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Health and the Marginal Utility of Consumption

Estimating Health State Dependence using Equivalence Scales

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Abstract

This paper estimates health state dependence in Europe. We develop a new approach that builds upon the approach by Finkelstein et al. (2013), and uses insights from the research domain of living standards and income adequacy. We estimate how much extra income is needed to keep financial wellbeing equal after a health shock, and we derive a simple relation between this estimate and the parameter for health state dependence. We find positive health state dependence, with a proportionality factor equal to 0.284 in the presence of ADL limitations. The positive health state dependence is not driven by medical expenditures, and the result is robust against alternative specifications and health measures such as mobility, IADL and the number of chronical diseases. Interestingly, for cognitive limitations we find negative health state dependence, presumably resulting from a decreased ability to plan, organize, and take initiatives.

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1 Introduction

Assumptions on the degree and sign of health state dependence, i.e. the change in marginal utility of consumption with health status, have large implications for the optimal design of social security systems and (long term) care insurance (Viscusi and Evans, 1990, and Finkelstein et al., 2013). Health state dependence influences the optimal level of life-cycle savings and the optimal level of health insurance. Health state dependence can also serve as an explanation for observed spending phenomena, such as the decreasing consumption path in old age (Börsch-Supan and Stahl, 1991, and Domeij and Johannesson, 2006).

Theoretically, health state dependence could be positive just as well as negative. Market services for physically demanding housework, like doing laundry, gardening, house-cleaning, and cooking, are natural substitutes for good health, raising the marginal utility of consumption in bad health. Leisure activities, on the other hand, are often seen as complements to good health (e.g. traveling may become less enjoyable in bad health), therefore decreasing the marginal utility of consumption. However, if individuals do not lose interest in leisure activities, but the activities become more costly due to the extra help or comfort that they need (e.g. travel assistance rather than solo traveling), the marginal utility of consumption rather increases. Without empirical grounding it is thus impossible to make assumptions on health state dependence.

Unfortunately, empirical work on the effects of health on consumption preferences provide ambiguous results. Research, mostly based on US data, shows evidence in favor of positive health state dependence (Finkelstein et al., 2013), in favor of negative health state dependence (Lillard and Weiss, 1997), and against the existence of health state dependence in either direction (De Nardi et al., 2010). The variation in outcomes may be attributed to the type of data and method used (Finkelstein et al., 2009, and Macé, 2015). However, there may also be important heterogeneities in the effect, so that the choice of sample and health measure may be the source of some of the variety in results. All these differences makes it difficult to draw conclusions from the body of empirical work.

In this paper we estimate health state dependence for European countries using the Survey of Health, Ageing and Retirement in Europe (SHARE). In order to do so we build upon a novel approach introduced by Finkelstein et al. (2013) and combine this approach with insights from the research domain of living standards and income adequacy (Pradhan and Ravallion, 2000). Finkelstein et al. (2013) use happiness as a direct proxy for utility and identify health state dependence by comparing the effect of a health shock on happiness for individuals with high and low permanent income. We take the same starting point, but instead of using a proxy for overall wellbeing, we investigate the effect of health shocks on financial wellbeing. We derive a 'health equivalence scale'[1] and show that health state dependence is a transformation of this parameter. Conditional on some assumptions, the two approaches should give similar results, but, given the higher signal-to-noise ratio of financial wellbeing data compared to general wellbeing data, we expect the latter approach to be more efficient. As with many approaches, we do not regard our new approach to be without any difficulties. However, a high signal-to-noise ratio could be important in the European setting, where longitudinal studies on individuals in old age have not been running for as many years as in the US.

The results indicate positive health state dependence in Europe. We show that the findings are not driven by medical expenditures. Furthermore, the results are robust against the use of different (physical) health measures and functional form assumptions. Using the original approach, based on overall wellbeing, we find estimates pointing in the same direction, but lacking the necessary precision to draw firm conclusions. Among the robustness checks we find one interesting anomaly: cognitive limitations lead to negative health state dependence. When cognitive health declines, the willingness to undertake (leisure) activities may decline and this may lower expenditures. On the other hand, with physical health problems leisure activities may become more expensive because of the extra help required.

The contribution of this paper to the literature is threefold. First, we extend on a novel approach introduced by Finkelstein et al. (2013) to estimate health state dependence. Second, we estimate health state dependence for a European rather than a US sample. And third, by analyzing different measures of physical and cognitive health, we provide insight into the mechanisms underlying health state

[1] We define the health equivalence scale as the relative change in income needed to maintain the same standard of living after a health shock. This equivalence scale is named after the common 'income equivalence scale', which measures the relative change in income needed to maintain the same standard of living with additional household members.

dependence.

The rest of the paper is set up as follows. In section 2 we discuss the theoretical and empirical model underlying the analysis. In section 3 we provide information on the data used, followed by the results of the empirical analysis in section 4. Finally, section 5 contains conclusions and a discussion.

2 Method

The contradictory results in the empirical work on the relation between health and the marginal utility of consumption can at large part be attributed to the different types of methods employed, as explained in both Finkelstein et al. (2009) and Macé (2015). Finkelstein et al. (2009) distinguish two classes of methods to investigate health-state dependence. The first class focusses on consumption itself. For example, one can investigate consumption responses to unexpected health shocks. Most methods in this class take an *ex-ante* approach: if there is some form of health state dependence and individuals are forward-looking, they can be expected to already reallocate resources across health states before they fall sick, so that more can be consumed when marginal utility is highest. One could thus exploit individuals' revealed demand for reallocating resources across health states to identify health state dependence. This can for example be done by investigating health insurance demand or by comparing consumption paths across individuals who vary in their predicted probability of entering poor health (Lillard and Weiss, 1997, and Butrica et al., 2009).

The second class of methods contains approaches focused on estimating the utility function itself. By comparing within-individual utility changes associated with a health shock for poor and rich individuals, one can identify the change in marginal utility of income due to a health shock. This can be done by using a direct proxy for utility, such as happiness (see Finkelstein et al., 2013). Another way is to ask individuals how much money they would require to compensate them for hypothetical exposure to specific health risks, and examine how these self-reported compensating differentials vary with income (Viscusi and Evans, 1990, Evans and Viscusi, 1991, and Sloan et al., 1998).

In this paper we build upon the second class of methods. We identify health state dependence by investigating within individual changes in observed financial wellbeing after a health shock. The main difference with the second class of methods described above is that we do not proxy overall utility changes after a health shock. Also, we do not ask people to report how much extra income they would require in the case of hypothetical health risks to keep overall utility the same. Instead, we compare the financial wellbeing of individuals before and after a health shock and we measure how much (extra or less) income is needed in the sick state to be financially as well off as in the healthy state. We show that this so-called 'health equivalence scale' is a simple transformation of the health state dependence parameter. The advantage of this approach is that we do not have to control for direct and indirect effects of health on subjective wellbeing that are unrelated to consumption.

Section 2.1 explains the theoretical framework in which the health state dependence parameter is analyzed. In addition, we show the relation between the health state dependence parameter and the 'health equivalence scale'. Section 2.2 explains how to estimate the health equivalence scale using data on financial wellbeing. Finally, the assumptions underlying our approach are laid out in section 2.3, together with the possible threats to identification.

2.1 Theoretical framework

Our theoretical framework builds upon that of Finkelstein et al. (2013). To ensure readability of this paper in itself, we give a short description of their model. For further details we refer to their paper.

Consider a retired individual with permanent income Y.[2] Let S denote an individual's health status. For expositional purposes we define health to be binary: one is either healthy ($S = 0$) or sick ($S = 1$). An individual lives two periods. In the first period the individual is healthy. In the second period a negative health shock arises with probability p. The health shock itself is unanticipated, but the individual is aware of his chances to fall ill.

We assume that retired individuals derive utility $U(C(S), S)$ from consumption (C) and health (S). Health thus has a direct effect on overall utility, but can also have an indirect effect on utility through consumption. This is in accordance with

[2] In line with Finkelstein et al. (2013) we select retired individuals who are not in the labor force, to ensure that health shocks do not influence permanent income.

Viscusi and Evans (1990) and Evans and Viscusi (1991), who show that an adverse health shock may not only lead to a utility drop, but could also alter the structure of the utility function (i.e., it may change the marginal utility of consumption). We are interested in this last part: how do health transitions affect the marginal utility of consumption.

Just as Finkelstein et al., we adopt the Epstein and Zin (1989) and Weil (1990) formulation of preferences, where lifetime utility aggregates first-period non-medical consumption C_1 and expected second-period utility according to:

$$\max \ U = \left(\frac{1}{1-\gamma}\right)\left(C_1^{1-\theta} + \frac{1}{1+\delta}((1-\gamma)E_1[U_2])^{(1-\theta)/(1-\gamma)}\right)^{(1-\gamma)/(1-\theta)} \tag{1}$$

where γ denotes the coefficient of relative risk aversion, $1/\theta$ is the elasticity of intertemporal substitution, and δ denotes the discount rate. Second-period utility is stochastic from the perspective of period 1, due to uncertainty about the individual's second-period health, and is given by:

$$U_2 = (1+\phi_1 S)\,\frac{1}{1-\gamma}C_2^{1-\gamma} + S\Psi(H), \tag{2}$$

where C_2 denotes second-period non-medical consumption, and H denotes medical consumption, from which he derives utility

$$\Psi(H) = \phi_2(1-\gamma)^{-1}H^{1-\gamma}. \tag{3}$$

Sickness thus multiplies the marginal utility of second period consumption by a factor of $(1+\phi_1)$ and sick individuals derive utility from medical consumption H. ϕ_2 indicates the relative preference for medical consumption (the higher ϕ_2, the higher the preferences for medical services compared to non-medical consumption).

