'Decision Making under Uncertainty: State-dependent Utility Functions and Applications on Health Outcomes'

PhD in Economics and Management of Technology (DREAMT)

XXXII Cycle

University of Pavia, University of Bergamo

Thesis

FRANCESCA GARBUGLIA

Contents

Abstract

According to several authors (e.g. Zeckhauser 1970, Arrow 1974), the dependence of the shape of the utility function on health conditions has relevant effects on a wide set of economic behaviors. For example, if marginal utility of consumption increases or decreases as a consequence of illness, this is likely to have an impact on the demand for health insurance (Gyrd Hansen, 2016) or on the optimal level of life-cycle savings (Kools and Knoef, 2017) or on optimal setting of social security systems (Viscusi and Evans, 1990, Finkelstein 2013). According to Finkelstein (2013), we develop an empirical model to estimate how the marginal utility of consumption varies with health. Our purpose is to investigate how possible shocks in the health status may lead to a change in an individual's preferences and decision making approach. Under the theoretical framework of the state dependent utility function, we developed an empirical model in which the impact of health on the marginal utility of consumption can be estimated from data on permanent income, health and utility proxies.

We tested the model on two different dataset. First, we used a sample drawn from retired people living in a subset of European countries, by means of data from the Survey of Health, Ageing and Retirement in Europe (SHARE). Second, we used data drawn from the 'English Longitudinal Study on Ageing' (ELSA) dataset. We wanted to check if testing the model on a sample of individuals with different features, values and beliefs, and living in a country with dissimilar social and cultural environment and institutional framework can influence our results, thus leading on different evidence compared to what we obtain on a sample drawn from continental Europe.

Our evidences, obtained testing the model on the two different dataset, points to the same direction. In fact, our results, stable in the two different datasets and robust under different specifications of the model, suggest the existence of positive state dependency of the utility function. What we observed is that the marginal utility of consumption tends to increase as a consequence of a health shock. In detail, our evidence related to the sign of the parameter assessing the state dependency of the utility function points in a positive direction, suggesting an increase in marginal utility associated to consumption when moving to an unhealthy state.

INTRODUCTION

1. Some introductive topics in Behavioral Economics

Behavioral economics is a discipline at the crossroads between economics and psychology, which in recent years is gaining increasing relevance inside as well as outside academia.
This field of research, which aims at increasing the explanatory power of economics by providing it with wider psychological foundations, is gaining more and more attention from economists and psychologists around the world, also in the light of mounting evidence of failures of predictive power of the classical economic conception (Frey and Stutzer, 2002)
Indeed, it is so far largely accepted that the standard model of human behavior in economics - which assumes that people are well-informed economic agents determined to maximize a consistent set of preferences - frequently produce not exhaustive and appropriate predictions. In fact, as demonstrated sometimes by historical evidence, the classical economic theory tends to generate outcomes which can be largely sub-optimal in terms of both economic performance and subjective well-being. To give an example, the global financial crisis started in the US in 2007 and in Europe in the years to follow (leading to the European Sovereigns crisis in in 2010-2012) is often considered as a case in which mainstream economics failed to provide accurate projections in terms of both dynamics and economic outcomes: indeed, the former chairman of the Federal Reserve Alan Greenspan, on the occasion of 2008 Congressional testimony, said: "I made a mistake in presuming that the self-interests of organizations, specifically banks and others, were such as that they were best capable of protecting their own shareholders and their equity in the firms."
In the same manner, the Nobel laureate and liberal economic commentator Paul Krugman argues: "[Economists] need to abandon the neat but wrong solution of assuming that everyone is rational and markets work perfectly. The vision that emerges as the profession rethinks its foundations may not be all that clear; it certainly won't be neat; but we can hope that it will have the virtue of being at least partly right." (quotations from Angner, 2016 [2], cap12, p. 256)

Therefore, after almost a century of separated patterns, in the last two decades economics has begun to import insights from psychology. 'Behavioral economics' is now considered a

prominent and well defined discipline, and can be identified as a field of research aiming at analyzing the impact of psychological factors (e.g. motives, emotions) on economic decision making, which is deemed a process reflecting individual behavior. Most of the applications vary from topics in economics, such as finance, game theory, labor economics, public finance, law, and macroeconomics (Camerer, Loewenstein 2005).

The key aspects of contributions from this comparatively new field of research can be envisaged in the fact that while standard economics portrays individuals as rational, self-interested agents seeking to maximize their personal utility, behavioral economics starts by evidencing that people do not always follow a rational approach when taking decisions.
Behavioral economics pursues the target of predicting actual behavior and providing important insights into the forces that shape economic decision-making, by examining cognitive, emotional, and social aspects of the decision process.
In this context, the main questions behavioral economics deal with are related to issues such as, for example: the kind of choices that people make, as well as the reasons behind such choices; how incentives affect behavior; the role of the way in which information is presented in the formation of preferences; the way people allocate money among different pools; how people manage their savings and/or their debt accounts; and so on.

Indeed, the attempt to overcome the *homo economicus* paradigm in modeling the economic behavior opens several new directions of investigation. Much has been done in the last decade in this perspective, as attested by new developments in theories relating to decisions and utility. Under this framework, our purpose is to take into account the decision making process, focusing on the methods people use to estimate probability, and subsequently, to explore possible applications to health outcomes.

In detail, in evaluating decision making under uncertainty, we basically refer to the theoretical framework which introduced and developed the concept of the 'state dependent utility function', in order to provide explanations on how possible change in the 'state of the world' (for example variations in an individual's state of health) may lead to deviations in an individual's decision making approach.

The origin of behavioral economics lies in the uncovering of behavioral paradoxes with respect to classical decision-theory frameworks such as the Von Neumann and Morgenstern decision-

theory under risk, and the Savage decision-theory under uncertainty. Respectively, the Allais paradox and the Ellbserg paradox reveal that the independence axiom did not hold behaviorally, and from then the alternative non-expected utility framework has been devised, making up the field of behavioral decision-theory, and leading to its leading model Prospect Theory, which tries to incorporate both a normative value and a prescriptive power.

In this work, we are more particularly interested in another behavioral violation of the classical frameworks. These frameworks postulate a full separability between probability and utility. Namely our preferences on consequences (represented by a characteristic utility function) should not depend on the probability of those consequences, or on the probability of the states in which they are realized. In Savage's framework, the fact of not being compliant with this separability principle amounts to a violation of the so-called postulate P3, or state-independence axiom. In health economics, behavioral data show that utility depends on health-states and that the probability of health- states (and a change of this probability due to a health shock) can affect the utility of the, e.g. monetary consequences associated with that state.

