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An Empirical Analysis of Health-Dependent Utility on SHARE and ELSA Data

Elena Bassoli[1] ⓘ

Abstract

This paper investigates the presence of health-dependent utility on a panel of European countries. We follow the strategy of Finkelstein et al. (J Eur Econ Assoc 11:221–258, 2013) and extend their analysis focusing on different health measures. The results show that utility exhibits an increase in the marginal utility to consume when physical health deterioration occurs. For cognitive decline, we find a decrease in the marginal utility for low memory skills and an increase in the marginal utility for low verbal fluency. However, both are not statistically significant, thus the evidence is limited. We show that individuals living in low-spending countries for long-term care services experience the greatest drop in marginal utility compared to the others. Overall, these results suggest the presence of heterogeneity in the direction of the marginal utility when the sick state occurs, and this evidence goes in the opposite direction compared to the recent empirical findings for US. A potential explanation might be found in different welfare systems.

Keywords Health-status · Physical decline · Cognitive decline · Health-dependent utility · Marginal utility · Long-term care · SHARE data

JEL Classification D90 · D91 · D81 · I10 · D01

1 Introduction

For many western economies, one of the great challenges of the XXI century is the increasing share of older people as a result of two significant changes in demographic variables: a reduced birth rate and increased longevity. Both these demographic trends generate concern about the sustainability of the welfare system, particularly pen-

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✉ Elena Bassoli
  elena.bassoli@unive.it

1 Department of Economics-, Ca' Foscari University of Venice, Cannaregio 873, Fondamenta San Giobbe, 30121 Venice, Italy

sions, but the latter is associated with a relevant risk of insufficient public and private resources caused by an increase in the number of years with potential health deterioration.

The standard framework dealing with insurance models or models which describe welfare interventions is based on the assumption that utility is not dependent on the health status of the individuals. But, if health can shape the utility function, generating state dependence, this has implications on several aspects such as the choice of the optimal insurance level, or the optimal amount of savings for the future periods in a life-cycle savings model.

If the utility of individuals depends directly on the level of their health, then the marginal utility of consumption varies as health changes. In particular, the marginal utility to consume will reflect the utility changes due to changes in the number of goods which might be complements to "good health", for example, leisure goods. On the other hand, some goods could be substitutes for good health, for example, private house services, which might be appreciated more in poor health conditions. The literature refers to the first example as a case of "negative state dependence" (marginal utility to consume decreases) and to the second example as "positive state dependence" (marginal utility to consume increases).

This brief introduction intends to stress that the effect of health on utility is relevant and that the sign of health state dependence is a priori unknown, making it necessary to resort to the empirical evidence. Indeed, a body of the literature has analysed empirically the effect of health on the marginal utility of consumption: Lillard and Weiss (1997) and Edwards (2008) have focused on older cohorts in the US and provided evidence of the existence of positive state dependence; while Evans and Viscusi (1991), Sloan et al. (1998), Viscusi and Evans (1990) and Finkelstein et al. (2013) conclude that there is no relationship or even a negative relationship, implying that marginal utility to consume decline as health deteriorates. A recent study by Kools and Knoef (2019) has provided evidence of positive state dependence using an equivalence scale approach on European data. They estimated how much extra or less income is needed to maintain the same level of financial well-being after a health shock.

Understanding the health effect on the marginal utility to consume in the late part of the life-cycle is also particularly important for policy. With increasing older cohorts living longer, knowledge of the shape of the utility in case of health deterioration is fundamental for the implementation of important welfare programs such as long-term care and health care provision to the elderly, or reforms related to annuity or health insurance markets. It also points towards the importance of considering that the marginal utility of consumption at older ages might be different from the one at the earlier stages of the life cycle - highlighting that individuals do not equate the expected marginal utility of consumption across states, as it is usually described in life-cycle models (Brown et al. 2016).

Furthermore, as stressed by several authors (Norton 2000; Callegaro and Pasini 2007; Carrino et al. 2018), Europe is facing an increasing unmet demand for long-term care by older individuals, this contributes to underline that it is fundamental to understand how people value consumption in the adverse health state and their demand for further assistance.

Although we can assume that public insurance in Europe is close to be universal, since in most countries the health care is publicly provided, there is still the necessity to cope with part of the unmet demand generated by the increasing need for long-term care. This leaves space for the private insurance market to protect against these events.

This study aims at testing the hypothesis of health state dependence, on a panel of European countries. We exploit data from the Survey of Health Ageing and Retirement in Europe (SHARE) and the English Longitudinal Survey on Ageing (ELSA), both are composed of individuals aged 50+ from different countries for SHARE and from England for ELSA. The survey provides a rich set of information related to the individuals and the households as well. The dimensions which are investigated are health, working or retirement situation, life satisfaction, income, a large set of questions about savings, the individual network, cognition, and more. The survey is longitudinal so this allows us to have repeated information for each respondent: we exploit waves from 1 to 7(8 for ELSA) which span from 2002 to 2017, more than a decade. The advantage of using the SHARE and ELSA data is that we have different health measures, such as the presence of severe diseases, mobility difficulties, and mental decline.

In this paper, we show evidence of positive state dependence when health is measured in terms of physical decline, while negative state dependence emerges only for memory decline, although this result is not statistically significant.

Indeed, our results for cognitive decline lack statistical power and most of the coefficients are non-significant, thus, the overall evidence is limited, and we take the magnitude of these estimates with caution.

Regarding the heterogeneity in the results, one possible explanation might be that individuals value more future resources when physically impaired since they need them to adapt to the new state to enjoy life as before, while when they are cognitively impaired future resources are not as worth as before since the disease prevents them from living life as before. Another potential reason could be that minor impairments, such as diabetes or hypertension, are equivalent to a monetary loss and thus result in an increase in the marginal utility to consume, as suggested by Viscusi (2019).

Although we do not know whether the differences in health state dependence are driven by differences in the consumption basket, since neither SHARE nor ELSA collects the full set of information on budget shares; we were able to stress that different health deterioration paths (physical versus cognitive) make individuals value resources for the future in a different way. This calls for policies able to meet the increasing demand for long-term care such as nursing homes when cognitive deterioration arises.

While in the US, Finkelstein et al. (2013) suggest that an increase in the number of chronic diseases is associated with a 10–25% decline in the marginal utility to consume concerning the healthy state, we were able to show that in European countries the same health deterioration can cause an increase in the marginal utility to consume of about 10%. Our results suggest that the optimal fraction of earnings saved for future periods might be greater than the one usually predicted by life-cycle models since individuals value more resources in future states when physical sickness manifests.

Another source of heterogeneity is found among countries based on the public spending for long-term care: when mental impairment occurs, individuals living in countries that spend less than 1% of their GDP in long-term care experience a greater drop in the marginal utility to consume than those individuals living in high spending

countries (more than 2% of GPD) and medium spending countries (between 1 and 1.9%), although the coefficient is statistically significant only for low spending countries. This evidence suggests that differences based on welfare systems are present and individuals' optimal consumption-savings path might be also influenced by the country's welfare.

Overall, these results suggest the need to rethink the optimal level of insurance and the optimal fraction of savings in a life-cycle setting. Indeed, suppose individuals do not equate the marginal utility of consumption across periods, as is often suggested in life-cycle models; in that case, this has implications for the optimal amount of savings and the optimal level of health insurance. In particular, based on our results for physical health decline, the evidence points towards a positive state dependence suggesting that individuals value more resources in the future. Thus, a greater amount of savings for future periods might be predicted compared to the one usually presented by life-cycle models. Finally, further analyses are needed to quantify the impact of the health state dependence on the optimal health insurance level.

2 Literature

Since the influential contribution of Grossman (1972), many authors have assumed that health enters the utility function and influences the decision to consume. Individuals are endowed with a stock of health that depreciates over time but can also increase with specific investments.

Finkelstein et al. (2013) have implemented a theoretical model where utility depends on the choice of non-health consumption and health service. The deterioration of health has a direct effect on the level of utility and an indirect effect on the marginal utility of consumption. While the sign of the direct effect has a general consensus and it is negative, since we expect that as health deteriorates, a decrease in health will cause a decrease in the individual's utility; the indirect effect of health has been argued and modelled by different scholars, but it is still under debate (Finkelstein et al. 2009).

Concerning this last point, Viscusi and Evans (1990) were among the first to claim that if health is able to change the slope of the utility function, it can also affect the marginal utility to consume. Also Evans and Viscusi (1991) points towards this finding.

To provide an example, individuals who face sickness might decide to decrease their consumption of leisure goods such as vacation, travels, or social events since now their cost to participate is higher than in the healthy state, that is, those goods are complements to good health. In such a scenario, the marginal utility of consumption decreases, and it is a case of negative health dependence. On the other hand, some goods such as private health care assistance and catered meals are substitutes for good health, and these goods might be viewed as more beneficial when the agent is in the sickness state. In that case, the marginal utility to consume increases, and utility exhibits a positive state dependence.

As Finkelstein et al. (2013) have shown, if there is negative state dependence, becoming ill causes a greater loss in consumption for wealthy people rather than low-income people. If utility shows a positive state dependence, the opposite is true.

Recently, Macé (2012) has developed a theoretical model concerning life cycle savings when health declines. The author pointed out that when utility shows state dependence, the marginal utility can vary over the life cycle: it can be very low at the very end of life when health deterioration is high, and conversely, it can increase from 60 to 75 years old where we suppose that the health status could be stable. Thus, as individuals face health risks as time goes by, they might save to transfer consumption when the marginal utility is higher.

From the empirical literature different methodologies have been implemented to measure the health state dependence. Finkelstein et al. (2009) classified them into two main approaches. The first one exploits the individual's demand and variation of resources across states (health/unhealthy), while the second looks at the variation of subjective well-being due to health shocks in individuals with different incomes.

Concerning the first approach, Lillard and Weiss (1997) developed a structural model in which the marginal utility of consumption varies with health, focusing on individuals who were exposed to the different health shocks and expected health shocks and comparing their consumption profiles. Their results suggested an increase in marginal utility to consume of 55%.