The resulting budget constraint is

$$Y(1-\tau) = C_1 + \frac{1}{1+r}(C_2 + (1-b)H), \tag{4}$$

where r denotes the real interest rate, and b is the fraction of medical expenditures covered by health insurance ($0 \leq b \leq 1$). Health insurance is financed by a tax rate τ on permanent income Y.

One may notice, that the model does not include a direct effect of health on utility. Just as Finkelstein, we abstract from this in the theoretical model to simplify the exposition.[3] Finkelstein et al. solve the model backwards and derive indirect utility in the second period for the healthy state and the sick state respectively, which are as follows[4]

$$V(Y, S=0) = \frac{1}{1-\gamma}(wY)^{1-\gamma} \tag{5}$$

$$V(Y, S=1) = \frac{1}{1-\gamma}(1+\phi_1)(1+\phi_2^{1/\gamma}(1+\phi_1)^{-1/\gamma}(1-b)^{1-1/\gamma})^{\gamma}(wY)^{1-\gamma}, \tag{6}$$

where w is a proportionality factor, which is a function of preference parameters, prices, and the probability of sickness.[5]

In the European countries under consideration in this study, most of the medical expenditures are covered by health insurances. Therefore, we assume that $b = 1$. In section 4.2 we provide tests that show that this assumption is justified. Equation (6) reduces to

$$V(Y, S=1) = (1+\phi_1)\frac{1}{1-\gamma}(wY)^{1-\gamma}, \tag{7}$$

To identify the health state dependence parameter ϕ_1, Finkelstein et al. (2013) combine (5) and (7), and evaluate within individual utility changes after a health shock for individuals with different levels of permanent income Y, using a nonlinear regression of the following form:

$$v = \chi_1 S \times Y^{(1-\gamma)} + \chi_2 Y^{(1-\gamma)} + \upsilon \tag{8}$$

Re-arranging equations yields an expression that can be used to infer the health state dependence parameter. In case of full insurance this is the ratio χ_1/χ_2 .

Here, we deviate from Finkelstein et al. (2013). We define μ to be the proportionality factor indicating how much extra (or less) income is needed in the sick

[3]In the process of optimizing life time consumption trajectories one equates the marginal utility of consumption in each period. When computing the marginal utility of consumption, the direct utility derived from health cancels out, so that it has no influence on intertemporal consumption choices.

[4]These equations are equivalent to equations (9) and (10) in Finkelstein et al. (2013).

[5]The expression for w can be found in online appendix A of Finkelstein et al. (2013).

state to be financially as well of as in the healthy state, that is,

$$V(\mu Y, S = 1) = V(Y, S = 0). \tag{9}$$

We give μ the name 'health equivalence scale' after the more common income equivalence scales, which are used to make income of households with different sizes comparable. Combining equations (5), (7), and (9) we find that

$$\mu = (1 + \phi_1)^{-\frac{1}{1-\gamma}} \tag{10}$$

The aim of our empirical analysis is to obtain an unbiased estimate of ϕ_1, which we accomplish by estimating μ and applying the nonlinear transformation in equation (10). The following section explains how we estimate μ.

2.2 Empirical model

Just as Finkelstein et al. (2013) we think of time periods in the empirical analysis as repeated observations on an individual in period 2 of the theoretical model. In order to translate the data on financial wellbeing to an estimate of the health equivalence scale μ we follow the reasoning of Pradhan and Ravallion (2000). For each individual i in period t we observe answers to a question on financial wellbeing (z_{it}) on a qualitative scale. Answers range from $z_{it} = 1$ to $z_{it} = K$, with higher values corresponding to higher levels of wellbeing.[6]

An individual will report financial wellbeing level k if an only if his permanent income is at or above a certain benchmark δ_{k-1}, but below δ_k, with

$$\begin{aligned} &\ln \delta_{k,it} = \alpha_k + \rho \ln Y_i + \beta S_{it} + \boldsymbol{\eta}' \boldsymbol{x}_{it} + \nu_i + \varepsilon_{it} \quad \text{for } k = 1, \ldots K-1, \\ &\quad \delta_{0,it} = -\infty, \text{ and } \delta_{K,it} = \infty. \end{aligned} \tag{11}$$

S_{it} and Y_i are health status and permanent income, respectively (as defined before), $\boldsymbol{x}_{it}$ is a vector of time constant and time varying variables of individual i in period t, ν_i an individual specific effect, and ε_{it} errors which we assume to be distributed

[6] Specifically, we observe whether individuals can make ends meet with great difficulty ($z_{it} = 1$), with some difficulty ($z_{it} = 2$), fairly easily ($z_{it} = 3$), or easily ($z_{it} = 4$).

as standard normal with mean zero and variance one independent of ν_i.[7]

Since μ is defined as the proportionality factor indicating how much extra (or less) income is needed in the sick state to be financially as well off as in the healthy state, we need to know the minimum required income levels in both the healthy and the sick state to reach some level of wellbeing k. From (11) it follows that the income needed in the sick state to reach the same level of wellbeing k in the healthy state is

$$\mu = \exp\left(\frac{\beta}{1-\rho}\right). \tag{12}$$

Now, since we know that the probability of observing outcome k is given by,

$$\begin{aligned}
Prob(z_{it} = k) &= Prob(\delta_{k-1,it} \leq Y_i < \delta_{kit}), && (13)\\
&= Prob(\ln \delta_{k-1it} \leq \ln Y_i < \ln \delta_{kit}), && (14)\\
&= Prob(\alpha_{k-1} + \rho \ln Y_i + \beta S_{it} + \boldsymbol{\eta}'\boldsymbol{x}_{it} + \nu_i + \varepsilon_{it} \leq \ln Y_i && (15)\\
&\qquad < \alpha_k + \rho \ln Y_i + \beta S_{it} + \boldsymbol{\eta}'\boldsymbol{x}_{it} + \nu_i + \varepsilon_{it}) &&\\
&= Prob(-\alpha_k + (1-\rho)\ln Y_i - \beta S_{it} - \boldsymbol{\eta}'\boldsymbol{x}_{it} - \nu_i \leq \varepsilon_{it} && (16)\\
&\qquad < -\alpha_{k-1} + (1-\rho)\ln Y_i - \beta S_{it} - \boldsymbol{\eta}'\boldsymbol{x}_{it} - \nu_i &&\\
&= \Phi(-\alpha_{k-1} + (1-\rho)\ln Y_i - \beta S_{it} - \boldsymbol{\eta}'\boldsymbol{x}_{it} - \nu_i) - && (17)\\
&\qquad \Phi(-\alpha_k + (1-\rho)\ln Y_i - \beta S_{it} - \boldsymbol{\eta}'\boldsymbol{x}_{it} - \nu_i), k = 1, \ldots, K, &&
\end{aligned}$$

we estimate a random effects ordered probit model,

$$z^*_{it} = \theta \ln Y_i + \beta S_{it} + \boldsymbol{\eta}'\boldsymbol{x}_{it} + \nu_i + \varepsilon_{it}, \tag{18}$$

where $\theta = -(1-\rho)$ and where observed ordinal responses z_{it} are generated from a

[7] Just as Pradhan and Ravallion (2000), we follow the literature and assume a loglinear specification for the required income levels to reach some level of financial wellbeing.

latent continuous response such that

$$z_{it} = \begin{cases} 1 & \text{if } -\alpha_1 < z_{it}^* \\ 2 & \text{if } -\alpha_2 < z_{it}^* \leq -\alpha_1 \\ \vdots & \\ K & \text{if } z_{it}^* \leq -\alpha_{K-1} \end{cases} \tag{19}$$

Following Mundlak (1978), we parameterize the individual specific effect as a linear function of the average time-varying explanatory variables over time plus a random individual specific effect that is assumed to be independent of the explanatory variables,

$$\nu_i = \zeta_0 \bar{S}_i + \boldsymbol{\zeta_1}' \bar{\boldsymbol{x}}_i + \xi_i, \tag{20}$$

where $\bar{S}_i$ and $\bar{\boldsymbol{x}}_i$ are the individual means of S_{it} and $\boldsymbol{x}_{it}$ respectively (the Mundlak terms) and ξ_i i.i.d. normal distributed with mean zero and variance σ_ξ^2. As explained by Mundlak (1978), the individual means are picking up the correlation between observed individual characteristics and the individual unobserved effects. In this way orthogonality between the explanatory variables and ξ_i is ensured. Equation (18) can now be rewritten as

$$z_{it}^* = \theta \ln Y_i + \beta S_{it} + \boldsymbol{\eta}' \boldsymbol{x}_{it} + \zeta_0 \bar{s}_i + \boldsymbol{\zeta_1}' \bar{\boldsymbol{x}}_i + \xi_i + \varepsilon_{it}. \tag{21}$$

Combining equation (12) and (21) leads to

$$\hat{\mu} = \exp\left(\frac{\hat{\beta}}{1-\hat{\rho}}\right) = \exp\left(\frac{\hat{\beta}}{-\hat{\theta}}\right), \tag{22}$$

such that $\hat{\phi}_1$ can be obtained by

$$\hat{\phi}_1 = \hat{\mu}^{\gamma-1} - 1 \tag{23}$$

$$= \left(\exp\left(\frac{\hat{\beta}}{-\hat{\theta}}\right)\right)^{\gamma-1} - 1, \tag{24}$$

where we need to fill in an appropriate value for the risk aversion parameter γ.