To deep dive the theoretical framework of state dependent utility function we refer to a model developed in 2000 by Drèze and Rustichini, described in detail in Chapter 1.
In that model the authors provided an axiomatic theory of decision under uncertainty when conditional preferences are allowed to be state dependent, leading to an expected state dependent utility representation.
In their seminal paper, the authors highlighted that possible applications of decision theory with state-dependent preferences deal in particular with problems involving states of 'life and death'. Moreover, they also envisaged a number of other problems that can be deemed as formally equivalent to those involving life and death, and therefore can be exhaustively explained relying on a model allowing for the state dependence of the utility function. Among these, for example, they mentioned those related to the loss of an irreplaceable object, as in Cook and Graham (1978) or those involving two alternative states of health, as in Zweifel and Breyer (1997), or in Finkelstiein et al. (2013).

According to several authors (e.g. Zeckhauser 1970, Arrow 1974), the dependence of the shape of the utility function on health conditions has relevant effects on a wide set of economic behaviors, and can provide relevant indication in terms of policy. For example, if marginal utility of consumption increases or decreases as a consequence of illness, this is likely to have

an impact on the optimal level of life-cycle savings (Kools and Knoef, 2017) or on the optimal setting of social security systems (Viscusi and Evans, 1990, Finkelstein 2013), or on the demand for health insurance (Hangen 2015, Gyrd Hansen, 2016). In detail, Hangen (2015) suggests that if the marginal utility of consumption is increased or decreased by deteriorated health, this is likely to have an effect on the theoretical predictions of demand of health insurance products. However, so far the number of studies dealing with the topic of health state dependence is still relatively limited; most of the papers proposing an analysis of the demand for health-related insurance products in general assume state independence of the utility function, stating that - in line with classic theory - the marginal utility of consumption remains constant whether the individual is ill or not.

In other words, this implies that, according to the previous literature (see, for example, Hall and Jones, 2007) rational individuals, in their optimizing behavior, act on the basis of a preference structure which is not affected by the underlying state of the world: the choice among different goods or activities is based on the evaluation of different options which reflects a structure of preferences which is assumed to be stable and not affected by any variations in the state of the world as, for example, variation in the health status. In this context, the decision about consuming a certain amount of non-medical consumption goods is not impacted by the individual being well, or sick and, consequentially, marginal utility of consumption goods is supposed to be equal across different health status, in good and bad health.

Nevertheless, this is not always in line with what empirical evidence often suggests: a decline in health is likely to trigger different a evaluation of consumption choices. As also Macè (2015) and Gryd Hansen (2016) suggested, an individual who is experiencing a deteriorating trend in health is likely to get more or less utility from the consumption of some specific goods (for example travelling, a tennis racket, or a prepared meal).

However, as Finkelstein highlighted (2009), the fact that a model assuming state independence of the utility function being more commonly used to study these dynamics is probably not attributable to a shared consensus among scholars that the shape of the utility function is not affected by the health states.

Rather, according to Finkelstein (2009), this is most attributable to the scarcity of empirical evidence able to demonstrate how utility function can vary with changes in health status. This, in turn, is deemed to be an indicative sign of the relevant empirical challenges associated with estimating this parameter.

What emerges analyzing literature is that – although the number of studies dealing with this topic is so far still limited - there exists a great variety of results in the empirical work on the relation between health and the marginal utility of consumption, which can be largely attributed to the different types of methods employed, as explained in Finkelstein et al. (2009), in Mace (2015), in Kolls and Knoef (2017).

According to Finkelstein et al. (2009), we define health state dependence as the impact of health on the marginal utility of nonmedical consumption. As Finkelstein (2009) stated, from a theoretical point of view, the sign of health state dependence is indefinite, and cannot be specified a priori. On one side, the marginal utility of consumption could decrease with bad health, as in the case of many consumption goods – for example travelling, car, sport – which are deemed as complements to good health. On the other side, the marginal utility of consumption could increase with deteriorating health, as happens with other consumption goods – among which prepared meals or home-based assistance in self-care – held to be instead substitutes for good health.

Finkelstein et al. (2009) report six studies that have attempted to estimate the magnitude of state dependence (Edwards, 2008; Lillard and Weiss, 1997; Sloan et al., 1998; Viscusi and Evans, 1990; Evans and Viscusi, 1991; Finkelstein et al., 2008; 2013). As far as we know, and as Gyrd-Hansen (2016) pointed out, four other studies (Levy and Nir, 2012; Tengstam, 2014, Gyrd-Hansen, 2016, Kools and Knoef, 2017) have subsequently been conducted on the subject. Of these ten studies, three demonstrate negative state dependence (i.e. poorer health decreases marginal utility of consumption), whereas six studies show positive state dependence, and one study shows no (neutral) state dependence (see chapter 1, par. 5 for more details).

In this work, we moved from the description of the theoretical issue envisioned so far – taking into account the reference model which introduced the concept, as described in Chapter 1- to an empirical model, which we tested in two different sets of countries, as described in chapter 2 and 3. This goes in the direction highlighted by some authors, among which Finkelstein (2013), and Kools and Knoef (2017), that stress the further need for empirical studies in order to assess the prevalence of state dependency of the utility function.

2. Summary of results

As stated above, we followed the approach introduced by Finkelstein (2008, 2013) and have developed a model in order to test how the marginal utility of consumption varies with health. We tested the model on two different samples, one drawn from a subset of European countries, and the other extracted from the population of England. We obtained consistent and robust results on the two different datasets, which are described in Chapter 2 and Chapter 3 respectively.

In detail, in chapter 2 we use as a proxy of the utility function a variable factoring subjective well-being in old age, i.e. the CASP-12 indicator. The CASP-12 questionnaire represents a psychometrically validated short version of the original 19-item version (CASP-19), a functional indicator of quality of life specifically developed in order to take into account aspects deemed to be relevant in determining quality of life in early old age. It is a self-reported index built on a 12 item questionnaire organized in four-point Likert ascending scales. CASP-12 captures four dimensions of quality of life: control (C), autonomy (A), self-realization (S) and pleasure (P). It provides an easily interpretable score ranging from 12 to 48, with higher scores indicating better quality of life.