Regarding the second approach, Sloan et al. (1998), Viscusi and Evans (1990) implemented a strategy to estimate the compensating differentials to exposure to hypothetical health risk and investigated the differences in compensation among income levels. Evidence was mixed based on the severity of the disease: from no state dependence (Evans and Viscusi 1991) to negative state dependence when severe conditions hit the individual (Sloan et al. 1998; Viscusi and Evans 2006), and positive state dependence with mild conditions (Viscusi and Evans 1990; Evans and Viscusi 1993; Viscusi and Evans 1998). Also, the magnitude varied significantly, highlighting that different assumptions about the curvature of the utility function lead to different results in terms of magnitude. Following Viscusi (2019), the fact that the mild impairment increases the marginal utility means that it is equivalent to a monetary loss and does not prevent the individual to benefit from consumption in the future. This evidence is also found by Gyrd-Hansen (2017) for temporary health effects on utility and by Levy and Nir (2012) for diabetes.

Within this approach, some scholars focused on the impact of hypothetical disability situations due to bad health events and found that the marginal utility of consumption increases in the new health conditions (Smith et al. 2005; Tengstam 2014; Ameriks et al. 2017 for long-term care needs), suggesting that people may adapt to the situation after catastrophic health events.

Within the second approach is the one by Finkelstein et al. (2013). Empirically, they find evidence of a decrease in the marginal utility to consume of about 10–25%, stressing that the magnitude has to be taken carefully. According to their analysis, their findings are not driven by medical expenditure, and so the decrease in the marginal utility to consume reduces the optimal share of earnings saved for retirement by about 3–5%. Also, the optimal share of expenditure reimbursed by insurance lowers from 20 to 45%, according to the authors.

Recently, Kools and Knoef (2019) focused on European countries and addressed the analysis of the health state dependence with an equivalence scale approach. They used insights from the domain of living standards and income adequacy and built a

measure of financial well-being. They aimed at quantifying the amount of income required to compensate an individual after the onset of a new disease. In their results, the authors obtained evidence of positive state dependence and motivated their findings based on population heterogeneity in Europe compared to the US case. Differences in consumption patterns and transportation contribute to explaining the positive sign of the health state dependence. Their evidence is not driven by medical expenditure, but they claim for further research on consumption patterns to confirm their findings.

Another stream of the literature has focused on the marginal utility to consume and how it is distributed among the population. Brown et al. (2016) documented a significant heterogeneity in health state dependence across individuals when different health disabilities are presented. They documented evidence of negative state dependence when cognitive impairment occurs and positive state dependence when physical health deteriorates.

Previous findings have been addressed in one recent work by Viscusi (2019). The author suggests that part of the mixed evidence can be explained by the differences in health measures that have been used in different studies. According to his research, severe health impairments (both physical or leading to long-term care) are associated with a decrease in the marginal utility of income; whereas mild health deterioration events, which are more transitory, are found to be in line with an increase in the marginal utility of income, because minor illnesses are compared to financial losses. Based on the author's study, the health measurement could influence the result of the analysis. Thus, it is fundamental to implement different measures to conduct our analysis.

Although Viscusi (2019) is able to summarize in detail the state of the art, his analyses mainly looked at studies about US data. However, the empirical results have not been entirely explored for the European case (apart from the recent analysis of Kools and Knoef (2019), which only looks at the financial well-being variation of individuals) yet, and this leaves space for further analyses.

3 Empirical Strategy

We proceed by presenting a strategy to assess the presence of health dependence on a panel of European countries. In our opinion, the specification used by Finkelstein et al. (2013) best fits the nature of our dataset. Furthermore, the specification allows testing directly the sign and magnitude of the health state dependence.

We focus on retired people as seen in Finkelstein et al. (2013), we decide not to include workers, since we want to avoid a health shock's first-order effect on income. In this analysis, we exploit the variation in subjective well-being due to adverse health events that are likely to occur as people get older. Through this analysis, we are also able to compare our results for Europe with the findings from authors examining the US context. A comparison analysis is useful for manifold reasons: individuals in US and Europe have shown different patterns in budget spending at older ages (Banks et al. 2016) and also have different health care systems. The US system is mostly privately supported (private insurance is compulsory except for those age 65

and above); whereas, the European primary health care services are provided to all citizens free of charge and supported via public expenditure.

Following Finkelstein et al. (2013) we implement a two-steps procedure. The first step is a linear OLS fixed effect regression where utility is measured through happiness (a binary variable, see Sect. 4 for details) as a function of health ($NumDisease_{it}$), permanent income interacted with health ($NumDisease_{it} * Log(pincome_i)$), a set of individual characteristics and individual (θ_i) and country (η_c) fixed effect .

Happiness is considered to be a good proxy able to capture the main features of the utility, and it has been extensively used in the subjective well-being literature (Frey and Stutzer 2001).

The second step is needed to retrieve the effect of permanent income which is absorbed by the individual effect in the first step. In the second step, the estimated fixed effect is regressed on permanent income and a set of controls; including some additional explanatory variables in order not to confound the effect of permanent income on happiness with demographics that are correlated with permanent income in the Eq. (1).

$$Happy_{it} = g(\beta_4 NumDisease_{it} + \beta_1 NumDisease_{it} * Log(pincome_i)$$
$$+ \omega_1 Controls_{it} + \theta_i + \eta_c CountryDummies_i) \tag{1}$$
$$\hat{\theta}_i = \beta_3 Log(pincome_i) + \omega_2 Controls_{it} + \eta_1 CountryDummies_i + \varepsilon_{it} \tag{2}$$

Where i refers to the individual and t to time.

In Eq. (1), happiness (*Happy*) is a proxy of utility, number of disease (*NumDisease*) is a measure of health status; permanent income (*Log(pincome)*) represents a proxy for consumption; finally θ is the individual fixed effect. To detect the presence of health state dependence, we look at the coefficient of the interaction term (β_1). We recall that the risk aversion parameter is $\beta_2 = 1 - \gamma$ and it is set equal to 1.[1]

To compute the magnitude of the state dependence, meaning the variation in the marginal utility of consumption after a health event, we exploit also the coefficient of permanent income (β_3). The ratio β_1/β_3 provides an upper bound of the magnitude of the state dependence. We do not have any prior expectation about the sign of the state dependence, nor the magnitude, since, as we discussed above, there might be either an increase or decrease in the marginal utility to consume after a health event.

Since we acknowledge the existence of differences in health trajectories between the US and Europe (Banks et al. 2006; Avendano et al. 2009), we want to exploit other measures of health that account not only for severe acute health conditions but also for the set of difficulties in mobility that lead people to poor health status. Thus, we measure health not only via chronic diseases but also, exploit mobility difficulties, which we will explain in detail in Sect. 4.

Another aspect of health deterioration involves the cognitive decline that usually occurs at older ages. With that in mind, we also measure such health shocks as low verbal fluency or low memory skills. Further details are provided in the next section. Our analysis investigates not only the role of an acute shock but also the effect of phys-

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[1] See Finkelstein et al. (2013) for more details on the theoretical model.

ical and mental deterioration that occurs for a longer period and leads the individual to a state of poor health.

Following Finkelstein et al. (2013), we require two assumptions to interpret the test for the state dependence.

The first assumption implies that the imposed mapping g(.) and the true mapping from the Von Neumann–Morgenstern utility to the utility proxy cannot vary with health by permanent income. This means that there may be errors in our g(.) map from latent utility to proxy utility, but the error cannot vary systematically with health by permanent income. We required that a change in the true utility associated with a given change in health must map into the same change in our utility proxy at different permanent income levels.

By following the same reasoning of Finkelstein et al. (2013), we investigate whether the choice of a linear probability model (LPM) leads to potential misspecification of the utility. In the LPM the assumption is that the probability of responding "yes" to the happiness question is a cardinal measure of the true utility, instead, in the probit specification, the assumption is that the latent variable in the probit model is a cardinal measure of the true utility. Results for the probit model are used as robustness to account for the non-linear effect of health on the probability of being happy. The estimates are reported in Table 11 of Appendix and align with the OLS findings; thus, confirming the soundness of our specification.

The second assumption requires that there are no omitted determinants of utility that vary with health differentially by permanent income. In the baseline specification, we apply the fixed effect model that takes into account the presence of unobserved heterogeneity, ruling out the problem of time-invariant omitted variables.

Since happiness scores are influenced by comparisons with one's peers, and comparisons may be country-specific, happiness based on different income levels varies by country depending on the country's income level. Thus, we include country fixed effects in the the analysis (Eqs. 1 and 2), which reflect the health care system and transfer programs, and these play a prominent role in the analysis.

Finally, we control for clustered robust standard error at the individual level, we also computed the bootstrapped standard errors at the individual level[2] and results are confirmed.

4 Data

This study uses data from the Survey of Health and Retirement in Europe (SHARE) and the English Longitudinal Survey of Ageing (ELSA).

These surveys are done through a computer-assisted personal interview and conducted a face to face using a laptop. SHARE started in 2004, while ELSA in 2002, both are conducted every two years. They gather information regarding health, wealth, working situation, retirement, and socio-economic status of individuals aged from 50 and above.

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[2] These results are available upon request.

The sample is representative at the country's older age population level. All respondents who were interviewed several times are part of the longitudinal sample. For every wave, new individuals are interviewed, in part to maintain the 50+ age composition and to compensate for the attrition that influences the sample.

In SHARE there are now up to 8 waves available. Among those, waves 3 and 7 are retrospective and focus on an individual's life history, in contrast with regular waves that collect information about the individual's current situation. Concerning ELSA, up to 9 waves are available too, wave 3 collects information on the life history of the respondent.

The surveys focus on several aspects of the individual dimension. Both SHARE and ELSA questionnaires start asking information about demographic characteristics and family composition and social networks, then explore the physical and mental health situation, and then move to the financial matters such as income, wealth, housing, consumption, assets, and activities.

With this great variety of information, SHARE and ELSA are among the best European datasets that enable researchers from sociology, economics, gerontology, and demography to produce meaningful analyses on the European population aged 50+.

For this work, we exploit all the waves in both surveys, except for the last wave available which was undertaken during COVID-19 pandemic[3]: for SHARE waves from 1 to 7, which span from 2004 to 2017, for ELSA waves from 1 to 8 (2002 to 2017).

For our purpose, we consider 12 countries out of the 28 ones that participated in the SHARE survey: Austria, Belgium, Switzerland, Germany, Sweden, Denmark, the Netherlands, Spain, Italy, France, Luxembourg, and Israel.

This choice is due to several reasons: first, we want to focus on those individuals who respond to the survey several times, and for which we have repeated information about income since it is our proxy to measure consumption.