2.3 Underlying assumptions and threats to identification

To summarize, we identify health state dependence from the effect of a health shock on (within individual) financial wellbeing. This method is related to identifying health state dependence from a measure of overall wellbeing. Overall wellbeing can be seen as a weighted combination of domain satisfactions such as health satisfaction, leisure satisfaction, and financial satisfaction (Van Praag and Ferrer-i Carbonell, 2004). A negative health shock has a negative effect on overall utility through a lower health satisfaction. In addition, a negative wealth shock may also affect overall utility through leisure satisfaction (when people get physical limitations, their leisure activities and their satisfaction with leisure may change). Furthermore, a negative health shock may also affect financial satisfaction: when a negative health shock means that one needs to take a taxi instead of a bus, one needs extra money and making end meet can become more troublesome (or the other way around, in case one is for example not going on holiday anymore). In this paper we use financial satisfaction instead of overall wellbeing. This has the advantage that we do not have to filter out other direct and indirect relations between health and wellbeing that are not related to consumption. Therefore, we expect a higher signal-to-noise ration when we use financial wellbeing instead of overall wellbeing.

Finkelstein et al. (2013) use a measure of overall wellbeing and isolate the effects of health that travel via financial satisfaction by using an interaction term between a change in health and permanent income. Within individual changes in overall wellbeing due to a health shock are compared for low and high income individuals. If health state dependence is the same across levels of permanent income (there are no omitted determinants of utility that vary with health differentially by permanent income), both methods should lead to the same results. We check this in section 4.4.4.

Some issues remain, regardless of the two approaches. First, in the above model we assume that wealth in the sick state is predetermined. Just as Finkelstein we therefore limit our sample to retired individuals, such that health shocks do not have a first order effect on income. Threats, however, can occur because of changes in mortality risk, changes in out-of-pocket (OOP) medical expenses, or when health changes are anticipated. If a health shock influences the (perceived) mortality risk, wealth per remaining year is affected and in that way financial wellbeing may change even if the marginal utility of consumption does not change, leading to a negative bias in the estimates of health state dependence[8]. We cannot control for this in our model, but we can check for this by comparing the results in the full sample to results in a sample limited to those with more than 75% of wealth annuitized (just as Finkelstein et al., 2013). The results are highly similar, which is as expected since appendix A shows annuitized wealth to be relatively small compared to income. OOP medical expenses may bias us towards finding positive state dependence. We check for this in section 4.2 and find that OOP medical expenses do not drive our results. In case health changes are anticipated, people who know that they will become sick save more (less) than they otherwise would have in case of positive (negative) health state dependence. Than, the actual health shock will not result in a lower or higher financial wellbeing, biasing health state dependence towards zero (but the sign remains correct). Finally, health shocks may affect home production and/or informal care, which can be considered as income in broad terms. In this paper we consider a narrow income definition, such that the health state dependence parameter increases in case more domestic services and repairs need to be bought in bad health.[9]

Second, a disadvantage stemming from the use of subjective data is that of differential item functioning: different people interpret scales in different ways. A person who is very optimistic in general may be more inclined to use the top ends of the scale, whereas one who takes the glass to be half empty will tend to give answers towards the bottom end of the scale (their financial situation being the same). As stressed by Ferrer-i Carbonell and Frijters (2004), it is important to account for unobserved individual effects. Therefore, we focus on the effect of within individual health transitions on the ability to make ends meet (rather than comparing making ends meet between healthy and unhealthy individuals). However, answering styles are not necessarily fixed over time. Health shocks, for example, may change an

[8]This bias is weakened under the existence of a bequest motive.

[9]This is common in the literature. For example, Finkelstein et al. (2009) mention that the marginal utility of consumption could increase with deteriorating health, as prepared meals or assistance with self-care may be substitutes for good health. Banks et al. (2015) classify domestic services and repairs as 'housing related' expenditures and not as medical spending.

individual's perception of scales.[10] In section 4.4 we attempt to capture possible changes in answering styles by augmenting the basic model with a set of time-varying controls that measure positive and negative affect (Fischer and Sousa-Poza, 2008).

Third, socioeconomic status and other third factors can make it difficult to establish causal relationships. Socioeconomic status (a combination of factors like education, income, and family background) may influence both health and financial satisfaction. As far as it concerns income and education, we control for these variables in the model. As far as it concerns family background, this is captured by following individuals over time and by analyzing variation in health within individuals. Similarly, time preference may influence both financial satisfaction and health. If someone is very impatient he may have more difficulties making ends meet. Furthermore, impatient people may be less healthy because of smoking, alcohol consumption and bad eating habits. However, since we compare health variation within individuals instead of between individuals this does not bias our results.

Fourth, there may be a problem of reverse causality. People who face difficulties in making ends meet may have more stress and this may have a negative effect on their health. The effect of stress on health is probably more substantial in the long run than in the short run. Long term stress may lead, amongst other things, to a higher probability of cardiovascular diseases and thereby also to more problems with activities of daily living in old age. These long term differences between people, that probably arose already before retirement, are captured by individual specific effects. Reverse causality may also arise when people who face difficulties with making ends meet are unable to pay for customary medical interventions. This may lead to a higher probability to encounter health problems. In Europe customary medical interventions are generally paid for by health insurance or the government and we do not expect this reverse causality to have a big influence on our results.

Fifth, attrition may be systematically related to health. However, there is no reason to assume that the probability of leaving the panel after a health shock depends on the (change in) ability to make ends meet. We thus believe that the results will not be affected by attrition bias. Finally, since we investigate retirees

[10] People in poor health tend to evaluate life satisfaction for anchoring vignettes more negatively than people in good health (Angelini et al., 2014).

without substantial income from work, we do not have to worry about the effect of physical health shocks on income.

3 Data

To estimate the parameters of the model we use the Survey of Health, Ageing, and Retirement in Europe (SHARE). SHARE is a multidisciplinary database of microdata on health, socio-economic status and social and family networks of individuals aged 50 and over. Data are collected in 2004/2005, 2006/2007, 2008/2009, 2011/2012 and 2013 in several European countries. In 2004/2005 eleven European countries and Israel contributed data to the SHARE project. Over the years eight more countries started to participate. Data were collected by face-to-face computer-aided personal interviews (CAPI), plus a self-completion drop-off part with questions that require more privacy.

The CAPI questionnaire of waves 1, 2, 4 and 5 is divided into eighteen modules of which the order remained roughly unchanged over the waves.[11] The interview is split in two parts, in between which some physical measurements are taken. The health module is in the first half of the interview, together with a module about demographics, and followed by a module on employment and pensions. Questions about informal care, income, wealth and consumption take place in the second half of the questionnaire. It is well known that questions asked earlier in a survey may influence how people respond to later questions. Luckily, questions about health and about 'making ends meet' (in the consumption module) are in different parts of the questionnaire.

The remainder of this section describes the data used for the baseline regressions. We refer to appendix A for more details and a description of the data used for the additional analyses.

3.1 Sample selection

For all households we select the 'household respondent', who answers the question on 'making ends meet' as a representative for all household members. Furthermore,

[11] Wave 3 is a special wave which focuses on people's life histories and collects retrospective information.

Table 1: Summary statistics

	mean	sd. within	sd. between	min	max	N
Age	75.85	2.93	5.83	65	102	25827
Male	0.36	0	0.48	0	1	25827
Partner in household	0.41	0.19	0.45	0	1	25827
High education level	0.15	0	0.36	0	1	25827

A respondent is considered highly educated with an ISCED level of five or higher.

our interest is in households in which both the household respondent and the spouse (if present) are aged 65 or older and where annual household income from a job or from self-employment is less than €2000. In this way we drop those households for whom a health shock may lead to a substantial change in permanent income, due to a job loss or early retirement.

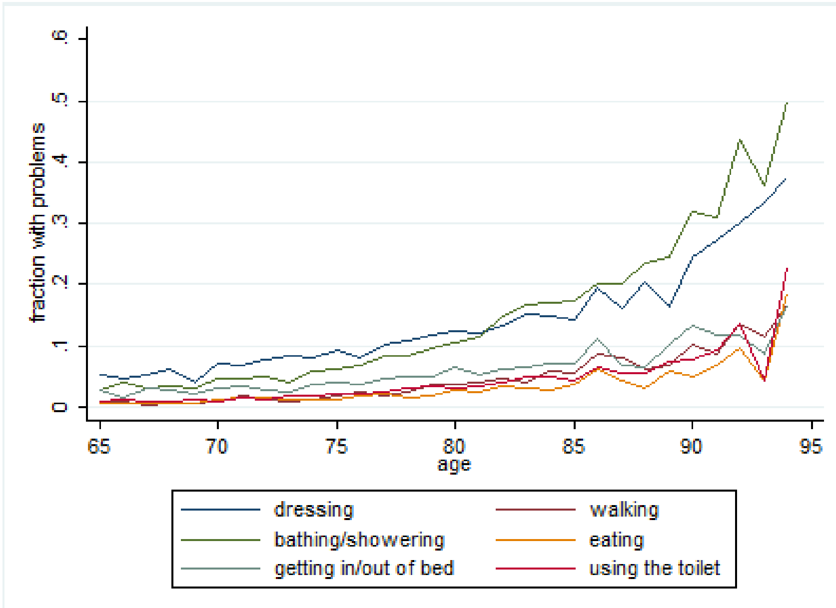
We select singles and 'household respondents' with a spouse and do not consider households with more than two people. SHARE only samples individuals living independently (i.e. not in a nursing home). However, if individuals make a transition into a nursing home over the course of the survey they remain in the sample. We drop individuals who are permanently living in a nursing home and we only consider individuals for whom data on two or more waves are available, so that we are able to measure transitions in health status. Because of this constraint we are left with fifteen countries, namely: Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, Greece, Italy, the Netherlands, Sweden, Czech, Poland, Estonia, and Slovenia[12]. Finally, we drop individuals in the top and bottom percentile of the income distribution, for each wave and country separately. Here, income is measured as the sum of net household wealth and 5 percent of net financial assets, to take into account that elderly households may be spending down their accumulated financial savings (just as in Finkelstein et al., 2013). The resulting data set contains 25,827 observations on 10,943 individual households. Table 1 shows descriptive statistics.