According to the previous studies on subjective well-being (SWB) (see for instance Boyce 2010; Kolls and Knoef, 2017) we estimate the model using different approaches: OLS, fixed effect (that takes into account the unobserved heterogeneity which characterizes and influences SWB), random effect, and random effect with Mundlak correction (which takes the group means of time explanatory variables into account in order to remove the time invariant individual effects from the model - Mundlak, 1978).

The model presented in Chapter 2 is estimated using data from five waves of the Survey of Health Aging and Retirement in Europe (SHARE) – 1, 2, 4,5,6 - collected over the period 2004-2016 (the third wave - SHARELIFE - was not included because retrospective). SHARE is a multidisciplinary and cross-national panel database of micro data, which contains rather detailed information on demographics, socioeconomic characteristics, health status and family relationship of the over 50s in Europe. The survey information for each wave of SHARE were collected through Computer-Assisted Personal Interviews (CAPI) supplemented by a self-completion paper. The interviews were carried out in twenty-seven European countries.

However, this study only uses data from those nine countries present in all the available waves: Austria, Belgium, Denmark, France, Germany, Italy, Spain, Sweden and Switzerland. In this study, we also restrict the sample of analysis to retired individuals to avoid potential first order effect on income of the health shock. After deleting records with missing values, we obtained a final sample of 17,509 observations.

Our preliminary findings, robust under different specifications of the model, support the existence of a positive health state dependence utility i.e. the marginal utility of consumption increases, relative to the situation where health state dependence is not taken into account.

In the third chapter we extend the analysis to England, in order to assess if different individual values and beliefs, and social interactions can influence the decision making approaches and choices people make on consumption after a health shock.
In the third chapter we tested the model on a dependent variable we built with the aim of jointly factoring two different aspects deemed of playing a role in determining the quality of subjective well-being, namely the fact of feeling happy and of being able to enjoy life (methodological aspects are described in paragraph 4 of chapter 3).

The dataset employed is the 'English Longitudinal Study on Ageing' (ELSA), a longitudinal household survey which contains rather detailed information on health, socioeconomic status, and quality of life of the people aged 50 and over living in England. ELSA design is based on the American Health and Retirement Study (HRS). Since the inception of the study in 2002, the ELSA sample has been re-surveyed biennially. We focus on seven waves, collected over the period 2002-2015.

Our results, which again appear to be robust under different specifications of the model, confirmed what we obtained on the European dataset, and point at the existence of positive state dependency of the utility function in England as well.

While our results deviate by evidence found by Finkelstein on a similar sample drawn by the US population, they are in accordance with the previous empirical literature which focused on European data (see for instance Kolls and Knoef, 2017).
A potential explanation of an increasing marginal utility of consumption in response to a health shock relies on the fact that bad health may increase the cost of everyday activities - also leisure

activities. One may need more money to keep doing every day activities since it may be necessary to involve extra help, or these activities need to be adapted to be still performed in case of bad health. To be able to keep up with ways of living experienced before sickness, people may be willing to afford higher expenses, with a consequent increasing level of the marginal utility of consumption.

As Kools and Knoef (2017) suggested, a crucial issue in explaining controversial results is related to the presence of important heterogeneities in the effect of health and ageing on financial needs so that the choice of sample, of the estimation methods, as well as the kind of health measure utilized may induce variability in the obtained outcomes. Besides, Kools and Knoef also suggested that differences in results can be mostly attributed to differences in the institutional and socio-economic context, as well as to cultural difference and differences in the consumption pattern among US and European countries. In this context, what is worth underlining is the difference in typical consumption patterns among countries, which may play a role in determining different outcomes. In fact, some studies, among which for example the contribution of Banks et al. (2015), compare the life-cycle consumption pattern between US and UK. What emerged from this analysis is that British citizens seem to allocate a higher budget share to recreation and leisure than Americans. Therefore, if the British find recreation a more relevant expenditure than US citizens, they are supposed to need more money to keep doing these activities in bad health (e.g. more health and assistance during a holiday), and this can partly explain different directionality in state dependency of the utility function between England and US.
Moreover, Macè (2015) in explaining controversial results, besides partly explaining this with the use of different data and approach, he also emphasizes the role of the difficulty the individuals generally experience in correctly estimating the extent to which they can adapt to different circumstances (hedonic adaption), so they are likely to overestimate the effect of being in bad health, and this can play a role in affecting decision making on consumption and consequently the directionality in state dependency of the utility function.

This work is structured as follows. In Chapter 1 a brief theoretical description of the theoretical model introducing the concept of state dependency of the utility function is provided. Chapter 2 describes the empirical model we adopted and presents results obtained on a subset of European countries. Chapter 3 describes the empirical results obtained by testing the model on a similar sample of people in England.

1

CHAPTER 1

'Decision making under uncertainty: state dependent utility functions and applications on health outcomes: brief theoretical description'

1. Introduction: topics in behavioral economics

As stated, in the last two decades, following almost a century of separated patterns, economics has begun to import insights from psychology. 'Behavioral economics' is now considered a prominent and well defined discipline, and can be identified as a field of research aiming at analysing the impact of psychological factors (e.g. motives, emotions) on economic decision making, which is deemed as a process reflecting individual behavior. Most of applications vary from topics in economics, such as finance, game theory, labor economics, public finance, law, and macroeconomics (Camerer, Loewenstein 2005)

The key aspects can be envisaged in the fact that while standard economics portrays individuals as rational, self-interested agents seeking to maximize their personal utility, behavioral economics starts by evidence~~s~~ that people do not always follow a rational approach in making decisions. Behavioral economics pursues the target of predicting actual behavior and providing important insights about the forces that shape economic decision-making, by examining cognitive, emotional, and social aspects of the decision process.

As Rabin highlighted (2003) Behavioral economics, grounding its fundamentals in the field of research in psychology known as 'Behavioral Decision Research', more than in others, typically classifies research topics into two key categories, namely choice and judgment. Choice is

referred to the process people generally use to 'select among actions, taking account of any relevant judgment they may have'. Judgment concerns with the process people use to 'estimate probabilities', i.e. judging the likelihood of events, which is central to economic life. (Camerer, 1999).

Moreover, according to Rabin (2003) there are several main assumptions that economists generally make about human nature, among which: individuals maximize their expected utility; they exponentially discount future well-being; they are self-interested; they have preferences over final outcomes, not over changes in such outcomes; they have only "instrumental/functional" taste for beliefs and information; they have well-defined and stable preferences, independent from the underlined state of the world.