Second, we select countries that have some features in common so we could follow the Esping-Andersen (1990) classification of welfare systems and cluster countries based on their social security regimes. Following the economic and sociological literature, we acknowledge that Eastern and Central-Eastern countries cannot be classified under the Esping-Andersen (1990) definition (Fenger 2007). Although the original design of the sociologist taught that the post-communist countries were in a transition to a welfare system such as those of western countries, there is evidence of a lack of accomplishment in various sectors. For example, following Soede et al. (2004), in these countries unemployment benefits are low and with a shorter duration than in western countries, pension benefits are below European averages, tax rates are quite moderate, and health care systems, disability, and child benefits are heterogeneous among Eastern countries compared to Western ones.

For these reasons, we decide not to include those countries in the sample, as there exists a great heterogeneity between Eastern and Western countries among the ageing population. Moreover, we also decide to exclude Greece and Portugal since those countries were severely affected by the financial crisis and their welfare systems were

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[3] This choice is due to avoid potential confounding effects of the COVID-19 onset with health deterioration.

drastically revised. Accounting for those exclusions, we are left with 80,976 individuals for an average of about 4 waves each.

Finally, we focus on retired males over 60 and females over 55. For men, we want to avoid individuals who exit the labour market due to bad health status. For women, we select a sample above age 55 since they tend to be younger than their partner on average.

4.1 The Happiness Measure

The proxy used for utility is happiness measured through a subjective well-being question that was introduced in each wave starting from wave 2. Our measure is based on the following question of both surveys[4]:

How often, on balance, do you look back on your life with a sense of happiness?

1. *Often*
2. *Sometimes*
3. *Rarely/not often (in ELSA)*
4. *Never*

We define a dummy variable that is 1 if the respondent answered "*often*" or "*sometimes*" and zero otherwise. This dichotomization leads to loss of information, in particular for those that report "rarely"; nevertheless, it contributes to improving the interpretation of the multiple category reply. Each individual was asked this question in each wave they participated in, thus giving us the possibility to evaluate changes in happiness as time passes.

This measure is interpreted as a proxy for Von Neumann–Morgenstern utility. This is one measure that has been widely used in the literature of subjective well-being but it is not the only one. Indeed, as documented by Viscusi (2020), there exist several alternative measures such as life satisfaction or quality-adjusted life years (QALY). These measures show a U-shaped pattern over the life cycle, with a minimum at middle ages as documented by Graham and Pozuelo (2017), Blanchflower and Oswald (2008), Weiss et al. (2012) and Steptoe et al. (2015). Some others found a flattering U-shaped (Frijters and Beatton 2012). Alternative approaches might be found in using the value of statistical life (VSL): this measure instead shows an inverted U-shape across the life cycle (Viscusi 2018).

Kimball and Willis (2006) suggest that happiness comes from the news about innovation to lifetime utility and the baseline mood which represents the current utility flow. Benjamin et al. (2021) show that there are differences between hypothetical choices and predicted happiness: individuals are more sensitive to money in hypothetical choices than in predicted self-rated happiness.

However, we know that answering this question can be sensitive to wording, framing, and question order (Bertrand and Mullainathan 2001).

One potential challenge of this measure is that the ordinal well-being scale does not necessarily imply cardinal significance: interpersonal differences are difficult to

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[4] The ELSA's question starts with "on balance" directly

Table 1 Distribution of ordinal measure of happiness

Happiness	Freq	Percent (%)	Cumulative (%)
Often	124,653	59.94	59.94
Sometimes	64,133	30.84	90.77
Rarely/not often	14,800	7.12	97.89
Never	4391	2.11	100.00
Total	207,977	100.00	

This table reports the distribution of the ordinal measure of happiness as it is framed in the questionnaires

interpret (going from 1 to 2 or from 3 to 4 might not imply the same gain from different individuals' perspectives), within-person and across group differences are not easily translated into monetary terms. Instead, one more comparable alternative might be monetary benefits incorporated into the VSL. However, we lack this information in the survey to test this proxy.

Moreover, an extensive literature provides evidence of the use of happiness as a good proxy for the Von Morgensten Utility approach (Frey and Stutzer 2002; Di Tella et al. 2001 and Hirschauer et al. 2015 to cite a few). Although the happiness measure has some drawbacks (Benjamin et al. 2012),[5] it has been shown that it is a good predictor of hypothetical choice (Finkelstein et al. 2013).

In our sample, around 90% of the individuals reported being "happy", as we code the variable. Overall, the average response for being happy is positive and in line with the evidence from Finkelstein et al. (2013), which found 89% of respondents being happy. Looking at the distribution of the ordinal variable of happiness in Table 1 we can see that the distribution of the variable is highly skewed towards "Often" and "Sometimes", while only 9% overall reported "Rarely/Not often" or "Never".

Overall, these descriptive statistics suggest that the average European happiness level is in line with those of the US population, at least for older ages.

4.2 The Health Measures

To measure health, we use different proxies. This choice is made since health can be measured via different components, and we also want to take advantage of the richness of information presented in the dataset. We focus not only on physical health status but also on cognitive status. We are notably aware of the increase in the number of pathologies related to the brain such as dementia or Alzheimer's disease, which have their roots (but not only there) in the cognitive decline, that usually takes place at older ages. Some symptoms of cognitive decline have been found at the early stage of older ages for smokers as well as Sabia et al. (2012). Therefore, we claim that it is essential to measure health not only via physical health but also through cognitive conditions. We first introduce the measure of physical and then cognitive health status.

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[5] The authors find that life satisfaction has a better-predicted power of choice compared to happiness. Also, financial well-being can play a role, as exploited by Kools and Knoef (2019), which is not directly captured through our question.

The first measure we exploit is the number of relevant diseases which are: cancer, stroke, hypertension, lung disease, heart disease, arthritis, and diabetes. We think that it is important to include all the set of diseases because it has been previously exploited in the literature as well. Indeed, the set of these diseases has been largely examined in the labour economics literature (Trevisan and Zantomio 2016), health and ageing (Smith 1999), and more. Looking at one disease by type would also reduce the statistical power of the analyses. In principle, we would expect a stronger impact of symptomatic diseases rather than asymptomatic ones, but we cannot reject that the effect of an additional disease is the same for symptomatic and asymptomatic. Thus, we will conduct some sensitivity analyses to test the goodness of our health measures.

The question about physical diseases is framed in the same way both in SHARE and ELSA. In particular, the question is: "Has the doctor ever told you that you have one of the following diagnoses/ Do you currently have (this option in case they have previously reported having the disease) this/these disease(s)". This question is the same used by Finkelstein et al. (2013), using the Health and Retirement Study data.

Overall, the percentage of individuals that are affected by more than 1 disease is about 20%, this suggesting that the individuals in the sample are less sick compared with individuals in the sample of Finkelstein et al. (2013), where each individual had 2 diseases on average. This difference in health status has also been highlighted by Banks et al. (2006) and Avendano et al. (2009). In particular, according to the authors, a potential cause of different health disparities might be attributed to different social determinants of health, namely the circumstances of living and working.

Another health measure we used is an index for mobility which includes several aspects of daily living. This choice was driven by the fact that mobility is a good indicator of individual health status. Additionally, differences in health patterns exist between Europeans and Americans (Banks et al. 2006; Avendano et al. 2009), such that we believe that other measures can be representative of the health condition. We exploit five indicators of experienced difficulties in that domain, specifically experiencing difficulties in getting up from the chair (*diffchair*), climbing one flight or several flights of the stairs (*diffclimb1* and *diffclimb2*), having difficulties in walking (*diffwalk*), stooping, kneeling and crouching (*diffstoop*). This index can capture difficulties in daily activities and can be a good measure of current health.

Concerning a health measure aimed at capturing the mental condition, we focus on two components: memory and verbal fluency. We also could have used other information about cognition but a large number of missing values prevented us from doing that. Therefore, we focus on two different questions: one asking to recall a list of 10 words previously heard (memory measure) and the other asking to name as many animals as possible in one minute (verbal fluency). These might appear simple tasks; however, there is a percentage of the sample that shows difficulties in that respect.

The first cognition measure is having a low memory: we code 1 for those individuals who were able to recall a maximum of 4 words out of 10. This choice is made following the Table 8 in the Appendix, where it emerges that half of the sample has low memory skills since around 57% could not remember more than 4 words. Given that the average age is 69 we believe that the low memory skill is consistent with the composition of the sample. In the sensitivity analyses, we have also tested alternative thresholds to test the robustness of our results.

When considering verbal fluency instead, we code 1 for those who were able to report a maximum of 10 animals in one minute and 0 otherwise. From the same Table 8 (bottom part) it is possible to see that these individuals were about 10% of the sample, this threshold is somehow more prudent compared to the one for low memory score. Yet, this choice is based on the fact that verbal fluency usually deteriorates at a slower pace compared to memory (Elgamal et al. 2011), thus in this way we aim to detect those affected by an intense deficit in verbal fluency. In the sensitivity analyses, we also try alternative measures (the scores 16 and 22 which represent the 33 and 66 percentile).

The set of these health proxies will allow us to compare health dimensions across the same specification and to assess whether some of them can better explain the effect of health deterioration on utility.

4.3 The Permanent Income Measure

We use permanent income as a proxy for consumption because the latter is usually scarce in the surveys. Furthermore, the surveys were precisely designed to focus on information about earnings and wealth, rather than on consumption. We exploit information about income at the household level, as this data is provided also via an imputation technique to treat missing values. Focusing on the household's income allowed us to attribute a source of earning for each partner of the house, even for those unemployed or otherwise not working such as home-makers.

Information about budget shares is notoriously scarce, and the permanent income hypothesis still holds. As it has been previously implemented by other authors in this literature such as Lillard and Weiss (1997), permanent income is considered to be a good proxy for consumption. Another example of permanent income measure has been used by Brunello et al. (2017) using the SHARE data. This measure can be subjected to reporting bias as analyzed by Bingley and Martinello (2014), but evidence has confirmed the lack of bias for the Danish data for example

We begin by following the same approach of Finkelstein et al. (2013) and we consider the household income, which was reported in each wave, weighting each household income over the household size, following the OECD 97 adjustment coefficients.

We also add the 5% of financial wealth to the income measure to account for the fact that older people might exploit their savings once they are out of the labor force. Financial wealth includes all assets, stocks, and bonds, but does not include non-financial wealth such as the value of the house or cars.

From the ELSA data, we consider the financial derived variables and combine the same information used from SHARE to be able to compute the permanent income measure.

We then average the amount for each individual based on the number of income observations we had available. We apply the logarithmic transformation to ensure a better interpretation of the results.

