compensate for the waiting term of a year? If you agree on the waiting term without the need to receive extra money for that, please type 0 (zero).

These questions are repeated with different amounts (750, 1000 and 100000) and asking for the present equivalent of a future amount instead of the future equivalent of a present amount. From questions 1 and 2 as illustrated above, δ can be computed as

$$\delta = \left(\frac{(1000 + answer\ to\ question1)}{(1000 + answer\ to\ question2)}\right)^{1/9}$$

where time is given in terms of months. The variable Delta is computed as the average over all values of δ.

<u>Beta</u>

Beta represents β in the quasi-hyperbolic discount function

$V(x_0, x_1, x_2, \dots, x_t) = u(x_0) + \beta \sum_{t=1}^{\infty} \delta^t u(x_t)$,

where we assume linear utility $u(x) = x$. It is based on the same questions as Delta. From questions 1 and 2 as illustrated above, β can be computed as

$$\beta = \frac{1000}{1000 + answer\ to\ question1} * \delta^{-3}$$

where time is given in terms of months. The variable Beta is computed as the average over all values of β.