In recent years, a relevant number of studies started to make challenges to some of the above mentioned assumptions, and propose possible evolution of the classic theory of choices by relaxing one or more of these assumptions, in most cases to capture some psychological insights which might play a role in individuals' making decision process.

Under this framework, our purpose is to take into account the decision making process, focusing on the methods people use to estimate probability, and subsequently, to explore possible application on health outcomes. In more details, in evaluating decision making under uncertainty, we basically refer to the theoretical framework which introduced and developed the concept of 'state dependent utility function', in order to provide explanations on how possible changes in the 'state of the world' (for example variations in an individual's health state) may lead to deviations in an individual's decision making approach. The theoretical framework is described in next paragraph.

2. Theoretical background: some preliminary insights

To start with, the main theoretical reference we are taking into account is the contribution from Jacques Drèze and Aldo Rustichini which provided an axiomatic theory of decision making under uncertainty when conditional preferences are allowed to be state dependent, leading to an expected state dependent utility representation, applied both in contexts of 'games against

nature' and for contexts of 'one-person games with moral hazard'. Drèze, J. Rustichini, A., 2000).

The authors' contributions started from the work of Savage, who promoted and axiomatized the process of decision making under uncertainty using the concept of subjective utility function. In his seminal book, the *'Foundations of Statistic*s', Savage (1954) characterized the behavior of decision-makers using subjective expected utility, formalizing what successively has become the standard analytical reference framework.

In proposing his theory of decision making under uncertainty - following previous work by Ramsey and von Neumann - Savage proposed subjective expected utility theory to define choice-based subjective probabilities, where these probabilities are meant to describe the decision maker's beliefs. (Karni 2005)

The theory of subjective expected utility combines two subjective concepts: on one side, the concept of a personal utility function, and on the other the one of a personal probability distribution (usually based on Bayesian probability theory).

Loosely speaking, in decision theory, subjective expected utility can be defined as the attractiveness of an economic opportunity as perceived by a decision-maker in the presence of risk of uncertainty.

To frame the concept in an historical perspective, it is worth to underline, as Karni evidenced (2005), that the interpretation of probability as a numerical expression of beliefs is 'as old as the idea of probability itself' (Karni 2005). According to Hacking (1984), the notion of probability emerged in the 1650s with a dual meaning; on one side, it was referred to 'the relative frequency of a random outcome in repeated trials' and, on the other, to 'a measure of a decision maker's degree of belief in the truth of propositions, or the likely realization of events'. These two approaches – i.e. the 'objective' and the 'subjective' one, respectively, as they are now identified - both played a key role in the formulation of the Savage's model of subjective utility function.

The ideas of utility and expected utility maximizing behavior were originally introduced by Bernoulli (1738).

In the same manner, von Neumann and Morgenstern's (1944) axiomatic characterization of expected utility-maximizing players (facing opponents who may employ a randomizing device to determine the choice of a pure strategy) assumes that probabilities of these strategies can be expressed as relative frequencies.

Originally, the expected utility hypothesis was formulated to be used with specified or 'objective' probabilities.
The pioneering work of Frank Ramsey (1926) and Bruno de Finetti (1937, 1949) demonstrated how, under certain assumptions, 'subjective' probabilities could be inferred from behavior in facing such uncertainty.
In other words, as Karni (2005) underlined, Ramsey and de Finetti formalized the concept of choice-based subjective probability assuming that individual seek to maximize expected utility when betting on the truth of propositions.
These developments culminated in the work of Savage. The latter, in fact, by combining and summarizing the previous work of de Finetti and von Neumann and Morgenstern, arrived to formulate a new analytical framework and to identify conditions that are necessary and sufficient for the existence and joint uniqueness of utility and probability, leading to the characterization of individual choice as expected utility- maximizing behavior.

Furthermore, Karni (2014) also highlighted that the Savage's model of subjective expected utility is based on the three main premises which, in the author's words, can be depicted as follows:

(a) 'that decision making is (or ought to be) a process involving the evaluation of possible outcomes associated with alternative courses of action and the assessment of their likelihoods;
(b) that the evaluation of outcomes and the assessment of their likelihoods are (or ought to be) quantifiable, by utilities and subjective probabilities, respectively, the former representing the decision maker's tastes, the latter his/her beliefs;
(c) that these ingredients of the decision-making process can be inferred from observed (or prescribed) patterns of choice and are (or should be) integrated to produce a criterion of choice.'

What is of main relevance for our analysis is to underline that in the standard formulation of subjective expected utility theory, the preferences on alternative courses of actions are assumed to be state independent. The representation of these preferences consists of a subjective probability measure on the set of states, supposedly representing the decision-maker's beliefs regarding the likely realization of the different events (that is, subsets of the set of states of nature) and a utility index representing his evaluation of the consequences, independent of the underlying events.

However, evidence suggested that the imposition of state-independent utility often appears to be not compatible with some particular applications, among which, for example, the choice of life insurance, certain aspects of health and disability insurance, and insurance of family bequests. In these cases, in fact, the decision-maker's evaluation of the monetary outcome is deemed to be not independent of the underlying state of nature. Hence, some authors were interested in the last decades in extending the subjective expected utility model to allow for state-dependent preferences, i.e. a preference relation is in which 'the prevailing state of nature is itself of direct concern to the decision maker' (Karni 2005)

Attempts to extend the theoretical framework to include an expected utility theory for state-dependent preferences were made by Fishburn (1973), Karni and Schmeidler (1980) and Drèze (1987). Karni and Schmeidler developed an approach to be used in the context of 'games against nature', relying on hypothetical preferences among all possible pairs (g; τ) where g is a game in G and τ is an 'assumed' probability on S. These
preferences are assumed to be well defined (which requires a strong test of internal consistency) and consistent with the conditional preferences derived from the observed preferences among games. As Drèze and Rustichini pointed out, in the theoretical setting proposed by Karni and Schmeidler there is a unique (fully identified) state-dependent expected utility representing simultaneously the actual and hypothetical preferences. (Karni and Schmeidler, 1980, 2016).
While Fishburn was mainly focused on assuming the existence of a preference relation over all acts conditioned on events, Drèze allowed for preferences to be state dependent, and provided a major contribution by combining state-dependent preferences with moral hazard problems.

The generalization allowing for state dependency may display ordinal state dependence, in which case the underlying state may affect the decision maker's preferences by altering his ordinal ranking of the consequences; or cardinal state dependence, by altering his risk attitudes; or both.