We also consider the potential reporting bias of our measure of permanent income. We start by looking at the distribution of the variable from Fig. 5: we include only individuals with positive permanent income and drop outliers, the distribution does not show anomalies. Furthermore, we restrict our sample to individuals which are mostly retired and only 12% is still working. Among those not working, about 88% receive a pension, which is a stable source of income, and this should attenuate the reporting bias.

Of course, the possibility that some categories of individuals, such as those with high income tend to under-report their revenues consistently, still exists. However, the fact that we use the permanent income variable as an independent variable should not make our estimates inefficient, and the measure as control could be thought of as a lower bound for true the permanent income measure.

Finally, some scholars provided validation studies where they documented that recall bias is not severe in the data (Garrouste and Paccagnella 2011), and also for socio-economic circumstances early in life (Havari and Mazzonna 2015).

4.4 Descriptive Analysis

Table 2 displays the summary statistics for the variables of interest. We have about 81,000 respondents who were interviewed four times on average. The sample is composed of retired[6] individuals aged 55 for women and 60 for men to 85 years old.[7] The average age is 68.6. Females represent 61% of the sample. 72% of the sample lives in couples, while 27% is single. On average, individuals spent 12.4 years in education. Regarding happiness as a proxy for utility, 90% of the sample reports to be happy: this is in line with the statistics of Finkelstein et al. (2013). Permanent income which is an average measure of household income plus 5% of the financial wealth, is on average about 22482 Euro, with a high standard deviation, as expected.

As for health, the average number of severe diseases is 0.81. When looking at the distribution of the single diseases: the most frequent ones are hypertension (30%), arthritis (28%), and diabetes (10%). Also, heart diseases are commonly reported (9%). Another important measure of health is given by the mobility difficulties index which is on average 1 on a scale up to 5. About that measure, the most common difficulties are those in stooping, kneeling, and couching (33%), climbing several flights of stairs (29%), and getting up from a chair (20%).

Following on, concerning mental health, we report the two measures of low memory skills (4 out of 10 words recalled) and low verbal fluency (10 animals mentioned out of 100). The former is more spread in the sample, with 57% of the respondents being affected by low memory: an understandable result considering the average respondent was aged 69. In contrast, almost 9% of the individuals surveyed are scored as having low verbal fluency.

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[6] Only 12% is still working.

[7] We select women from age 55 since we want to keep respondents which are couples and usually the female partner is younger than the male partner. We keep individuals until age 85 to avoid attrition due to death, which is a potential concern in panel data analysis.

Table 2 Summary statistics

Variable	Mean	Std. dev.	Min.	Max.	N. obs
Age	68.622	8.022	55	85	207,977
Female	0.613	0.487	0	1	207,977
Couple	0.727	0.446	0	1	138,772
Single	0.272	0.445	0	1	207,977
Years educ	12.374	4.703	0	35	206,567
Happy	0.908	0.289	0	1	207,977
Income	22.482	30.589	0	4,724,612	207,977
Health measures					
Number of diseases	0.810	0.946	0	7	207,977
Hypertension	0.309	0.462	0	1	198,893
Arthritis	0.281	0.449	0	1	104,745
Diabetes	0.101	0.302	0	1	197,857
Cancer	0.047	0.212	0	1	207,977
Lung disease	0.055	0.228	0	1	205,846
Heart disease	0.089	0.284	0	1	189,013
Stroke	0.029	0.168	0	1	205,846
Mobility index	1.061	1.464	0	5	207,977
Diff stooping	0.328	0.47	0	1	207,927
Diff climb2	0.291	0.454	0	1	207,653
Diff chair	0.206	0.404	0	1	207,927
Diff climb1	0.129	0.335	0	1	207,927
Diff walk	0.108	0.31	0	1	207,927
Low memory	0.573	0.495	0	1	232,222
Low verbal fluency	0.089	0.284	0	1	201,242

N of individuals is 80976 and the average number of interviews per respondents is four. diff climb1(2) measures difficulties in climbing one (several) flight(s) of stairs

In Table 9 in the Appendix, we also looked at the within and between components of the standard deviation of the main variables of interest. In this Table, based on the within standard deviation, for the outcome variable, there is up to 0.88 variance between units (1.78–0.90), which we could somehow expect given the multiple interviews over time. For the health measures, it appears that the between standard deviation is usually higher than the within one. This is consistent with a greater variation between individuals, and relatively small within individual differences over time, which we might expect, given that we see the respondents only for about four interviews on average.

Finally, we report the health measures of interest by individual characteristics. Figures 1 and 2 show the average number of disease/mobility difficulties by marital status and gender, based on socio-economic status. Low-income individuals are those with the greatest average number of diseases and mobility difficulties, furthermore singles are worse off compared to individuals in couples. While men report a greater average number of severe diseases (Fig. 1, right), women have more mobility difficul-
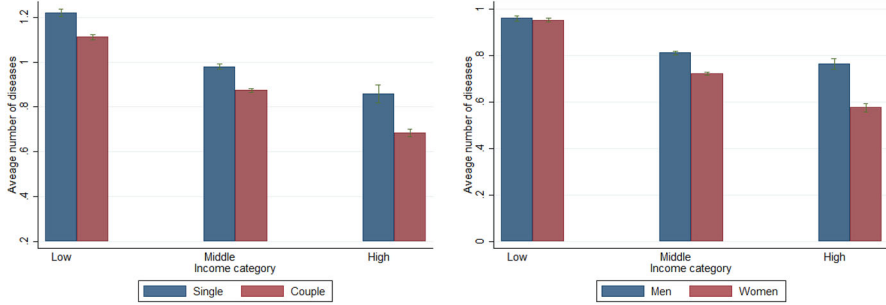
Fig. 1 Average number of diseases by marital status (left) or gender (right)
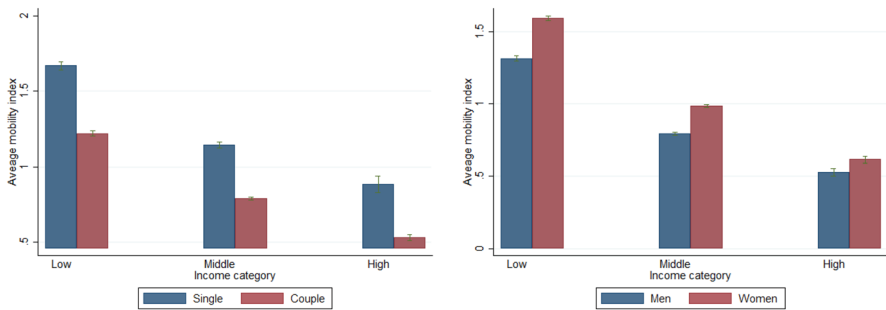
Fig. 2 Average mobility difficulties by marital status (left) or gender (right). Note: Figures 1 to 2 show the prevalence of the average number of relevant diseases and mobility difficulties, for individuals in couple or singles and for genders, based on socio-economic status
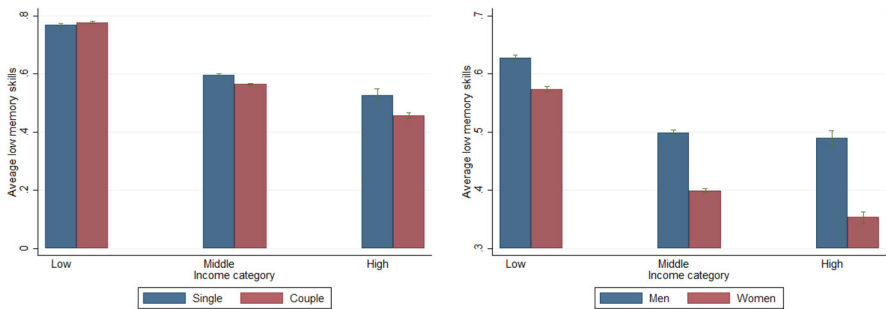
Fig. 3 Average low memory skills by marital status (left) or gender (right)

ties on average (Fig. 2, right). Finally, it is interesting to notice that low-income women are the most affected by mobility difficulties, with an average of 1.6 impairments.

Figure 3 represent the average memory skills by marital status and gender: while differences by marital status are limited, by gender instead, men show greater memory difficulties compared to women. Interesting, for low-income individuals, scores are similar by gender. Finally, Fig. 4 report evidence for low verbal fluency: singles seem to be more affected at any income level compared to couples, while gender differences are narrow at low-income levels.

Fig. 4 Average low verbal fluency skills by marital status (left) or gender (right). Note: Figures 3 to 4 show the prevalence of the average low memory skills and low verbal fluency, for individuals in couple or singles and for genders, based on socio-economic status

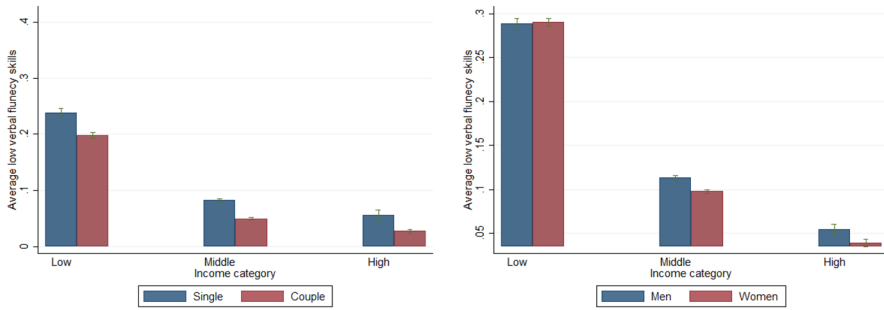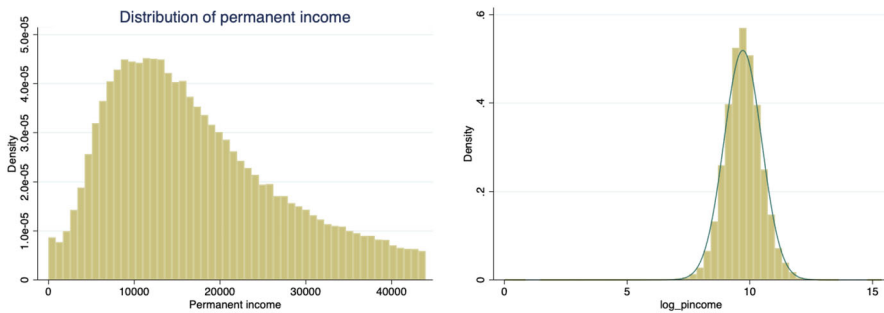**Fig. 5** Distribution of permanent income. Note: These pictures report the distribution of the permanent income and of the same measure in logarithm

5 Results

Table 3 display results of the model in Eqs. (1) and (2). We control for age, age squared, household size, being single, female, years of education, and individual and waves fixed effect. We control also for country dummies to account for potential country heterogeneity. In the tables, we report clustered standard errors at the individual level. We also run analyses with bootstrapped standard errors at the individual level: results do not change.