3.2 Health

SHARE includes many different measures of health, ranging from self-perceived health status to reported limitations and major health conditions, health care us-

[12]Israel is excluded because their surveys were conducted at different points in time than the rest and differ slightly from those of the other countries.

Figure 1: Prevalence of limitations in activities of daily living at different ages.



age, and physical performance measures. In this paper our main health measure is limitations in activities of daily living (ADL), which are encountered by many in old age. Figure 1 plots the prevalence of the six types of limitations in ADL against age. The prevalence of limitations increases with age and the most common problems are those with dressing, bathing, and showering. We define individuals to be 'limited' when they have one or more problems with ADL. 16% of the person-year observations have at least one ADL problem.

The use of ADL limitations has several advantages. First of all, ADL limitations are relatively objective. This is important since the variable we aim to explain (making ends meet) has a subjective component. Would the measure of limitations also be subjective (like for example self-perceived health status), errors may be correlated and therefore bias the results. Moreover, by taking a measure of physical limitations we focus on that aspect of health that is assumed to be a mediating factor between health and consumption. When considering a measure like the number of chronic diseases, the range of illnesses (from asthma to cancer) could make it hard to differentiate the possible implications of these illnesses to everyday life, hindering interpretation of the estimation results. Identifications arises both from positive and negative health shocks. 19.5% of the individuals in our sample experience a health shock (measured by the presence of ADL limitations), of which about two third experience a negative health shock.

3.3 Income and assets

SHARE contains data on income, assets, and housing wealth. In line with Finkelstein et al. (2013), we construct an aggregated measure of household income by computing the sum of net household income and 5 percent of net financial assets. As said before, in this way we account for the fact that elderly households may be spending down their accumulated financial savings. Then, as a measure of permanent income we take the average of income over the different waves for each individual. All amounts are equivalized to a one person household using the OECD equivalence scale[13] and ppp-adjusted to 2004 German price levels.

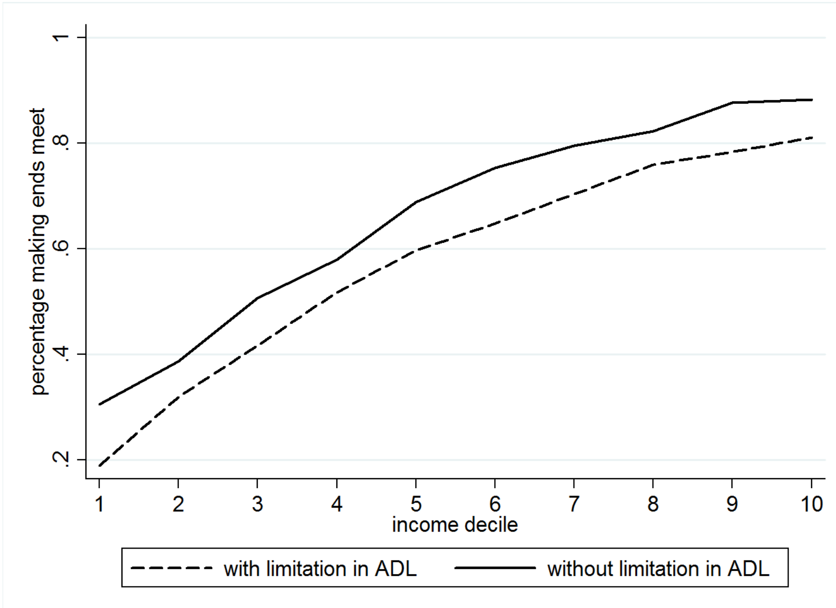
For our selected sample average net household income equals €17,999 per year. Net household income is right skewed, with a median of €13,080 (substantially lower than the average). The average value of net financial assets equals €31,620, with a median of €7914. Permanent income is on average €19,225, with a median of €15,092. We control for the presence of positive net housing wealth and we add wave dummies to take into account possible effects of the Great Recession. Appendix A provides detailed information on income and assets per country.

Like all major household surveys, SHARE suffers from item non-response. In this paper we make use of the imputations provided by SHARE for total net household income, net financial assets and net housing wealth. A multiple imputation technique has been used, which means that we have five different complete datasets that differ from one another only with respect to the imputed values. To capture uncertainty due to the imputation of missing values we perform the regressions on each dataset separately and then combine the results from all five datasets using the method explained by Christelis (2011)[14].

[13] This means that income is divided by 1.5 for two person households.

[14] The averages in this section are based on the first set of imputations.

Figure 2: ‘Making ends meet’ across health and income



3.4 Making ends meet

To measure financial wellbeing, respondents were asked the following question:

> Thinking of your household’s total monthly income, would you say that your household is able to make ends meet...

Respondents can answer by choosing either one of the categories (1) with great difficulty, (2) with some difficulty, (3) fairly easily, or (4) easily.

Figure 2 shows the fraction of individuals without difficulties to make ends meet (i.e. they answered fairly easily, or easily) across income percentiles for two groups: (1) those without any ADL limitations and (2) those with one or more ADL limitations. As expected, the ability to make ends meet increases with income. Moreover, conditional on income, individuals without physical limitations have less difficulty making ends meet.

Table 2: Baseline results

	(1) baseline	(2) excl. wave 4	(3) excl. wave 4 + OOP med. exp.
A. Estimation results			
limitation	-0.110***	-0.0813	-0.0719
	(0.0353)	(0.0564)	(0.0561)
$\ln(Y)$	0.880***	0.834***	0.844***
	(0.0323)	(0.0476)	(0.0479)
hh OOP med. exp.			-3.75e-05*
			(2.10e-05)
age	-0.0482**	0.00848	0.00786
	(0.0217)	(0.0312)	(0.0313)
has partner in household	0.281***	0.213***	0.216***
	(0.0596)	(0.0810)	(0.0811)
positive housing wealth	-0.0186	-0.0598	-0.0590
	(0.0467)	(0.0799)	(0.0800)
male	0.169***	0.169***	0.169***
	(0.0264)	(0.0410)	(0.0410)
high education	0.328***	0.331***	0.330***
	(0.0371)	(0.0597)	(0.0596)
cut 1	8.552***	8.142***	8.261***
	(0.372)	(0.548)	(0.551)
cut 2	10.14***	9.714***	9.834***
	(0.375)	(0.554)	(0.556)
cut 3	11.63***	11.22***	11.34***
	(0.379)	(0.559)	(0.561)
σ_u^2	0.890***	0.895***	0.893***
	(0.0327)	(0.0509)	(0.0507)
Observations	25,827	11,000	11,000
Number of id	10,943	4,882	4,882
b. Health parameter estimates			
unit change in limitations			
Health equivalence scale ($\widehat{\mu}$)	1.133	1.102	1.089
	(1.044, 1.223)	(0.956, 1.249)	(0.947, 1.231)
Health state dependence ($\widehat{\phi}_1$)	0.284	0.215	0.186
	(0.081,0.487)	(-0.108, 0.538)	(-0.124, 0.495)
sd change in limitations			
Health equivalence scale ($\widehat{\mu}$)	1.029	1.022	1.019
	(1.010, 1.047)	(0.992, 1.053)	(0.989, 1.049)
Health state dependence ($\widehat{\phi}_1$)	0.058	0.045	0.039
	(0.020,0.096)	(-0.018, 0.107)	(-0.022, 0.010)

Estimated using a random effect ordered probit estimator with clustered standard errors, combining the results for 5 sets of imputations of the income and OOP variable. Income and OOP medical expenditures are in 2004 German euro's and equivalized to a one-person household using the OECD equivalence scale. Dummies for country dummies, wave, and wave participation and Mundlak terms are included. $\widehat{\mu}$ and $\widehat{\phi}_1$ are constructed according to equations (22) and (24), chosing $\gamma = 3$. Panel A: Robust standard errors in parentheses. Panel B: 95% confidence intervals between parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4 Results

4.1 Baseline

Column (1) of table 2 presents the baseline estimation results. The coefficients in panel A show that after a health shock individuals report a lower ability to make ends meet. More income is required after a health shock for individuals to reach the same level of financial wellbeing as before. This is reflected by the health equivalence scale reported in panel B, which has a point estimate of 1.133. This implies that individuals on average need 13.3% more income after a health shock to be financially as well off as before. To calculate the corresponding health state dependence parameter we assume the risk aversion parameter γ to be 3, a common assumption in the literature. We find positive health state dependence: the marginal utility of consumption is higher in bad health than in good health, with a proportionality factor of $\widehat{\phi}_1 = 0.284$.