State dependent preferences appears to be more suitable to be applied at several situations as, for example, the case of acquiring an health insurance. In fact, taking out a health insurance policy can be seen as choosing an act whose consequences — the indemnities — depend on the realization of the decision maker's state of health. In this example, the decision maker's health condition can be interpreted as the 'state'. As Karni highlighted, it affects the decision maker's

well-being directly, and indirectly, through the payoff prescribed by the health insurance policy. (Karni 2005)

In other words, the utility of the monetary compensation associated with a health shock for which an insurance contract has been contracted (possibly under conditions of moral hazard) can be affected in an unpredicted way after the health shock occurs.

3. Savage formulation

The analytical framework introduced by Savage (1954) consisted of a finite set S, whose elements can be described as follows:

- ✓ the alternative states of the world (with the exact current state of the world being unknown to the agent)
- ✓ an arbitrary set C, of 'consequences', referred to 'things that can happen as a result of the agent's actions'
- ✓ the set F, of 'acts' (f: S→F , that is, functions from the set of states to the set of consequences).

As Karni (2005) specifies, in Savage formulation, 'acts' correspond to 'courses of action', consequences describe 'anything that may happen to a person', and states are 'possible resolutions of uncertainty'.

As the agent may be uncertain for what concerns the exact results of its actions, this can be considered as an expression of his uncertainty about the state of the world.

Besides, a decision maker is characterized by a preference relation, $\succcurlyeq$, on F. The statement:

$f \succcurlyeq f'$ can be interpreted as follows: 'the course of action f is at least as desirable as the course of action f ', or, in other words,

$f \succcurlyeq f'$ means that the act f is at least as desirable as the act f '.

Moreover, the strict preference relation $\succ$ and the indifference relation $\sim$ are defined as follows:

$f \succ f'$ if $f \succcurlyeq f'$ and not $f' \succcurlyeq f$; $f \sim f'$ if $f \succcurlyeq f'$ and $f' \succcurlyeq f$.

A 'consequence' can be intended as a description of anything that might happen to the decision maker. The set of consequences is arbitrary. Putting it differently, 'consequences' can be

interpreted as ‘assigned utilities that are independent of the underlying state of the world’, and ‘events’ as ‘assigned probabilities that are independent of acts’. (Karni 2005)
A combination of an act, f, chosen by the decision maker, and a state, s, ‘selected’ by nature determines a unique consequence, $c\,f$, $s \in C$.

The possibility for the decision maker to evaluate the course of action in a context of uncertainty implies the existence for the decision maker of the possibility to have a taste for possible consequences and beliefs regarding their likely realization. As Karni highlighted (2014), Savages’ subjective expected utility theory postulates a preference structure, depicted axiomatically, permitting the numerical expression of the decision maker’s valuation of the consequences by a utility function, that of his beliefs by a (subjective) probability measure on the set of all events, and the evaluation of acts by the mathematical expectations of the utility with respect to the subjective probability.

Following Karni (2005, 2014), we can present the Savage’s formulation, using the following notation:

- Given an event E and acts f and h, $f_E\, h$ denotes the act defined by $(f_E\, h)(s) = f(s)$ if $s \in E$, and $(f_E h)(s) = h(s)$ otherwise. An event E is *null* if $f_E h \sim f\,'_E h$ for all acts f and f ’ otherwise it is *nonnull*.
- A constant act is an act that assigns the same consequence to all events. Constant acts are denoted by their values (that is, if $f(s) = x$ for all s, the constant act f is denoted by x).

To frame the subjective expected utility function model, Savage introduced seven postulates, which are described in the followings.

The first postulate asserts that the preference relation is a weak order, i.e. the preference relation is transitive and all acts are comparable. Formally:
P.1(**Weak order**) The preference relation is a transitive and complete binary relation on F.

The second postulate, also known as the ‘Sure Thing Principle‘, requires that the preference between acts depend only ‘on the consequences in states in which the payoffs of the two acts being compared are distinct’ (Karni 2005) . This implies that the valuation of the consequences of an act in one event is independent of the payoffs of the same act in the complementary event. Formally:

P.2(**Sure-Thing Principle**) For all acts, f, f ‘, h, h ‘, and every event E, $f_E h \succcurlyeq f'_E h$ if and only if $f_E h' \succcurlyeq f'_E h'$.

The third postulate is the one from which the state independency of preference is derives, as it asserts that, conditional on any nonnull events, the ordinal ranking of consequences is independent of the conditioning events (thus referring to monotonicity concept). Formally:

P.3(**Ordinal Event Independence**) For every nonnull event E and all constant acts, x and y, $x \succcurlyeq y$ if and only if $x_E f \succcurlyeq y_E f$ for every act f.

According to P3, it is possible to state that x is preferred to y, independently from the underlying state, i.e. it does not matter if they are compared on two different states, i.e. s_1 or s_2; the preference holds independently from the state on which it is realized. The utility in a state depends only on the consumption in the state but not directly on the state itself.

The fourth postulate requires that ‘the betting preferences be independent of the specific consequences that define the bets’ (Karni 2005). Formally:

P.4 (**Comparative Probability**) For all events *E* and *E* ‘ and constant acts *x*, *y*, *x*’ and *y’* such that $x \succ y$ and $x' \succ y'$, $x_E x' \succcurlyeq x_{E'} y$ if and only if $x'_E y' \succcurlyeq x'_{E'} y'$.

As Karni (2005) evidenced, postulates P.1–P.4 imply the existence of a transitive and complete relation on the set of all events that has the interpretation of ‘at least as likely to obtain as,’ representing the decision maker’s beliefs as *qualitative probability*. Moreover, these postulates also imply that the decision maker’s risk attitudes are event independent.

The fifth postulate requires the existence of constant acts between which the decision maker is not indifferent.

P.5(Nondegeneracy) For some constant acts x and x, $x \succ x$.

The sixth postulate introduces a form of continuity of the preference relation. It asserts that no consequence is either infinitely better or infinitely worse than any other consequence. In other words, it requires that there be no consequence that, were it to replace the payoff of an act on a nonnull event, no matter how unlikely, would reverse a strict preference ordering of two acts. Formally:

P.6(**Small-Event Continuity**) For all acts f, g, and h, satisfying $f \succ g$, there is a finite partition $(E_i)^n_{i=1}$ of the state space such that, for all i, $f \succ f_{Ei}\, h\, g$ and $h_{Ei} f \succ g$.