We recall that the sign of the health state dependence is given by β_1, which gives evidence of whether the marginal utility of consumption varies with health decline; whereas, the magnitude of the state dependence is given by the ratio β_1/β_3. The model is estimated via OLS fixed effect. We report the analysis of the first and second steps in a single column for each estimate, to allow an easy interpretation of the results.

Table 3 column (I) to reports the analysis for health measured via the number of relevant diseases: the sign of β_4 is negative as expected, implying a decrease in happiness as the individual gets sick. Thus, for someone with the average income (since permanent income is demeaned), an increase in one disease leads to a decline of about 0.3 percentage point in the probability of being happy. The coefficient of β_3 is positive as we expected and around 0.022, this means that for a 10% increase in

Table 3 Happiness analysis with physical or/and mental health measures

Dep Var: Happy	(I)	(II)	(III)	(IV)	(V)	(VI)
Num disease (β_4)	−0.003***				−0.005***	
	(0.0012)				(0.0013)	
	[−0.006, −0.001]				[−0.007, −0.002]	
Num disease*log_pincome (β_1)	0.005***				0.004**	
	(0.0017)				(0.0020)	
	[0.002, 0.008]				[0.000, 0.008]	
Mobility index (β_4)		−0.006***				−0.007***
		(0.0008)				(0.0009)
		[−0.008, −0.004]				[−0.008, −0.005]
Mobility index*log_pincome (β_1)		0.001				0.002
		(0.0012)				(0.0014)
		[−0.001, 0.004]				[−0.001, 0.005]
Low memory (β_4)			0.001		0.001	0.001
			(0.0018)		(0.0020)	(0.0020)
			[−0.002, 0.005]		[−0.003, 0.005]	[−0.003, 0.005]

Table 3 continued

Dep Var: Happy	(I)	(II)	(III)	(IV)	(V)	(VI)
Low memory*log_pincome (β_1)			-0.002		-0.002	-0.002
			(0.0026)		(0.0029)	(0.0029)
			[-0.007, 0.003]		[-0.008, 0.003]	[-0.008, 0.003]
Low verbal fluency (β_4)				-0.011***	-0.011***	-0.011***
				(0.0029)	(0.0029)	(0.0029)
				[-0.017, -0.005]	[-0.017, -0.005]	[-0.016, -0.005]
Low verbal fluency*log_pincome (β_1)				0.003	0.003	0.002
				(0.0049)	(0.0049)	(0.0049)
				[-0.006, 0.013]	[-0.007, 0.012]	[-0.007, 0.012]
Log_pincome (β_3)	0.022***	0.023***	0.029***	0.026***	0.024***	0.024***
	(0.0014)	(0.0014)	(0.0012)	(0.0015)	(0.0015)	(0.0013)
	[0.019, 0.025]	[0.021, 0.026]	[0.027, 0.031]	[0.024, 0.029]	[0.021, 0.027]	[0.022, 0.027]
R-squared	0.000	0.001	0.000	0.000	0.001	0.001
N	207,977	208,274	204,030	176,077	175,674	175,752
% change in the Marginal Utility for a 1 standard deviation increase in						
Num disease	10.2%				8.5%	
Mobility index		2.28%				6.3%
Low memory			-2%		-2.5%	-2.5%
Low verbal fluency				2.3%	2.1%	2.1%

The dependent variable is a dummy for happiness. Health is measured via physical or/and mental health status. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. Clustered standard errors at individual level are in parenthesis. p-value: *p < 0.10, **p < 0.05, ***p < 0.01

permanent income there is a 2.2 percentage point higher probability that the respondent reports being happy.

Regarding our coefficient of interest, β_1, it is around 0.005: the sign is positive and suggests the presence of positive state dependence. This means that as health worsens, the marginal utility of consumption increases. The significance level is at 1%. To compute the magnitude of the state dependence, we proceed by calculating the ratio β_1/β_3. We consider a one within-person standard deviation increase in: the number of relevant diseases ($\sigma = 0.51$) and find that it is associated with a 10.2% increase in the marginal utility to consume. Marginal utility increases from 0.025 for a healthy individual to 0.035 for a person with one disease, to 0.045 with two diseases, to 0.055 with three diseases (only 5.3% of the sample).

This result goes into the opposite direction with respect to the findings of Finkelstein et al. (2013), who found negative state dependence. Their analysis suggested a decline of about 11.2% for an individual shifting from being healthy to a one standard deviation increase in: the number of severe diseases.

The difference between the results on US data with our findings suggests the existence of different patterns on the two continents. One of the underlying mechanisms associated with this finding of an increase in the marginal utility to consume could be that individuals enjoy more some goods such as health assistance or domestic help in the sick state, rather than in the healthy state. However, because of a lack of information about consumption baskets, we are unable to corroborate this hypothesis. Another explanation might be that people hit by physical diseases need more resources to buy health care services or to adapt their home, again we do not have this budget-shares information to validate this argument. Finally, also the role of the governments' healthcare coverage might play a role and so the differences in the results of the marginal utility between the two continents might also be explained through this channel.

Another health measure that was used is mobility difficulties, results are reported in column (II): looking at β_4, as one mobility difficulty arises, results show a decrease in the probability of being happy of about 0.6 percentage point. Here, as well as in the previous estimates, the sign of β_3 is positive and the effect of about 2.3 percentage points.

Our key coefficient β_1 is about 0.001, but not significant. This implies a ratio β_1/β_3 of 3%, meaning that for a one within-person standard deviation increase in mobility difficulties ($\sigma = 0.76$), the marginal utility of consumption increases around 2.28%. For an individual with no difficulty who has a marginal utility of about 0.023, it increases to 0.051 with one difficulty, to 0.080 with two impediments. The size of these variations is modest but consistent with the onset of difficulties in mobility conditions, which do not have a strong impact as the onset of severe disease.

These first findings suggest that older people place greater value on future resources when physical health is affected, rather than when they are healthy. One potential explanation is that being sick involves future expenditures, both medical and nonmedical, to adapt to life in an unhealthy state. However, as suggested by Viscusi (2019), another explanation might be that the response of the marginal utility could also be related to the type of health shocks considered, whether physical or cognitive, mild or severe. Thus, we look at the effect of cognitive decline as follows.

In columns (III) and (IV) we focus on cognitive decline. Overall, results suggest evidence of negative state dependence for low memory skills and positive state dependence for low verbal fluency. However, in both cases, the state dependence coefficient turns not significant. Thus we lack the statistical power to confirm our findings in terms of magnitude.

From column (III), it is possible to see that an increase in memory loss leads to a coefficient of β_1 of -0.002. This result indicates a decrease in the marginal utility and it can be explained through a decline in the enjoyability of goods such as travel or leisure, given that the mental impairment precludes living life as before. However as mentioned above, we do not have enough information to confirm this explanation.

This result suggests a different path for marginal utility when memory skills get worse compared to physical health. When it comes to the magnitude of the state dependence, although not significant, one within-person standard deviation increase in low memory ($\sigma = 0.30$) decreases the marginal utility to consume of about 2%.

Looking at the estimates for low verbal fluency, column (IV): a decrease in low verbal fluency skills leads to an increase in the marginal utility, with β_1 of 0.003. The magnitude of the state dependence given by the ratio β_1/β_3 is about 1.9% for one standard deviation increase in low verbal fluency ($\sigma = 0.17$).

To summarize this first set of results: we find evidence of both positive and negative state dependence on a panel of European retirees. Concerning physical deterioration, we find that as the number of severe diseases increases, individuals experience an increase in the marginal utility to consume of about 10.2%, for an increase in mobility impairments the increase is instead about 2.28%. Regarding mental deterioration, the decline in memory reports a decrease in the marginal utility of 2%, while worsening verbal fluency implies an increase of around 1.9% in the marginal utility to consume. However, for cognitive decline, we lack the statistical power to confirm our findings.

The size of these effects is different both in terms of sign and magnitude. Concerning the sign, as previously mentioned, it is possible that when the physical decline occurs, people need more resources to adapt their life to the previous state, while when the memory decline occurs, the individuals' marginal utility declines since the unhealthy state prevents living life as before. Concerning the magnitude of the state dependence, although not significant for cognitive decline, we found heterogeneity in the size of the effects that could also be due to different health measures sensitivity. Nevertheless, the magnitude is in line with results found in the literature (Finkelstein et al. 2013; Kools and Knoef 2019), although not significant for the cognitive health shocks case.

Furthermore, in columns (V) and (VI) we estimates the model including both physical and cognitive health. We found evidence of positive state dependence for the number of diseases, and negative state dependence for the low memory, although insignificant.

These findings further indicate the presence of heterogeneity in the marginal utility to consume as health drops. Different health trajectories and impairments may cause different results in terms of state dependence. This evidence sheds some light in favour of the previous work of Brown et al. (2016), who found both evidence of increase and decrease in the marginal utility to consume after bad health events.

Overall, we find positive health state dependence for physical health, and negative state dependence, but not significant, for low memory. The fact that the coefficient is

not significant for the cognitive decline might be due to the measurement threshold, thus we tried some alternative measures to test the robustness of the findings, which are in Sect. 6. Another explanation for the lack of statistical power could be that our sample is composed of individuals relatively young since the average age is 69, and that the cognitive decline develops at later ages, which we do not capture largely.

Finally, in our baseline analysis we have also set the risk aversion parameter $\beta_2 = 1$ following Finkelstein et al. (2013). We have tried alternative measures of the risk aversion parameter such as $\beta_2 = 1.5$ or $\beta_2 = 2$ based on the literature on insurance and savings (although there is no overall consensus on the coefficient of the relative risk aversion): the results overall confirm the baseline results, although not always statistically significant and are available upon request.

5.1 Results by Welfare Models

Since Europe is facing an increasing unmet demand for long-term care by older individuals, this underlines that it is fundamental to understand how people value consumption in the sick state and their demand for further assistance. Thus, in this section, we take advantage of the countries' variation in terms of welfare states that are present in SHARE to address heterogeneity based on the country's welfare.