In order to be able to compare the results for different kinds of limitations we also provide the estimates for a standard deviation change in limitations, rather than a unit change. In this way we can take into account that the scale as well as the severity of limitations differ.

4.2 Medical costs

For the baseline estimates we assumed that health insurance coverage in Europe is universal and that the insured in Europe have negligible OOP medical expenditures, so that we do not need to worry about personal expenditures on health care. However, if individuals do bear medical costs in (some) European countries, the positive health state dependence that we find could be driven by increased medical expenditures, rather than an increase in the marginal utility of non-medical consumption. OECD (2015) shows that especially in the north of Europe health care is mainly financed by the government and social security. Private OOP medical expenses are low. However, other sources raise concern when it comes to universal coverage and OOP medical expenses (Cylus and Papanicolas, 2015, and Scheil-Adlung and Bonan, 2012). Therefore, we perform two tests for medical expenditures.

First, we include survey data on OOP medical expenditures in our regression.

Table 3: Test for coverage of health care costs

	North	Central	South/East
a. Estimation results			
limitation	-0.0837	-0.106**	-0.113*
	(0.0810)	(0.0525)	(0.0589)
$\ln(Y)$	0.901***	0.876***	0.913***
	(0.0873)	(0.0458)	(0.0533)
age	-0.0662**	-0.0216	-0.0726***
	(0.0264)	(0.0240)	(0.0252)
partner in household	0.483***	0.160	0.270***
	(0.110)	(0.104)	(0.0983)
positive housing wealth	0.266**	-0.0635	-0.0608
	(0.124)	(0.0711)	(0.0706)
male	0.0895	0.258***	0.112***
	(0.0602)	(0.0407)	(0.0433)
high education	0.187**	0.297***	0.485***
	(0.0802)	(0.0515)	(0.0718)
Observations		25,827	
Number of id		10,943	
b. Health parameter estimates			
unit change in limitations			
Health equivalence scale ($\widehat{\mu}$)	1.097	1.128	1.131
	(0.903, 1.292)	(0.995, 1.261)	(0.988, 1.275)
Health state dependence ($\widehat{\phi}_1$)	0.204	0.272	0.280
	(-0.223, 0.632)	(-0.028, 0.573)	(-0.046, 0.606)
sd change in limitations			
Health equivalence scale ($\widehat{\mu}$)	1.020	1.029	1.029
	(0.981, 1.060)	(1.000, 1.058)	(0.999, 1.060)
Health state dependence ($\widehat{\phi}_1$)	0.041	0.059	0.059
	(-0.039, 0.122)	(-0.001, 0.118)	(-0.004, 0.122)

Estimated using a random effect ordered probit estimator with clustered standard errors, using 5 sets of imputations for the income variable. Income is in 2004 German euro's and equivalized to a one-person household using the OECD equivalence scale. Age, dummies for partner in the household, positive housing wealth, gender, education, country, wave, and wave participation and Mundlak terms are included. $\widehat{\mu}$ and $\widehat{\phi}_1$ are constructed according to equations (22) and (24), choosing $\gamma = 3$. Panel A: Robust standard errors in parentheses. Panel B: 95% confidence intervals between parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Unfortunately, data on OOP medical expenditures in SHARE are erratic.[15] The non-response rate is high and as from wave 4 the question components were changed. More importantly, in wave 4 the questions were temporarily moved to the drop-off questionnaire[16], so that imputations are not available for wave 4. If we want to include OOP medical expenditures we thus need to drop wave 4, leading to a large decrease in the number of observations. To facilitate comparisons, we first re-estimate the baseline model on the new (smaller) sample. The results are shown in column (2) of table 2. The estimated health state dependence is slightly smaller for this subsample, namely $\widehat{\phi}_1 = 0.215$ and insignificant, due to the lack of observations. Next, we add household OOP medical expenditures to the regression, for which the results are shown in column (3) of table 2. The point estimate for health state dependence hardly changes, from 0.215 to 0.186. We thus conclude that the presence of OOP medical expenses may lead to a slight overestimation of the health state dependence parameter, but does not drive our results.

Second, we exploit variation in institutions between countries. Our data cover fifteen European countries that can be roughly divided into three groups based on their long-term care system (Verbeek-Oudijk et al., 2014). In the northern European countries the government is mainly responsible for organizing long term care. In the south/eastern countries, on the contrary, the family of the individual bears the main responsibility for providing care. In central countries, the responsibility for long term care is shared between the government an the family[17]. Medical costs are likely to be higher in countries where the government plays a small role in long term care. Therefore, we expect individuals in central and south/eastern European countries to encounter more medical costs than individuals in northern European countries. In table 3 we interact all variables in the baseline model with the north, central and south/east European country groups. In correspondence with the test for OOP medical expenses, we find a slightly higher $\widehat{\phi}_1$ for central and southern/eastern

[15]Therefore, we did not include this in the baseline regressions.

[16]A questionnaire that is send out separately from the CAPI questionnaire and filled out on paper. The drop off questionnaire in general has a higher non-response than the regular CAPI questionnaire.

[17]Verbeek-Oudijk et al. (2014) classify northern countries: Denmark, Sweden, the Netherlands; central countries: Austria, Belgium, France, Germany; and south/eastern countries: Czech Republic, Estonia, Hungary, Italy, Poland, Portugal, Slovenia, Spain, Switzerland. We classified Greece to the south/east group.

Table 4: Results for alternative health measures

	(1) limitations in IADL	(2) limitations in mobility	(3) nr chronic diseases	(4) cognitive disfunctioning
a. Estimation results				
limitation	-0.138***	-0.135***	-0.0501***	0.0807***
	(0.0294)	(0.0283)	(0.0194)	(0.0287)
$\ln(Y)$	0.866***	0.868***	0.878***	0.886***
	(0.0319)	(0.0323)	(0.0316)	(0.0327)
Observations	25,827	25,824	25,797	25,334
Number of id	10,943	10,942	10,928	10,736
b. Health parameter estimates				
unit change in limitations				
Health equivalence scale ($\widehat{\mu}$)	1.173	1.169	1.059	0.913
	(1.094, 1.252)	(1.093, 1.244)	(1.013, 1.105)	(0.855, 0.971)
Health state dependence ($\widehat{\phi}_1$)	0.377	0.366	0.121	-0.166
	(0.191, 0.562)	(0.190, 0.542)	(0.024, 0.218)	(-0.272, -0.060)
sd change in limitations				
Health equivalence scale ($\widehat{\mu}$)	1.044	1.044	1.030	0.976
	(1.025, 1.063)	(1.026, 1.063)	(1.007, 1.052)	(0.959, 0.992)
Health state dependence ($\widehat{\phi}_1$)	0.090	0.091	0.060	-0.048
	(0.050, 0.129)	(0.052, 0.130)	(0.013, 0.107)	(-0.081, -0.015)

Estimated using a random effect ordered probit estimator with clustered standard errors, using 5 sets of imputations for the income variable. Income is in 2004 German euro's and equivalized to a one-person household using the OECD equivalence scale. Age, dummies for partner in the household, positive housing wealth, gender, education, country dummies, wave, and wave participation and Mundlak terms are included. $\widehat{\mu}$ and $\widehat{\phi}_1$ are constructed according to equations (22) and (24), choosing $\gamma = 3$. Panel A: Robust standard errors in parentheses. Panel B: 95% confidence intervals between parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

European countries (0.272 and 0.280 compared to 0.204). However, health state dependence in the central and south/east European countries is not significantly different from health state dependence in north European countries, suggesting that OOP medical expenses are not driving our results.

4.3 Alternative health measures

In order to improve our understanding of the mechanisms underlying health state dependence, we re-estimate our model using other health measures. First, we examine problems with instrumental activities of daily living (IADL) and a measure of mobility problems. IADL and mobility problems are composite measures for a range of problems that can be encountered in daily life (just as ADL problems). Examples of IADL are shopping for groceries, taking medications and preparing a hot meal. Examples of mobility tasks are walking 100 meters, climbing stairs, and pulling/pushing large objects. IADL and mobility problems are of a milder nature than the ADL limitations, are observed at a higher frequency, and occur already earlier in life. Detailed descriptives about problems with IADL's, mobility problems, and their relation to ADL limitations can be found in appendix A.

Column (1) and (2) of table 4 show that IADL and mobility problems result in slightly larger estimates than ADL problems (0.377 and 0.366, compared to 0.284). This may indicate that, apart from increased preferences for assistance in housework, increased preference for assistance in leisure activities is part of the positive effect (e.g. special transport and adapted leisure activities to keep up old ways of living). However, if physical limitations become to severe, one rather gives up on some of these activities. When we include the three types of limitations in one model simultaneously, we do not find significant differences between the sizes of the estimates.

Column (3) of table 4 shows that for each additional chronic disease, individuals need about 5.9% more income to be just as well off as before, corresponding to a parameter of health state dependence equal to 0.121. So, also here we measure positive health state dependence. The estimates are highly comparable, with a health state dependence parameter of 0.058 for a standard deviation in ADL limitations and a parameter of 0.060 for a standard deviation in the number of chronic diseases. This strengthens our baseline results.

In addition to measures of physical health, column (4) of table 4 shows the results when considering cognitive functioning as a measure of health status. As individuals age, their ability to take initiatives, to plan, and to organize activities decreases. This is, amongst others, probably due to a decline in the functioning of the frontal lobe, which is vulnerable to the effects of aging (this has been found both in behavioral and MRI studies, Craik and Grady, 2002). The frontal lobe is also heavily demanded in memory tasks. In this study we use a test on long term word recall to construct a measure of cognitive functioning[18]. Whereas we find a positive effect of physical limitations on the marginal utility of consumption, we find that

[18]See appendix A for more details on the measure

cognitive limitations have a negative effect on the marginal utility of consumption. This suggests that, in contrast to individuals with physical limitations, individuals that experience a cognitive decline probably might not be willing to invest in adapted activities, as their motivation and will to undertake any activities declines.