As Karni mentioned (2005), The seventh postulate is a monotonicity requirement asserting that if the decision maker considers an act strictly better (worse) than each of the payoffs of another act, taken as constant acts, on a given nonnull event, then the former act is conditionally strictly preferred (less preferred) than the latter. Formally:

P.7(**Dominance**) For every event E and all acts f and f' if $f \succ_E f'(s)$ *for all* s in E then $f \succcurlyeq_E f'$ and if $f'(s) \succ_E f$ for all s in E then $f' \succcurlyeq_E f$.

Again following Karni (2005), we underline that postulate P.7 is deemed to be not necessary to obtain a subjective expected utility representation of *simple acts* (that is, acts with finite range). However, it is supposed as necessary if the model is to include nonsimple acts and it is sometimes regarded as a purely technical condition.

Savage's (1954) theorem establishes that the properties described by the postulates P.1–P.7 are necessary and sufficient conditions for the representation of the preference relation by the expectations of a utility function on the set of consequences with respect to a probability measure on the set of all events. This leads to the representation of an utility function which is unique up to a positive affine transformation, and the probability measure is 'unique, nonatomic, and finitely additive'. (Karni 2014)

The representation of the Savage's theoretical framework is expressed by the following theorem:

Savage's theorem: Let $\succcurlyeq$ be a preference relation on F. Then the following two conditions are equivalent:

(i) $\succcurlyeq$ satisfies postulates P.1-P.7.

(ii) There exists a unique, nonatomic, finitely additive, probability measure π on S such that $\pi(E) = 0$ if and only if E is null, and a bounded, unique up to a positive affine transformation, real-valued function u on C such that, for all acts f and g, $f \succcurlyeq f' \succcurlyeq$ if and only if

$$\int_S u(f(s))d\pi(s) \geq \int_S u(f'(s))d\pi(s).$$

The structure of the preference relation, in particular postulates P.3 and P.4, implies that the preference relation is state independent. That is to say, the ordinal rankings of consequences and bets are independent of the underlying events. As Karni pointed out, this representation leads to an 'event- independent risk attitudes but does not, by itself, rule out that the states affect the decision maker's well-being, or that the utility of the consequences is state dependent' (Karni 2014).

4. Drèze and Rustichini theoretical framework

Among the attempts to extend the above discussed framework in order to obtain a model generalization allowing for state dependent preferences, we refer to Drèze and Rustichini (2000) formulation, which provided a relevant contribution to model not only the process of a (unique) individual decision making process ('games against nature'), but also useful to approach the moral hazard problems.

Following Drèze and Rustichini, a reformulation of Savage's model can be described as follows:

if we define consumption conditional on a state as vector $x_S \in R$, we can say that preference are defined over vectors $x=(x_1 \ldots x_n) \in R$, and are assumed complete and continuous, so that they can be represented as a utility function U(x).

Under the assumption P1, labelled weak separability, there exists a separable representation of the form:

$U(x)=f\,(v_1(x)_1 \ldots\ldots v_s(x)_s))$

Defining $\sigma \in R^s$ as a strictly positive probability vector, we can specify the following associated expected utility representation

$$U(x) = \sum_s \sigma_s u_s(x_{)s)}$$

which always exists, but σ is exogenous, whereas a specific target of decision theory is to determinate it endogenously. This is what is obtained with Savage's representation of state independent preferences.

If preferences are both additively separable and state independent, the functions v(s) in the additive representation can be written as $\alpha_s u(.) + \beta_s$, with $\alpha_s \geq 0, \sum_s \alpha_s = 1,\ \sum_s \beta_s = 0$.

Therefore, U(x) can be rewritten as:

$$U(x) = \sum_{s} \alpha_s u(x_{s)}$$

where α is a probability vector. Besides, α is the unique probability vector such that preferences can be embodied in a state-independent representation. In this formulation, the probability vector is no longer exogenous: as the authors pointed out, it is implied (uniquely) by the assumption on preferences introduced by Savage, and the selection of the unique representation in terms of a state dependent expected utility.

As mentioned, Drèze and Rustrichini extended the formulation proposed by Savage allowing preferences to be state dependent, on the basis of the evidence that this representation is often deemed as not applicable to represent the decision process in some specific situation, as for example when dealing with medical decision.

The authors, by relaxing the assumption of monotonicity (P3 in Savage's formulation), obtained a representation theorem in terms of S linear functions on outcomes v(.) such that

$$f \succcurlyeq g \text{ iff } \sum_s v_s(f(s)) \leq \sum_s v_s(g(s)).$$

Therefore, given an arbitrary probability σ on S, it is possible to rewrite the function v(s) as

$$\sigma_s u_s\ (.)\ , \text{ where } u_s\ (.) = \frac{v_s\ (.)}{\sigma_s}$$

Consequently, there exists an expected state dependent utility representation[1], but as the authors states 'the subjective probability are not identified from observable choices among games' (DR, 2000, pag. 9)

[1] For complete derivation, ref. DR, 2000, section 4

5. State of the art: empirical studies on state dependency of the utility function

In literature there is some evidence of different possible ways to provide empirical estimation of the dependency of the utility function on health status.

In particular, Finkeslstein (2009) envisaged two main empirical approaches to estimate health state dependence of utility functions: on one side, approaches based on individuals' demand for moving resources across different health states (among which, for example, Lillard and Weiss, 1997, and Edwards, 2008); on the other, approaches based on observed utility changes associated with health changes for individuals with different consumption or resource level (as, among others, in Finkelstein 2013, Kolls and Knoef, 2017). Other authors – among which Tengstam (2014) and Levy and Nir (2012) adopted an approach with which estimation is based on stated preferences.

To go into further detail regarding the approaches used and the results obtained, we can underline that while Lillard and Weiss (1997) examined changes in consumption patterns among individuals with different health status and found evidence of positive health state dependence, other authors, among which Sloan et al.(1998), Viscusi and Evans (1990, 1991) focused on possible changes in monetary compensations reported to be required by individuals with a different income level (still active on the job market) in order to accept the risk of health deterioration.

Moreover, Edward (2008) evaluated the effect of health on portfolio allocation, by using data from the Study of Assets and Health Dynamics among the Oldest Old (AHEAD) and obtained evidence of positive state dependency.