Different welfare systems can provide different levels of social protection to individuals and this may imply different levels of health state dependence on utility. Our analysis assesses whether there are relevant welfare system effects that may affect the individual's utility between the healthy and sick condition.

This exercise wants to investigate the presence of further heterogeneity in the sample. Since the literature has highlighted the effect of the welfare systems on individuals' portfolio choice (Atella et al. 2012), we wonder whether living in a country with a more generous or not generous welfare system has implications on the health-dependent utility of the individual.

In the European framework, several approaches have been used to group countries, from the Esping-Andersen (1990) classification of the three welfare states to the health care systems approach of Atella et al. (2012). None of the cited studies focused on the dimension of long-term care (henceforth LTC) spending, which varies among countries and it is fundamental when considering health shocks in late life. Carrino et al. (2018) demonstrate that there is a great unmet demand for formal long-term care in Europe, with tailored requirements on a country basis, and also differences in the eligibility rules to the programs across regions.

In our analysis, we proceed by focusing on the degree of expenditure for LTC both public and private per country. We focus on this aspect since we want to group countries not only based on basic health care services but also to consider the heterogeneity in terms of support for LTC that has been documented by Brugiavini et al. (2017). To do this, we define three groups of countries based on the public spending on long-term care (health and social components) in 2014 as a percentage of GDP, according to the OECD Health Statistics (2019). We select Sweden, Denmark and the Netherlands as "high spending countries", with more than 2% of GDP spending for LTC. We group Germany, Austria, France, Luxembourg, Belgium, Switzerland and England as

"medium spending countries" with a share of expenditure between 1% and 1.9% of their GDP. Finally, Italy, Spain, and Israel are considered "low spending countries" with less than 1% of GDP expenditure.

We proceed by re-estimating the baseline analysis by groups of countries based on our classification. In Tables 4 and 5 we report the results.

In Table 4 we find significant results only in low-spending countries for the number of diseases (column (V)): here the presence of positive state dependence is confirmed by the coefficient of the interaction term between the number of diseases and permanent income. The fact that we find an effect only in low-spending countries suggests that in those countries the individuals' utility and marginal utility react more when physical ailment occurs compared to other individuals in medium-high spending countries. In low-spending countries, individuals value more resources for the future when they might face a physical health decline, potentially due to lack of welfare support. Overall this table confirms the results for physical health shocks, although coefficients the state-dependence coefficient is significant only for low spending countries. Furthermore, for physical health the sign of the coefficient is not in line with the one found by Finkelstein et al. (2013) for physical health decline, which suggested a negative state dependence.

Following on, when measuring health via cognitive decline in Table 5, the marginal utility of consumption decreases as memory loss arises in each of the three groups, but the coefficients are statistically insignificant.

In particular, by looking at the effect of memory decline in high and medium spending countries (columns (I) and (III), respectively), we see a decrease in the marginal utility to consume for memory loss, although not statistically significant.

For verbal fluency deterioration, individuals in high and medium LTC spending countries (columns (II) and (IV)) show positive-state dependence, but the coefficient is not significant. Instead, people in low spending countries (column (VI)) experience the greatest drop in the marginal utility to consume, which is about 25% ($\sigma = 0.25$). Although the magnitude of these results might be uncertain because we lack the statistical power, they suggest the existence of differences in health state dependence of utility when controlling for countries' heterogeneity in LTC spending. This evidence reflects different coverage and degree of protection, which translates into different changes in terms of marginal utility after a cognitive health shock.

In particular, the fact that we find significant coefficients of health state dependence only in low LTC spending countries also suggests that individuals in these countries are more affected by health shocks compared to individuals in other countries. One explanation could be that since the welfare protection is low in these countries, they need to adapt more in terms of their marginal utility to consume when bad health events occur. However, for cognitive decline only the coefficient of verbal fluency in low spending countries is significant, thus we lack the statistical power to confirm our findings.

We have also run the analysis separately by country: results, which are not included for sake of space, are overall confirmed by each country, although we lack statistical power in several cases, potentially due to the low number of observations in each model.

Table 4 Happiness analysis with physical health by group of countries

Dep Var: Happy	Countries					
	High		Medium		Low	
	(I)	(II)	(III)	(IV)	(V)	(VI)
Num disease	−0.003		−0.001		−0.008*	
	(0.0044)		(0.0014)		(0.0042)	
	[−0.012, 0.007]		[−0.003, 0.001]		[−0.016, −0.000]	
Num disease*log_pincome	0.001		0.000		0.008*	
	(0.0069)		(0.0021)		(0.0044)	
	[−0.015, 0.017]		[−0.003, 0.004]		[0.001, 0.015]	
Mobility index		−0.004		−0.005***		−0.013***
		(0.0030)		(0.0010)		(0.0028)
		[−0.008, −0.001]		[−0.007, −0.002]		[−0.019, −0.008]
Mobility index*log_pincome		0.007		0.001		−0.004
		(0.0048)		(0.0016)		(0.0028)
		[0.002, 0.012]		[−0.002, 0.004]		[−0.011, 0.003]
Log pincome	0.020***	0.016***	0.034***	0.031***	0.005*	0.016***
	(0.0038)	(0.0037)	(0.0018)	(0.0017)	(0.0027)	(0.0027)
	[0.013, 0.028]	[0.008, 0.023]	[0.031, 0.036]	[0.029, 0.034]	[−0.001, 0.010]	[0.010, 0.022]
R-squared	0.000	0.001	0.000	0.001	0.002	0.003
N	29,474	29,501	139,876	140,092	38,627	38,681
% change in the Marginal Utility for a 1 standard deviation increase in						
Num disease	2.5%		–		88%	
Mobility index		23.3%		2.2%		−21.2%

The dependent variable is a dummy for happiness. Health is measured *via* number of diseases or mobility index. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. The group of countries "high" are Sweden, Denmark and the Netherlands, "medium" are Germany, Austria, France, Luxembourg, Belgium, Switzerland and England; "low" are Italy, Spain and Israel. Clustered standard errors at individual level are in parenthesis, p-value: *p < 0.10, **p < 0.05, ***p < 0.01

Table 5 Happiness analysis with mental health by group of countries

Dep Var: Happy	Countries					
	High		Medium		Low	
	(I)	(II)	(III)	(IV)	(V)	(VI)
Low memory	0.008		−0.001		0.004	
	(0.0055)		(0.0020)		(0.0064)	
	[−0.003, 0.019]		[−0.005, 0.003]		[−0.009, 0.017]	
Low memory*log_pincome	−0.007		−0.002		−0.000	
	(0.0083)		(0.0030)		(0.0090)	
	[−0.023, 0.010]		[−0.008, 0.004]		[−0.015, 0.014]	
Low verbal fluency		−0.021		−0.006**		−0.044***
		(0.0179)		(0.0029)		(0.0123)
		[−0.056, 0.014]		[−0.012, −0.001]		[−0.068, −0.020]
Low verbal fluency*log_pincome		0.053		0.002		−0.022*
		(0.0342)		(0.0051)		(0.0136)
		[−0.014, 0.120]		[−0.008, 0.012]		[−0.049, 0.004]
Log pincome	0.024***	0.018***	0.035***	0.033***	0.016***	0.022***
	(0.0037)	(0.0038)	(0.0018)	(0.0018)	(0.0029)	(0.0034)
	[0.017, 0.032]	[0.010, 0.025]	[0.031, 0.038]	[0.029, 0.036]	[0.010, 0.022]	[0.015, 0.028]
R-squared	0.001	0.001	0.001	0.000	0.001	0.003
N	29,031	26,205	138,252	119,010	36,747	30,862
% change in the Marginal Utility for a 1 standard deviation increase in						
Low memory	−8.1%				−	
Low verbal fluency		29.4%		−1.65%		−25%

The dependent variable is a dummy for happiness. Health is measured via cognitive measures. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. The group of countries "high" are Sweden, Denmark and the Netherlands, "medium" are Germany, Austria, France, Luxembourg, Belgium, Switzerland and England; "low" are Italy, Spain and Israel. Clustered standard errors at individual level are in parenthesis, p-value: *p < 0.10, **p < 0.05, ***p < 0.01

Finally, we proceed by running a series of sensitivity analyses to confirm our findings, which are available in the next section.

6 Sensitivity Analysis

6.1 Alternative Happiness Measures

In this section, we tried alternative measures of happiness to test the goodness of our results.

First, we select the threshold 1 out of 4 on the happiness scale in such a way that we consider it as "happy" only those reporting to be happy "often" on the scale. Results in Table 6 from column (I) to (IV) confirm the previous findings except for mobility index and for low memory skills which are now positive. However, the coefficients of the state dependence are no more statistically significant. Overall, the magnitude of the state dependence is in line with previous results (although not significant). Second, we measure happiness using the ordinal scale and report the results in columns (V) to (VIII). Here, although it might seem that the coefficient of the number of diseases is suggesting a negative state dependence, the negative sign cancels out with the negative coefficient of permanent income, thus confirming a positive state dependence. Regarding the results for cognitive decline: the results are confirmed only for memory loss, although not significant.

In Table 6 the evidence aligns with our baseline results overall, but we lack statistical significance, suggesting that the scale of the outcome variable is crucial when addressing this type of analysis.

Furthermore, we also run this specification using an ordered probit model and report the results in Table 10 in Appendix. Our findings are overall confirmed once accounting for the different cutoffs of the outcome variable. Also, we have computed the analysis using a probit model in Table 11: results from column (I) to (IV) are confirmed.

Finally, we test an alternative measure for utility could be the CASP indicator, which has been used in the literature on subjective well-being. This measure involves four dimensions: control (C), autonomy(A), self-realization (S), and pleasure (P). CASP is scaled from 12 to 48, with higher values indicating a better quality of life. It has been used by scholars such as Hyde et al. (2003), and Di Novi et al. (2015) in the field of health and subjective well-being.

Estimates with this specification are reported in the Appendix in Table 11 from column (V) to (VIII): with this alternative measure, results hold both for the number of diseases and for mobility index, confirming the positive state dependence. Regarding the cognitive decline: the state dependence is not significant and also positive for low memory. Overall results are in line with our baseline findings, except for memory loss.

To summarize, we recognise that the outcome variable's scale is fundamental when addressing this test of state dependence. Our main results are confirmed, although we lack the statistical power in some specifications.