4.4 Robustness checks

4.4.1 Differential item functioning

Although the baseline model takes into account individual specific answering styles, biases in reporting may also be due to time-varying optimism or pessimism. Therefore, we construct two measures of positive and negative affectivity using questions from the EURO-D depression scale, similar to Fischer and Sousa-Poza (2008). Negative affectivity is a summation of dummy variables indicating whether the individual experiences feelings of sadness, guilt, and hostility, whereas positive affectivity is a summation over dummy variables indicating whether the individual experiences feelings of self-assurance, attentiveness, and joviality. As shown in table 5, individuals with ADL limitations tend to experience less positive feelings and more negative feelings. When including the measures of positive and negative affect to the regressions, the estimated health state dependence parameter is still significant at a 5% level and only slightly smaller than the baseline estimate, 0.208 compared to 0.284 (column (1) of table 6). So, reporting error in ability to make ends meet, correlated with limitations, thus does not seem to drive our results.

4.4.2 End of scale

Financial wellbeing is measured by answers on a four-point scale. The fact that the scale is finite may lead to a bias in our estimates. The baseline estimates show that, in general, individuals tend to rate their financial wellbeing lower after a health shock than before. Now imagine a healthy individual who is very dissatisfied with his or her financial situation. When this individual experiences a health shock, (s)he might experience an even lower financial wellbeing than before, but cannot express this in the answer to the survey question, because the answering scale does not provide a lower category of satisfaction.

Table 5: Percentage of respondents experiencing feelings of positive or negative affect.

	≥ 1 ADL	no ADL
Positive affect		
- has hopes for the future	66%	82%
- has good concentration on reading/entertainment	62%	82%
- has enjoyed an activity recently	75%	88%
Negative affect		
- has been sad or depressed in the last month	60%	40%
- has felt to rather be death in the last month	21%	8%
- has feelings of guilt or self-blame	11%	7%
- has been irritable recently	31%	21%
- has cried in the last month	39%	25%

As a robustness check we therefore repeat the baseline regression, while excluding those in the lowest or highest income quartile for each country within the selected sample. As shown in figure 2, individuals with low incomes often provide answers on the bottom end of the scale when healthy. Therefore, we would expect to find a larger decline in financial wellbeing after a health shock and thus a higher estimate of health state dependence when excluding the lowest income quartile. Indeed, as shown in column (2) of table 6, the estimated parameter is larger than in the baseline (0.582 compared to 0.284). The higher estimate can also be the result of heterogeneous effects for individuals with a low and a high income. In any case, the positive health state dependence found in our baseline specification remains convincing. This also holds when we exclude the highest income quartile for each country (column (3) of table 6).

4.4.3 Choice of functional form

The functional form of a model may have large impact on the size of the coefficients. Following the method of Pradhan and Ravallion (2000) we estimate the coefficients using a random effects ordered probit model. However, one could also think about a linear specification. Riedl and Geishecker (2014) compare linear and nonlinear ordered response estimators and find that in general the choice seems to have little

Table 6: Specification checks

	(1) incl PA/NA	(2) excl. bottom 25%	(3) excl. top 25%	(4) linear
a. Estimation results				
limitation	-0.0811**	-0.146***	-0.105**	-0.0603***
	(0.0361)	(0.0454)	(0.0419)	(0.0196)
$\ln(Y)$	0.857***	0.636***	1.214***	0.468***
	(0.0322)	(0.0469)	(0.0575)	(0.0161)
positive affect	0.0720***			
	(0.0164)			
negative affect	-0.0333***			
	(0.0121)			
Observations	25,128	17,441	16,727	25,827
Number of id	10,658	7,412	7,123	10,943
b. Health parameter estimates				
unit change in limitations				
Health equivalence scale ($\widehat{\mu}$)	1.099	1.258	1.09	1.138
	(1.008, 1.190)	(1.078, 1.438)	(1.016, 1.164)	(1.044, 1.231)
Health state dependence ($\widehat{\phi}_1$)	0.208	0.582	0.188	0.294
	(0.008, 0.409)	(0.129, 1.035)	(0.026, 0.35)	(0.081, 0.507)
sd change in limitations				
Health equivalence scale ($\widehat{\mu}$)	1.021	1.051	1.02	1.03
	(1.002, 1.04)	(1.018, 1.083)	(1.004, 1.037)	(1.001, 1.049)
Health state dependence ($\widehat{\phi}_1$)	0.043	0.104	0.041	0.06
	(0.005, 0.082)	(0.036, 0.172)	(0.008, 0.075)	(0.021, 0.100)

Estimated using a random effect ordered probit estimator with clustered standard errors, using 5 sets of imputations for the income variable. Income is in 2004 German euro's and equivalized to a one-person household using the OECD equivalence scale. Age, dummies for partner in the household, positive housing wealth, gender, education, country dummies, wave, and wave participation and Mundlak terms are included. $\widehat{\mu}$ and $\widehat{\phi}_1$ are constructed according to equations (22) and (24), choosing $\gamma = 3$. Panel A: Robust standard errors in parentheses. Panel B: 95% confidence intervals between parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

effect on the size of ratios of estimated coefficient. Column (4) of table 6 shows the results for the linear specification. The estimated health state dependence parameter are very similar (0.294 compared to 0.284).

4.4.4 Choice of method

To check the validity of our model, we re-estimate health state dependence on the same data, but using the method of Finkelstein et al. (2013). As explained in section 2 our hypothesis is that as long as there are no unobserved characteristics that are correlated with income and have an effect on the change in utility due to a health shock, the methods should provide roughly the same results. Moreover, we expect more precise estimates when using financial wellbeing instead of overall wellbeing.

We estimate equation (8), using life satisfaction as a proxy for utility[19] and apply a linear random effect specification with Mundlak terms to deal with possible problems of endogeneity. Because the answering scale of life satisfaction question was different in wave 1 than in the other waves, we drop wave 1 for this part of the analysis. Column (1) of table 7 shows the results of the baseline analysis excluding the observations of wave 1. The estimate is almost equal to the estimate including wave 1, and has only a slightly larger 95% confidence interval. Column (2) shows the estimates based on the same sample, but using overall life satisfaction and the method of Finkelstein et al. (2013). We find a somewhat larger positive result, that is $\hat{\phi}_1 = 0.438$ instead of 0.285. However, the estimate is imprecise and the confidence interval includes zero. The alternative estimates thus seem to confirm our hypothesis, that both methods lead to comparable estimates, though with different levels of precision.

In order to compare the results using our European dataset with the results of US data (HRS) in Finkelstein et al. (2013), we re-estimate column (2) using the same health measure as Finkelstein et al., namely the number of chronic diseases. This measure has been constructed in correspondence with the baseline health measure used in Finkelstein et al. (2013) (appendix A.3). As shown in column (3) of table 7

[19]Finkelstein et al. (2013) use a measure of happiness. This is not included in SHARE. We assume here that life satisfaction and happiness are exchangeable concepts for this context.

Table 7: Results using general wellbeing indicators as dependent variable.

	(1)	(2)	(3)
	Baseline excl. wave 1	Method Finkelstein et al. (2013)	
	at least one ADL	at least one ADL	nr chronic diseases
a. Estimation results			
limitation	-0.114***	-0.295***	-0.114***
	(0.0400)	(0.0513)	(0.0270)
$\ln(Y)$	0.911***		
	(0.0367)		
$Y^{1-\gamma}$		-0.0801***	-0.0773***
		(0.0195)	(0.0281)
limitation$*(Y^{1-\gamma})$		-0.0351	-0.0316*
		(0.0391)	(0.0179)
age	-0.0727**	-0.0123	-0.00427
	(0.0307)	(0.0371)	(0.0376)
partner in household	0.344***	0.257***	0.249***
	(0.0711)	(0.0786)	(0.0785)
positive housing wealth	0.0195	0.0222	0.0213
	(0.0526)	(0.0616)	(0.0617)
male	0.201***	0.00546	0.00868
	(0.0292)	(0.0316)	(0.0321)
high education	0.306***	0.244***	0.261***
	(0.0402)	(0.0378)	(0.0379)
Observations	20,025	20,508	20,490
Number of id	9,022	9,222	9,213
b. Health parameter estimates			
unit change in limitations			
$\widehat{\phi}_1$	0.285	0.438	0.409
	(0.063, 0.507)	(-0.540, 1.417)	(-0.102, 0.919)
sd change in limitations			
$\widehat{\phi}_1$	0.057	0.098	0.192
	(0.017, 0.098)	(-0.121, 0.316)	(-0.048, 0.431)

Column (1) is estimated using a random effect ordered probit model. Column (2) and (3) are estimated using a linear random effect model. For all columns clustered standard errors are applied and 5 sets of imputations for the income variable are used. Income is in 2004 German euro's and equivalized to a one-person household using the OECD equivalence scale. For sake of readability of the coefficients in column (2) and (3) Y is divided by 10,000. Age, dummies for partner in the household, positive housing wealth, gender, education, country dummies, wave, and wave participation and Mundlak terms are included. For the calculation of the health state dependence in column (1) and the construction of the income measure in column (2) and (3) we assume $\gamma = 3$. Panel A: Robust standard errors in parentheses Panel B: 95% confidence intervals between parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

we find an estimate of 0.192 (insignificant at a 5% level) for one standard deviation change in limitations. For a comparable sample to ours (age ≥ 65, not in the labor force, and with health insurance) and under the assumption of $\gamma = 3$, Finkelstein et al. (2013) find a proportionality factor of -0.142 for one standard deviation change in limitations[20]. The direction of health state dependence thus seems to differ between Europe and the US. This may be due to cultural differences, institutional differences or differences in consumption patterns. Banks et al. (2015) compare life-cycle consumption patterns for the US and the UK.[21] They show that budget shares on recreation are higher in the UK than in the US (although the UK is not included in SHARE). If people in the UK find recreation a more essential consumption good than people in the US, they may need more money to keep doing these activities in bad health (e.g. more help and assistance during a holiday). Transportation costs, on the other hand, are relatively high in the US compared to the UK (maybe because of the long distances in the US). The question arises whether Americans still incur these costs when they become sick. If not, this may explain (part of the) negative state dependence in the US. More research on microdata is needed to provide clear answers.