As mentioned, Finkelstein et al. (2008, 2013) studied the variation in subjective well-being as a consequence to health shocks across individuals of different permanent incomes and demonstrated the existence of negative state dependence of the utility function, in a panel of retired US individuals.

Taking the model of Finkelstein as reference, Kolls and Knoef (2017) repeated a similar analysis on a sample of retired individuals living in Europe, and found evidence of positive state dependency on the utility function. In particular, Kools and Knoef provided estimates of how much extra income is needed to keep financial wellbeing equal after a health shock, and their findings suggest the existence of positive health state dependence, which they proved not to be driven by medical expenditure. Similar results were obtained by Gryd Hansen (2016) who found evidence of a positive relation between health deterioration and increasing marginal utility of consumption, suggesting positive state dependency of the utility function, for levels

of sickness which are deemed to be mild. The author ran the analysis on a sample of Danish citizens who were asked to participate in an experiment in which they could hypothetically insure themselves against a certain loss of income across two periods of time (one in which the respondent was in good health and one in which the individual experienced a deterioration in health). In this study, evidence of positive state dependence has been confirmed in correspondence to intermediate health states, while no state dependence turned out to be associated with both less and more compromising states of health.

Finally, Tengstam (2014) and Levy and Nir (2012) have adopted a third estimation approach, based on stated preferences.
In Tengstam (2014), individuals participating in the analysis were told that their grandchild would have faced a 50–50 risk of being irreversibly paralysed in both legs at birth. Subsequently, respondents were asked to choose an income distribution for the two potential health states on behalf of their hypothetical grandchild. The study pointed in the direction of suggesting the existence of positive state dependence, as poorer health profiles were associated with higher marginal utility of consumption.

Levy and Nir (2012), based their analysis on a sample of patients who having received a cancer or diabetes diagnosis were asked to evaluate their current health state using standard gamble; subsequently, the same patients were asked to indicate their maximum level of willingness-to-pay for receiving a cure. In line with Finkelstein (2008, 2013), the Levy and Nir's (2012) findings demonstrate negative state dependency of the utility function, as they obtained evidence that deteriorated health decreases the marginal utility of consumption.

In this work our aim was to provide estimations of health state dependence, and we developed a model in which the impact of health deterioration on consumption pattern can be estimated starting from data on permanent income, health conditions, and utility proxies. In line with Finkelstein (2008, 2013) and other scholars (among which Frey 2002, Ferrer I Carbonell 2005, Fischer 2009) we used a proxy of subjective well-being (from now on SWB) as a dependent variable and test the model on two different dataset, covering different countries. Some considerations related to the use of a proxy of utility function as a dependent variable are reported in the next paragraph. The results we obtained from estimations are presented in the following chapters.

6. Subjective well-being as a proxy for the utility function

After decades in which the study of happiness and life satisfaction remained under the domain of other disciplines, recently research on subjective well-being (from now on SWB) gained more and more room also in economics. However, some methodological aspects related to the reliability of measures of SWB are still at the center of debate, and still to be addressed.
As far as measurement of SWB is concerned, as Frey (2003) pointed out, much work has been done by numerous psychologists (see for instance Diener et al. 1999, Kahneman et al. 1999, Kahneman et al. 2006, Bruni and Porta 2005), and this has led to a great improvement in the measurement of utility and life satisfaction. As a result, it is now possible to approximate an individual's utility in a satisfactory way, using representative surveys. As Frey (2003) highlighted, by using a single question, or several questions on global self-assessment, it is possible to obtain reliable indications of individuals' evaluation of their life satisfaction or happiness. Behind the score indicated by a person lies a cognitive assessment to what extent their overall quality of life is judged in a favorable way (Veenhoven 1993). According to many economics scholars, the measures of reported subjective well-being can thus serve as a proxy for individual utility, allowing for the study of the relationship between individual well-being and economic conditions such as income, unemployment, inflation and inequality and the analysis of the determinants of individual well-being in general. (Frey, 2010).

In more detail, the idea that subjective well-being can be used as a proxy for utility is related to Bentham's conception of utility, which refers to "that property in any object, whereby it tends to produce benefit, advantage, pleasure, good, or happiness" (Khaneman, et al, 1997). In fact, as Khaneman et al (1997) stated, two main core meanings can be envisaged in the term "utility". On the one side, "experience utility" is referred to as an hedonic quality, as in the Bentham approach. It can be reported in real time, (instant utility), or in retrospective evaluations of past episodes (remembered utility). (Khaneman, 1997). On the other side, "decision utility" can be considered as "the weight of an outcome in a decision". (Khaneman, 1997).
The work of Khaneman et al (1997) suggests that subjective well-being can be deemed as a better measure of utility than choices - as assumed in traditional economics - because it measures experienced utility rather than decision utility. As the authors pointed out, measuring the experienced utility opened the way to other lines of empirical research, which has seen huge development in recent years. Indeed, as Fisher (2009) highlighted, although various definitions now exist and are still evolving, in recent studies the expression "subjective well-being" is

generally deemed as reflecting the "perceived quality of the life one leads and the positive emotions one experiences" (Fischer, 2009). It is therefore a concept generally based on purely subjective evaluations, in contrast to the traditional measures of individual satisfaction, which in the classical framework is factored by the utility function. In fact, as Fischer (2009) highlights, traditional economic theory incorporates Khaneman's definitions of 'decision utility', and equates utility with the "satisfaction achieved through consumption of material goods, services, and leisure" (Ficher, 2009). In a life-time utility model, current income is split between current consumption and savings. Savings, however, constitute postponed consumption, which will take place later in time. Through mathematical transformation, utility can be thought of as being directly determined by income and the price level ('indirect utility'). In this framework, as income increases, so does utility, and this can provide an explanation – according to Fischer - for the dominating role in the past decades of national income and economic growth in public discussions and political decision-making processes.

Although the traditional positivistic view still dominates in economics, numerous scholars have challenged standard economic theory from different angles, and latterly an increasing number of contributions in economic research to the study of individual well-being are being be envisaged, which incorporate Khaneman's definition of 'experience utility'. In fact, as Frey (2010) evidenced, most of these contributions are mainly based on a 'subjective view' of utility, based on recognizing that everyone has his own ideas about happiness and high quality of life and, in contrast with the previous approach, observed behavior has to be considered as 'an incomplete indicator of individual well-being'. (Frey, 2010)

Recently, some authors (among which Chen, 2019) underlined that the study of individual subjective well-being has been one of the fastest growing research fields in economics in the past twenty years (see for example Kahneman and Krueger 2006, Clark et al. 2008), as it stands at the basis of several policy implications (Chen, 2019): as the author stated, by looking at what socioeconomic and other factors predict or can induce individuals to report higher (or lower) scores on a subjective well-being (SWB) scale, researchers have been able to add new insights to standard views in economics.