Table 6 Happiness analysis with alternative dependent variables

Dep Var:	Happy (1/4)				Happiness Scale			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Num disease	−0.003*				0.008***			
	(0.0018)				(0.0025)			
	[−0.007, 0.000]				[0.002, 0.013]			
Num disease*log_pincome	0.003				−0.008**			
	(0.0025)				(0.0038)			
	[−0.002, 0.008]				[−0.015, −0.000]			
Mobility index		−0.013***				0.021***		
		(0.0013)				(0.0019)		
		[−0.015, −0.010]				[0.017, 0.024]		
Mobility index*log_pincome		−0.001				0.000		
		(0.0018)				(0.0027)		
		[−0.005, 0.002]				[−0.005, 0.005]		
Low memory			−0.003				0.004	
			(0.0029)				(0.0041)	
			[−0.008, 0.001]				[−0.004, 0.013]	
Low memory*log_pincome			0.007				−0.004	
			(0.0043)				(0.0061)	
			[−0.002, 0.016]				[−0.016, 0.008]	

Table 6 continued

Dep Var:	Happy (1/4)				Happiness Scale			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Low verbal fluency				−0.023***				0.035***
				(0.0045)				(0.0066)
				[−0.031, −0.015]				[0.021, 0.049]
Low verbal fluency*log_pincome				0.000				−0.002
				(0.0065)				(0.0105)
				[−0.013, 0.014]				[−0.019, 0.015]
Log_pincome	0.057***	0.058***	0.058***	0.061***	−0.087***	−0.088***	−0.094***	−0.096***
	(0.0065)	(0.0056)	(0.0025)	(0.0026)	(0.0037)	(0.0036)	(0.0038)	(0.0039)
	[0.045, 0.070]	[0.047, 0.069]	[0.053, 0.063]	[0.056, 0.067]	[−0.104, −0.070]	[−0.104, −0.074]	[−0.102, −0.087]	[−0.104, −0.089]
R-squared	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002
N	207,977	208,274	204,030	176,077	207,977	208,274	204,030	176,077
% change in the Marginal Utility for a 1 standard deviation increase in								
Num disease	2.6%				4.6%			
Mobility index		−1.3%				–		
Low memory			3.6%				1.2%	
Low verbal fluency				–				0.3%

The dependent variable is a dummy for happiness or the happiness scale. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. Clustered standard errors at individual level are in parenthesis, p-value: *p < 0.10, **p < 0.05, ***p < 0.01

6.2 Alternative Health Measures

We assess the sensitivity of our analysis by re-running the baseline model with alternative health measures such as limitations with activities of daily living (ADL), limitations with instrumental activities of daily living (IADL), the minor-major approach, symptomatic versus asymptomatic diseases and different cognitive health thresholds.

First, we looked at the alternative health measures: ADL and IADL are extensively used in the literature and considered to be a good proxy for the health status of the individual. ADL scores from 1 to 6 limitations, while IADL up to 9 limitations.

In Table 7 we report the results where we estimate the baseline model with ADL in column (I), IADL in column (II), minor-major diseases in column (III), and asymptotic-symptomatic diseases in column (IV).

Starting from columns (I) and (II): the coefficients of interest are statistically significant. In both cases, the sign of the interaction of health with permanent income is negative, suggesting a decrease in the marginal utility, but only significant for IADL. For an increase in ADL number, the marginal utility of consumption drop of 5.3%, based on a within-individual standard deviation of 0.46; while for one additional IADL, the decline is about 8.2%, given a standard deviation of 0.70 per respondent.

As a second step, we focus on the distinction between minor and major health conditions and we divide the set of 7 severe diseases into two categories. We consider diabetes, hypertension, and arthritis as minor diseases since they can be treated via medication and kept under control. We group cancer, stroke, heart, and lung disease as major diseases since these are in principle more dangerous, severe and some of them are sudden (such as cancer and stroke, heart attack, ischemia, and more).

Results, which are reported in column (III), suggest that only major diseases have a strong and significant effect on utility. An increase in one major disease causes a drop in the probability of being happy of about 0.6 percentage point; the state dependence is positive, with a coefficient of about 0.007 for the state dependence and suggests an increase of the marginal utility of consumption of about 8% (given a within standard deviation of 0.27). This result confirms the presence of positive state dependence of physical disease as it was seen in Table 3. It is interesting to note that the results are driven only by major conditions, whereas minor conditions are not statistically significant and do not impact the marginal utility to consume. This is consistent with the fact that major conditions are a stronger health shock compared to minor diseases, and thus they have a greater impact on the individual's utility.

Also, one possible explanation is that in practice major ailments make having additional financial resources available for care beneficial, which are not a priori covered overall across European welfare systems.

Finally, we group the number of diseases based on whether the disease is symptomatic or asymptomatic: in the first group we include lung disease, stroke, cancer and arthritis, while in the second group the remaining.[8] Results are reported in column (IV) and suggest the presence of positive state dependence although the coefficient is statistically significant only for asymptomatic diseases.

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[8] This grouping choice is made after Finkelstein et al. (2013).

Table 7 Happiness analysis with alternative health measures

Dep Var: Happy	(I)	(II)	(III)	(IV)
adl	-0.006***			
	(0.0011)			
	[-0.008, -0.003]			
adl*log_pincome	-0.003			
	(0.0017)			
	[-0.006, 0.001]			
iadl		-0.007***		
		(0.0014)		
		[-0.009, -0.004]		
iadl*log_pincome		-0.003*		
		(0.0017)		
		[-0.007, 0.000]		
Minors			-0.003	
			(0.0016)	
			[-0.006, 0.001]	
Majors			-0.006***	
			(0.0022)	
			[-0.011, -0.002]	
Minors*log_pincome			0.003	
			(0.0024)	
			[-0.001, 0.008]	
Majors*log_pincome			0.007**	
			(0.0033)	
			[0.000, 0.013]	
Symptomatic				-0.004**

Table 7 continued

Dep Var: Happy	(I)	(II)	(III)	(IV)
Symptomatic				
				(0.0019)
				[−0.008, −0.001]
Asymptomatic				−0.002
				(0.0019)
				[−0.006, 0.001]
Symptomatic*log_pincome				0.002
				(0.0028)
				[−0.003, 0.008]
Asymptomatic*log_pincome				0.005*
				(0.0028)
				[−0.000, 0.011]
Log_pincome	0.026***	0.025***	0.023***	0.023***
	(0.0014)	(0.0016)	(0.0014)	(0.0014)
	[0.024, 0.029]	[0.022, 0.028]	[0.020, 0.025]	[0.020, 0.026]
R-squared	0.000	0.001	0.000	0.000
N	208,274	139,069	208,274	208,274
% change in the Marginal Utility for a 1 standard deviation increase in				
adl	−5.3%			
iadl		−8.2%		
Minors			4.5%	
Majors			8.2%	
Symptomatic				2.5%
Asymptomatic				6.7%

The dependent variable is a dummy for happiness. Health is measured via different health specifications. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. Clustered standard errors at the individual level are in parenthesis, p-value: *p < 0.10, **p < 0.05, ***p < 0.01

Following on, we select a cutoff of 3 or 5 out of 10 for the memory score, which is respectively the 39% and 75% in the distribution on the memory scores. This exercise enables us to test the sensitivity of our main results with cognitive health. In Table 12 in the Appendix, we can see that in both cases the state dependence coefficient is negative but not significant, suggesting that the sign of the result is confirmed, but when using different thresholds we lack the statistical power to confirm the magnitude of the results.

Then, we explore other thresholds for verbal fluency, such as 16 and 22 which situate at the 33% and 66% of the variable's distribution. Here, we can confirm our findings for both cases. They suggest an increase in the marginal utility of about 4.2% for 16 and 2.8% for 22 scores (both given a standard deviation of about 0.17). This evidence suggests that the verbal fluency measure is sensitive to the threshold used and, thus, the coefficients of the state dependence must be taken with caution.

To summarize, this set of analyses with alternative measures of health suggests that the sign of the coefficients of our baseline analysis is confirmed, but that the magnitude might be sensitive to the health-related threshold for the measures of the cognitive skills. Also, when grouping diseases by severity, only major diseases, and asymptomatic ailments show significant positive health dependence. Thus, we believe that using a single disease as a health measure might be insufficient to account for multiple effects of different diseases and comorbidities.

7 Conclusion

This paper investigates the presence of health state dependence on utility by following the framework of Finkelstein et al. (2013) for Europe. We also use different health measures to account not only for physical deterioration but also for cognitive decline, which generally occurs at older ages.

The baseline analysis confirms the presence of positive state dependence for physical diseases, meaning that when health deteriorates, the marginal utility to consume increases by about 10.2%.

Concerning mental decline, we find evidence of negative state dependence for low memory: the marginal utility to consume decreases by about 2% as memory skills deteriorate; and of positive state dependence with an increase of 2% in the marginal utility for low verbal fluency. However, for these shocks the coefficients of the state dependence are often insignificant, thus, we lack the statistical power to confirm our findings. Nevertheless, by looking at the sign of the coefficients,the results suggest the need for policies able to meet the increasing demand for long-term care when cognitive deterioration arises.

These findings of different health state dependencies based on the physical or mental decline are crucial and suggest heterogeneity in the marginal utility to consume. To be more clear, when physical issues arise, people value resources more in the future since they necessitate more wealth in the sick state to keep up with the previous living standards. Of course, another potential interpretation can be drawn for physical impairments, such as the one by Viscusi (2019), who compares minor diseases to financial losses, which increase the marginal utility. Instead, when cognition decline

occurs, people are less willing to value wealth in the future state because the cognitive impairment prevents them from living life as before. However, we lack the statistical power to confirm this last finding.

We document that different countries' welfare systems generate different declines in terms of marginal utility after a mental health shock. In particular, individuals living in a country where less than 1% of GDP expenditure goes to LTC face the greatest drop in the marginal utility when memory loss occurs. This advocates the need for policy interventions able to provide more health care support.

We run a series of sensitivity analyses that confirmed the nature of our findings. These results contribute to underline that European countries face different scenarios when dealing with health state dependence compared to the US, for whom the evidence suggests negative state dependence. We provide a possible explanation to understand what drives these differences, but we think that there is a need for more information about consumption and budget shares to shed light in that respect.

Indeed, a potential limitation of the study lies in the lack of available information on consumption shares of the individuals: with this information, we could have explored how the basket of individuals is affected by the health deterioration and to what extent.

Another interesting analysis will be to look at the effect of health decline on individuals aged less than 50 years old, to explore whether there are differences in health dependence based on the life cycle period of the individual. Unfortunately, the survey does not include these individuals too.