5 Conclusion

This paper estimates health state dependence in Europe. We develop a new approach that builds upon the approach of Finkelstein et al. (2013), and uses insights from the domain of living standards and income adequacy (Pradhan and Ravallion, 2000). We derive a simple relation between the health state dependence parameter within the optimal life cycle framework and a so called 'health equivalence scale', which we define as the relative change in income needed to keep financial wellbeing the same after a health shock. This allows us to identify health state dependence using a measure of financial wellbeing rather than overall wellbeing. By using financial wellbeing instead of overall wellbeing we do not have to control for direct and indirect effects of health on subjective wellbeing that are unrelated to consumption.

[20] See table 3, column 2b of Finkelstein et al. (2013)

[21] The UK is not included in SHARE, but this comparison may give us some clue about differences between the US and Europe.

The higher signal to noise ratio allows us to estimate health state dependence in Europe, where longitudinal surveys on elderly have only been running for a limited number of years.

We implement the approach using panel data from the Survey of Health, Ageing and Retirement in Europe. Our baseline estimates show positive health state dependence, with a proportionality factor equal to 0.284 in the presence of ADL limitations. We show that our results are not driven by medical expenditures, and that they are robust against alternative physical health measures and specifications. The effect seems to be stronger when limitations are mild. This suggests that as long as physical limitations do not take the fun out of leisure, it may well be that the budget share for leisure activities increases due to a health shock (e.g. people need more assistance with their leisure activities). On the other hand, when limitations become too severe, the number of (out of the house) activities probably declines. Interestingly, for cognitive health limitations we find negative health state dependence. When cognitive health declines, people's ability to plan, organize, and take initiatives becomes worse. These developments seem to lower the marginal utility of consumption.

For the sake of comparison, we also apply the approach of Finkelstein et al. (2013) based on overall wellbeing on the SHARE data. Again, we find positive health state dependence. The sign thus remains the same, however, the coefficient is somewhat larger and not significantly different from zero. Remarkably, for the European countries in our sample we find positive health state dependence repeatedly, whereas Finkelstein et al. (2013) find negative health state dependence in the US for the same age group (retirees). Maybe differences in consumption patterns, such as budget shares on leisure and transportation, play a role. Further research is needed to explain this difference. Further research could also aim at exploring heterogeneities in health state dependence across individuals with different characteristics.

The health state dependence parameter is important for many economic questions such as the optimal savings rate and the optimal level of health insurance. Positive health state dependence means that both the optimal savings rate and the optimal level of health insurance increase, relative to the situation where health state dependence is not taken into account. However, in old age cognitive health also declines and this lowers the marginal utility of consumption. As far as health limitations occur early in the lifecycle when people are in good cognitive health, extra money may be desirable to be able to keep doing (leisure) activities. On the other hand, in old age, where health limitations coincide with a decline in cognitive health, our results show that extra money or a high insurance for health costs is less relevant.

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A Appendix

A.1 Income and assets

SHARE contains detailed questionnaires on income and assets. Different income components are elicited stepwise, so that we can be sure transfers from private and public pension programs are earmarked as income.

Over the years there are some slight changes in the wording of the questionnaire. Most importantly, in the first wave the respondents are asked to provide gross amounts of income, whereas from wave two on net amounts are elicited. To correct for this we translated the gross amounts to net amounts using information from the OECD on each country's average tax rate per decile for singles and couples separately[22].

Detailed information on income and assets per country can be found in table 8.

A.2 Health

In our baseline and additional analyses we make use of five different health measures. For the baseline analysis we consider one health measures, having at least one limitation in one of the activities of daily living, which is further described in Section 3. In the additional analyses we use data on instrumental activities of daily living, physical mobility, the number of chronic diseases and cognitive functioning. This section provides a description of these variables.

A.2.1 IADL and mobility

Both the measure limitations of instrumental activities of daily living (IADL) as the measure of limitations of physical mobility are closely related to the measure of limitations in activities of daily living (ADL). IADL constitutes out of a list of activities 7 activities: (1) using a map to get around, (2) preparing a hot meal, (3) shopping for groceries, (4) making telephone calls, (5) taking medications, (6) working around the house or garden, and (7) managing money. These type of limitations

[22]OECD.stat: Benefits, Taxes and Wages - Net incomes 2004 retrieved from `ttp://stats.oecd.org/Index.aspx?DataSetCode=FIXINCLSA`

Table 8: Income split up by component and country

	permanent income		household income			financial wealth			housing			
				conditional on ownership			conditional on ownership			conditional on ownership		
	mean	median	owner	mean	median	owner	mean	median	owner	mean	median	N
Austria	18648	16183	1.00	18108	15562	0.92	13938	4231	0.46	164692	132314	2415
Germany	17899	16205	1.00	16990	15065	0.92	22548	9078	0.54	146961	125253	1259
Sweden	25376	23371	1.00	23715	18625	0.91	37430	20317	0.68	94539	64884	2005
Netherlands	24796	20786	1.00	23420	17802	0.96	34800	11185	0.49	189272	173505	1790
Spain	10651	9052	0.99	10366	8766	0.87	9472	2110	0.93	149524	101360	1519
Italy	12912	10771	0.98	12640	10373	0.76	14658	5901	0.80	138570	110357	1622
France	21227	18023	1.00	19196	15741	0.95	43641	10416	0.73	191325	143973	3100
Denmark	18930	16108	1.00	17645	13115	0.89	32815	13731	0.61	106058	76290	1596
Greece	9683	8550	0.98	9635	8169	0.42	11137	5859	0.84	90396	77316	954
Switzerland	34902	29106	1.00	30749	24983	0.95	89015	37597	0.49	317244	210254	1529
Belgium	29053	19547	1.00	26864	15139	0.95	49482	15455	0.75	162389	144667	3069
Czechia	9305	8988	0.98	9101	8887	0.66	10270	5473	0.69	83186	66327	1763
Poland	6223	5549	1.00	6115	5463	0.66	4123	3621	0.71	48101	32429	260
Slovenia	19022	12246	0.99	19029	10301	0.86	4489	502	0.84	116696	92260	804
Estonia	7217	6651	1.00	6558	5829	0.90	15029	2092	0.81	335775	92674	2142
Total	19225	15092	0.99	17999	13080	0.87	31625	7914	0.68	167822	114943	25827

Based on the first set of imputations

Table 9: Summary statistics for health variables

	mean	sdwithin	sdbetween	min	max	N
limitation in ADL	0.16	0.29	0.23	0	1	25827
nr chronic disease	1.59	0.65	1.03	0	7	25797
limitation in IADL	0.26	0.34	0.28	0	1	25827
limitation in mobility	0.65	0.35	0.32	0	1	25824
limitation in cognitive ability	0.75	0.35	0.26	0	1	25334

are slightly milder than limitations with ADL, therefore are more prevalent: 26% of observations have at least one limitation in IADL, see table 9. The most common limitations are limitations with house and garden work, grocery shopping and using a map. Starting the age of 80 also problems with managing money and preparing a hot meal start to become more prevalent, see Figure 3.

Physical mobility constitutes out of a list of 10 activities: (1) walking 100m, (2) sitting for 2 hours, (3) getting up from a chair, (4) climbing stairs, (5) climbing one flight of stairs, (6) stooping, kneeling or crouching, (7) reaching above one's shoulder, (8) pulling or pushing large objects, (9) lifting or carrying over 5kg, and (10) picking up a small coin. These limitations are even milder than those listed for IADL, not only do more observations experience these type of limitations (65%, see table 9), also they start to appear earlier in life. At early ages individuals often report problems with stooping, kneeling or crouching or climbing stairs, followed by sitting for 2 hours and getting up from a chair, see Figure 4.

As the listed limitations in physical mobility and IADL are slightly milder than those in ADL, often individuals who report to have limitations in ADL, also report to have limitations in one of the other categories. Table 10 shows a transition probability matrix for the different health states one can be in. Figure 5 shows the prevalence of the different limitations as age progresses.