When comparing our results to the ones of Simonsen and Kjær (2021) for Denmark, we think that since we found consistent evidence when applying different health measures (the number of diseases, mobility index limitations, memory, and verbal fluency loss), we are not subjected to the same paradox that the authors found when using different health measures (i.e. positive dependence with the number of diseases vs negative dependence with the Charlson Comorbidity Index (CCI)). Of course, if we could have access to administrative data for the countries considered, we could test our findings by using the same CCI. Unfortunately, we lack access to administrative information.

In conclusion, this work highlights the necessity of implementing models with health-dependent utility, to assess the optimal amount of life-cycle saving and insurance levels. Our results provide grounds for an increasing level of social protection from governments, mostly in countries with low spending for long-term care, where individuals are the most affected in terms of marginal utility when cognitively sick. Based on our evidence, since individuals value more resources in future states when sickness manifests, the optimal fraction of earnings saved for future periods might be greater than the one usually predicted by life-cycle models.

Data availibility SHARE data are permanently available to the scientific community upon registration through the website http://www.share-project.org.

Declarations

Conflict of interest The author declares that he has no conflict of interest.

Code availability Not applicable.

A Appendix

See Tables 8, 9, 10, 11, 12.

Table 8 Distribution of cognitive skills

	Frequency	Percent	Cumulative
Distribution of memory skill			
0	20,256	8.72	8.72
1	13,300	5.73	14.45
2	21,865	9.42	23.87
3	34,887	15.02	38.89
4	42,853	18.45	57.34
5	40,923	17.62	74.96
6	29,369	12.65	87.61
7	16,757	7.22	94.83
8	7716	3.32	98.15
9	3081	1.33	99.48
10	1215	0.52	100.00
Total	232,222	100.00	
Distribution of verbal fluency skill			
0	993	0.49	0.49
1	706 0	0.35	0.84
2	363 0	0.18	1.02
3	389 0	0.19	1.22
4	541 0	0.27	1.49
5	995 0	0.49	1.98
6	1330	0.66	2.64
7	1924	0.96	3.60
8	2625	1.30	4.90
9	3351	1.67	6.57
10	4688	2.33	8.90
11	5358	2.66	11.56
12	7095	3.53	15.09
13	7281	3.62	18.70
14	8766	4.36	23.06
15	10,176	5.06	28.12
16	10,657	5.30	33.41
17	11,222	5.58	38.99
18	11,764	5.85	44.83
19	11,227	5.58	50.41
20	11,783	5.86	56.27
21	10,855	5.39	61.66
22	10,418	5.18	66.84
23	9701	4.82	71.66
24	8550	4.25	75.91
25+	8459	24.20	100.00
Total	201,242	100.00	

This table shows the distribution of the cognitive measures

Table 9 Standard deviation components of the variables of interest

		Mean	Std. dev.	Min	Max	N/n/T-bar
Happy	Overall	0.907	0.289	0	1	210403
	Between	.	0.248	0	1	74715
	Within	.	0.192	0.032	1.782	2.816
Num disease	Overall	0.808	0.950	0	7	242699
	Between	.	0.881	0	7	80766
	Within	.	0.510	− 3.391	5.808	3.004
Mobility index	Overall	1.073	1.482	0	5	243114
	Between	.	1.318	0	5	80,976
	Within	.	0.763	− 3.301	5.448	3.002
Low memory	Overall	0.573	.494581	0	1	232222
	Between		0.412	0	1	79348
	Within		0.306	− 0.301	1.44	2.926
Low verbal fluency	Overall	0.089	0.284	0	1	201242
	Between	.	0.267	0	1	75159
	Within	.	0.173	− 0.768	0.946	2.677

This table shows the within and between variation of the outcome variable and the main health measures of interest

Table 10 Happiness analysis with the ordinal outcome, modelled via an ordered probit model

Dep Var: Happy	(I)	(II)	(III)	(IV)
Num disease	0.093***			
	(0.0044)			
	[0.085, 0.102]			
Num disease*log_pincome	−0.109***			
	(0.0047)			
	[−0.118, −0.099]			
Mobility index		0.099***		
		(0.0031)		
		[0.093, 0.105]		
Mobility index*log_pincome		−0.046***		
		(0.0033)		
		[−0.053, −0.040]		
Low memory			0.192***	
			(0.0082)	
			[0.176, 0.208]	
Low_memory*log_pincome			−0.213***	
			(0.0080)	
			[−0.228, −0.197]	
Low verbal fluency				0.152***
				(0.0132)
				[0.126, 0.178]
Low verbal fluency*log_pincome				−0.167***
				(0.0159)
				[−0.198, −0.135]

Table 10 continued

Dep Var: Happy	(I)	(II)	(III)	(IV)
Log_pincome	−0.092***	−0.071***	−0.117***	−0.036***
	(0.0013)	(0.0012)	(0.0012)	(0.0008)
	[−0.094, −0.089]	[−0.073, −0.069]	[−0.119, −0.115]	[−0.038, −0.035]
cut1				
Constant	0.422***	0.451***	0.454***	0.406***
	(0.0067)	(0.0064)	(0.0072)	(0.0065)
	[0.409, 0.435]	[0.439, 0.464]	[0.440, 0.469]	[0.393, 0.419]
cut2				
Constant	1.982***	2.013***	2.030***	1.983***
	(0.0092)	(0.0091)	(0.0096)	(0.0097)
	[1.964, 2.000]	[1.995, 2.030]	[2.011, 2.048]	[1.964, 2.002]
cut3				
Constant	2.978***	3.010***	3.036***	2.995***
	(0.0137)	(0.0138)	(0.0141)	(0.0151)
	[2.951, 3.005]	[2.983, 3.037]	[3.008, 3.063]	[2.966, 3.025]
sigma2_u				
Constant	1.034***	1.028***	1.064***	1.116***
	(0.0142)	(0.0141)	(0.0149)	(0.0169)
	[1.006, 1.062]	[1.000, 1.055]	[1.035, 1.094]	[1.083, 1.149]
N	207975	208272	204030	176077

Table 10 continued

Dep Var: Happy	(I)	(II)	(III)	(IV)
% change in the Marginal Utility for a 1 standard deviation increase in				
Num disease	60.4%			
Mobility index		49.2%		
Low memory			54.6%	
Low verbal fluency				78.8%

The dependent variable is a ordinal variable for happiness. Health is measured via different health specifications. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. Clustered standard errors at the individual level are in parenthesis, p-value: *p < 0.10, **p < 0.05, ***p < 0.01

Table 11 Happiness analysis with probit specification (average marginal effects are reported) or the CASP measure

Dep Var:	Happy				CASP			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Num disease	0.015***				−0.396***			
	(0.0006)				(0.0363)			
	[0.013, 0.016]				[−0.457, −0.336]			
Num disease*log_pincome	0.007***				0.143***			
	(0.0007)				(0.0418)			
	[0.006, 0.008]				[0.057, 0.229]			
Mobility index		0.003***				−0.712***		
		(0.0004)				(0.0272)		
		[0.002, 0.003]				[−0.765, −0.659]		
Mobility index*log_pincome		0.003***				0.133***		
		(0.0004)				(0.0318)		
		[0.002, 0.004]				[0.085, 0.180]		
Low memory			0.040***				−0.203***	
			(0.0010)				(0.0646)	
			[0.038, 0.042]				[−0.335, −0.071]	

Table 11 continued

Dep Var:	Happy				CASP			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Low memory*log_pincome			-0.008***				0.075	
			(0.0012)				(0.0777)	
			[-0.010, -0.006]				[-0.079, 0.229]	
Low verbal fluency				-0.010***				-0.805***
				(0.0016)				(0.1392)
				[-0.013, -0.007]				[-1.087, -0.522]
Low verbal fluency*log_pincome				0.000				0.227
				(0.0017)				(0.1635)
				[-0.003, 0.004]				[-0.083, 0.536]
Log_pincome	0.006***	0.007***	0.016***	0.011***	2.367***	2.233***	2.984***	3.167***
	(0.0008)	(0.0007)	(0.0009)	(0.0007)	(0.8806)	(0.8332)	(0.0455)	(0.0485)
	[0.004, 0.007]	[0.005, 0.008]	[0.014, 0.017]	[0.009, 0.012]	[0.641, 4.093]	[0.600, 3.866]	[2.895, 3.073]	[3.072, 3.263]
N	207975	208272	204030	176077	181306	181399	178625	160504
% change in the Marginal Utility for a 1 standard deviation increase in								
Num disease	59.5%				3.08%			
Mobility index		32.5%				4.5%		
Low memory			-15%				0.7%	
Low verbal fluency				–				1.2%

The model with happiness as dependent variable is estimated using probit specification, average marginal effects are reported for comparability purpose; while the model with CASP is estimated using fixed effect. Health is measured via different health specifications. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. Clustered standard errors at the individual level are in parenthesis, p-value: *p < 0.10, **p < 0.05, ***p < 0.01

Table 12 Happiness analysis with different cutoffs for the cognitive measures

Dep Var: Happy	(I)	(II)	(III)	(IV)
Threshold	3/10	5/10	16/100	22/100
Low_memory	−0.003	−0.003		
	(0.0022)	(0.0021)		
	[−0.007, 0.002]	[−0.007, 0.001]		
Low_memory*log_pincome	−0.004	−0.002		
	(0.0043)	(0.0038)		
	[−0.013, 0.004]	[−0.010, 0.005]		
Low_verbfluency			−0.007***	−0.002
			(0.0020)	(0.0016)
			[−0.011, −0.004]	[−0.005, 0.001]
Low_verbfluency*log_pincome			0.006**	0.004*
			(0.0030)	(0.0023)
			[0.000, 0.012]	[−0.001, 0.008]
Log_pincome	0.027***	0.027***	0.024***	0.024***
	(0.0014)	(0.0014)	(0.0014)	(0.0014)
R-squared	0.000	0.000	0.000	0.000
N	208272	208272	208272	208272
% change in the Marginal Utility for a 1 standard deviation increase in				
Low memory	−2.5%			
Low memory		−1.3%		
Low verbal fluency			4.2%	
Low verbal fluency				2.8%

The dependent variable is a dummy for happiness. Health is measured via mental health status. Permanent income (*pincome*) is a proxy for consumption. Demographic controls, wave and country dummies apply. Clustered standard errors at individual level are in parenthesis, p-value: *p < 0.10, **p < 0.05, ***p < 0.01

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