A.3 Chronic diseases

The prevalence of chronic diseases is an objective measure of health which is used often in other literature. For sake of comparability we construct this variable in correspondence with Finkelstein et al. (2013). SHARE contains a list of 18 chronic diseases (three of which are not included in the first wave), for which the respondents

Table 10: Transition probabilities for the different type of limitations

from to	none	only mobility	only iadl	only adl	mobility & iadl	mobility & adl	iadl & adl	all	Nr in row
none	0.628	0.261	0.019	0.004	0.049	0.018	0.001	0.020	3759
only mobility	0.201	0.521	0.007	0.002	0.154	0.042	0.001	0.073	3993
only iadl	0.424	0.224	0.129	0	0.165	0.012	0	0.047	170
only adl	0.353	0.176	0.059	0.029	0.029	0.206	0	0.147	34
mobility & iadl	0.072	0.303	0.016	0.001	0.345	0.031	0.003	0.229	1374
mobility & adl	0.080	0.347	0.004	0.004	0.118	0.183	0.004	0.261	476
iadl & adl	0.231	0	0	0	0.308	0.231	0	0.231	13
mobility & iadl &adl	0.027	0.134	0.002	0.002	0.171	0.047	0.003	0.615	1056

Figure 3: Prevelance of limitations in instrumental activities of daily living at different ages.

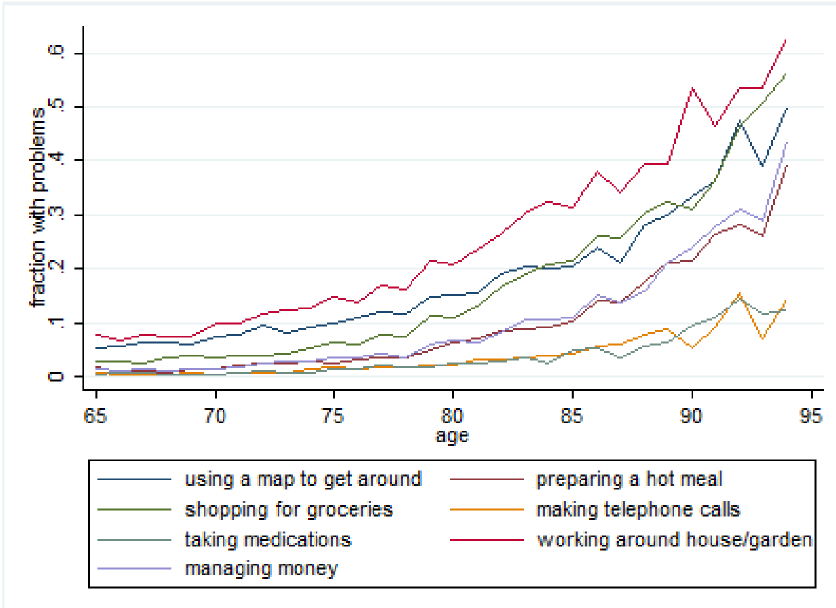


Figure 4: Prevelance of limitations in physical mobility at different ages.

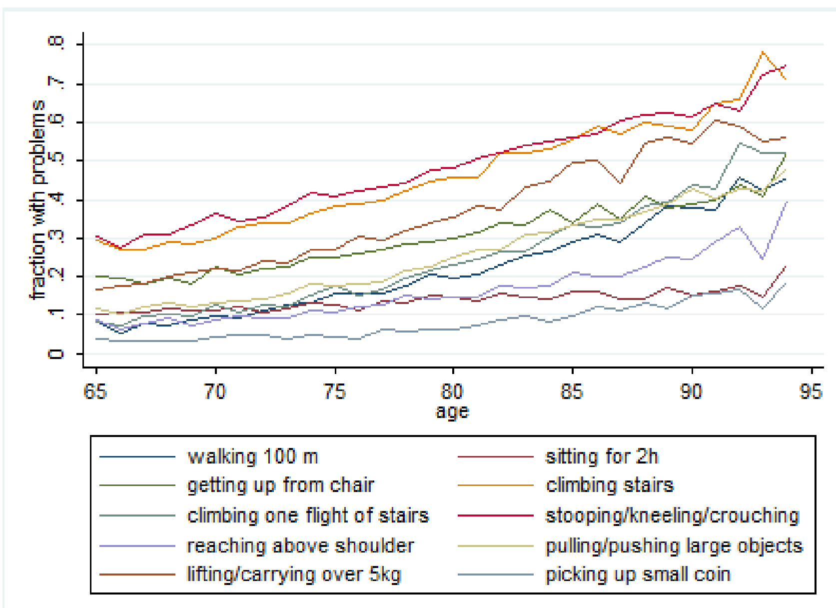
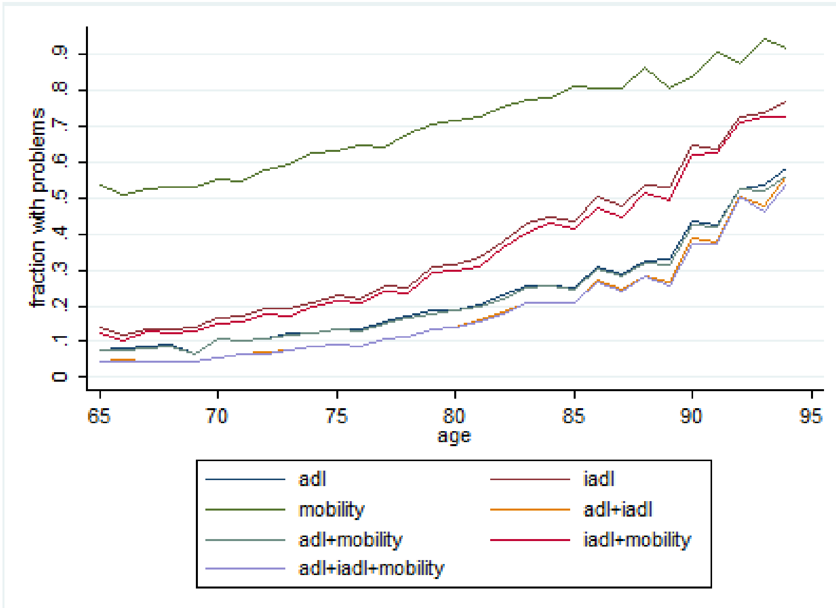


Figure 5: Prevelance of the different type of limitations at different ages.



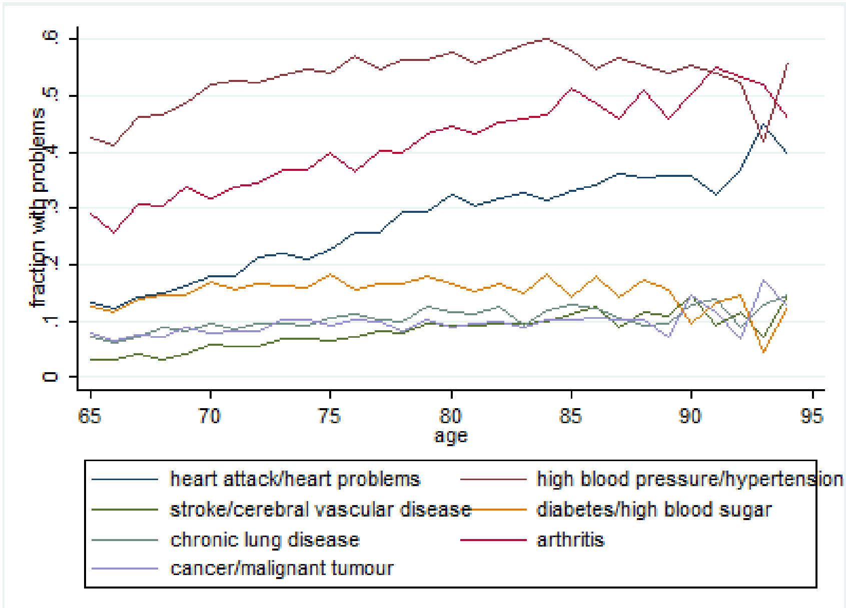
should indicate whether a doctor has ever told that them they had or that they are currently being treated for or bothered by that condition. We include (1) heart attack/heart problems, (2) high blood pressure/hypertension, (3) stroke/cerebral vascular disease, (4) diabetes/high blood sugar, (5) chronic lung disease (e.g. chronic bronchitis or emphysema), (6) arthritis, including osteoarthritis or rheumatism, (7) cancer or malignant tumor, including leukemia or lymphoma, but excluding minor skin cancers. Contrary to ADL limitations, chronic diseases are considered permanent. For each chronic disease, prevalence is modeled as an absorbing state. 82% person-years have at least 1 chronic disease. High blood pressure and arthritis are the most common diseases, see figure 6.

A.4 Cognitive functioning

Cognitive functions encompass aspects like attention, memory, perception, language, and decision making Glisky (2007). As individuals age cognitive functioning may decline, such that the ability to take initiative, plan, and organize activities decreases and individuals experience more fear.

Our measure of cognitive functioning is based on a word recall question. The

Figure 6: Prevelance of chronic diseases at different ages.



interviewer reads a list of 10 words to the survey respondent. After the interviewer is finished he asks the respondent to recall aloud as many words as possible, in any order. The amount of words the remember is stored and seen as the ability of short term recall. After this task the respondent is given a verbal fluency task and a series of computational tasks. Then he is asked again to remember aloud the words provided in the beginning of the series of tasks, in any order. He gets one minute to complete the task. The amount of words they remember at this point is stored as the ability of longterm recall. We use this second variable to measure cognitive functioning: the more words one can remember, the higher the cognitive functioning. We dichotomize the variables, in correspondence with the other health measures, by defining someone to experience cognitive limitations if the number of words recalled is less than average in our sample (5/10 words recalled). According to this cut off 75% of individuals has a limitation in cognitive functioning, see table 9.