However, subjective well-being has also attracted relevant criticism so far, in particular as far as methodological implication is concerned (Bond and Lang, 2019)

Although several studies provided descriptive evidence that wellbeing responses are comparable from one person to another (among which Oswald and Wu 2010), this statement

has been recently challenged by some scholars (among which Bond and Lang 2019), who claimed that average ranking of both observed and latent SWB scores across groups can be arbitrarily reversed unless some unreasonably strong conditions are assumed.

This position has in turn been reverted by other authors (Chen et al. 2019, Kaiser et al, 2019), who demonstrated the reliability of SWB scale if some specific methodological steps are followed.

Different approaches are therefore on the table, the question is under vivid discussion, and further research in this topic is needed in order to shed light on all the relevant methodological aspects.

We took into account the contribution of several scholars who investigated the methodological concerns related to SWB, in particular Ferrer I Carbonell (2004), Frey and Stutzer (2002, 2010), Di Tella (2006), among others.

We largely discussed the methodological issues related to the empirical estimation of SWB at paragraph 2.5, in which we also explained the econometric specification we selected as our model baseline in order to deal with methodological aspects related to SWB estimation.

2

CHAPTER 2

'Decision Making under Uncertainty: State-dependent Utility Functions and Applications on Health Outcomes: Evidence from SHARE'

1. Introduction

According to the previous literature (see, for example, Feldman and Dowd 1991, or Hall and Jones, 2007), rational individuals, in their optimizing behavior, act on the basis of a preference structure which is not affected by the underlying state of the world. This implies, for example, that the structure of preferences does not vary according to health, and marginal utility of consumption of (non-medical) goods remains the same both in good and bad health.

However, when this assumption of state independency of the utility function is relaxed, and preferences are allowed to vary according to the underlying state of health, this is likely to affect many economic behaviors, and many relevant public finance problems such as the optimal structure of health insurance, or optimal life-cycle savings (Finkelstein et al., 2009), or labor supply choices, mainly with regard to older workers approaching retirement (Trevisan and Zantomio, 2016). Moreover, health state dependence can provide a potential explanation for observed spending phenomena, such as the decreasing consumption path for older people (Borsch-Supan and Stahl, 1991; Domeij and Johannesson, 2006).

According to Finkelstein et al. (2009) health state dependence can be defined as the impact of health on the marginal utility of nonmedical consumption; the sign of health state dependence may be indefinite, and cannot be stated a priori. From a theoretical perspective, health state

dependence could, in fact, be both positive and negative. On one side, the marginal utility of consumption could decrease with bad health, as many consumption goods – for example travelling, car, sport – which are complements to good health. On the other side, the marginal utility of consumption could increase with deteriorating health, as other consumption goods – among which prepared meals or home-based assistance in self-care – are deemed to be substitutes for good health.

Although the presence of health state dependence has relevant implications in terms of implied economic policy, the number of studies dealing with this topic is still limited. Finkelstein et al. (2013), for instance, suggest that even a modest amount of state dependence can have a substantial effect on the optimal level of health insurance benefits, and a relevant effect on the optimal level of life-cycle savings. So far most papers proposing estimates for the demand for health-related insurance products or calibrating optimal life-cycle saving patterns in general assume state independence of the utility function. As Finkelstein argued (2009), this is probably not to be attributable to a shared consensus among scholars that the shape of the utility function is not affected by the health states. Rather, this can be considered an indication of the empirical challenges associated with the estimations of this parameter.

This paper investigates how possible shocks in the health status may lead to a change in an individual's preference structure and decision-making approach. Specifically, this study aims to understand whether, and in what direction, the utility function varies in response to health shocks.

The elements of novelty of this paper are related to the fact that we test the existence of health state dependency on a European panel dataset by using a proxy of utility function i.e. an indicator of subjective well-being (from now on SWB), thus replicating an analysis previously performed on US data.

According to the previous studies which test the presence of state dependence utility using measures of SWB (see for instance Boyce 2010; Kools and Knoef, 2017) we estimate our model by using different empirical approaches: OLS, fixed effect (that takes into account the unobserved heterogeneity which characterizes and influences SWB), random effect, and random effect with Mundlak correction (which takes the group means of the time explanatory variables into account in order to remove the time invariant individual effects from the model - Mundlak, 1978).

Our preliminary findings, robust under different specifications of the model, support the existence of positive health state dependence utility i.e. the marginal utility of consumption increases, relative to the situation where health state dependence is not taken into account. Our

results are in accordance with the previous empirical literature which focused on European data (see for instance Kools and Knoef, 2017). A potential explanation of an increasing marginal utility of consumption in response to a health shock relies on the fact that bad health may increase the cost of everyday activities - also leisure activities. One may need more money to keep doing every day activities in the same manner as before sickness, since it may be necessary to involve extra help, or these activities need to be adapted to be still performed in case of bad health. To be able to keep up with ways of living experienced before the health shock, people may be willing to afford higher expenses, with a consequent increasing level of the marginal utility of consumption.

This paper is organized as follows. Section 2 describes the background and theoretical framework, Section 3 describes data, while Section 4 describes the methodology. In Section 5 model results are presented, while Section 6 concludes with a discussion of the results and their potential policy implications.

2. Background

According to Finkelstein et al. (2009), Mace (2015), and Kools and Knoef (2017) there is contradictory evidence of empirical results on the relation between health and the marginal utility of consumption, which might be partly attributed to the different methods employed. Specifically, Finkelstein (2009) envisaged two main approaches to estimate health state dependence of utility functions: on the one side, approaches based on individuals' demand for allocating resources across different health states and, on the other side, approaches based on observed utility changes triggered by health changes for individuals with different resource level.

As also Kools and Knoef (2017) underlined, the first approach can be considered an 'ex ante' approach, and it is focused on consumption itself. It implies that if the shape of the utility function is affected by health, an individual who anticipates the probability of falling sick is likely to already allocate resources across different health states, in order to be able to increase consumption when marginal utility is higher. Therefore, health state dependence can be deducted by analyzing individuals' revealed demand for products that allow for reallocation of resources across different health states (for example insurance products).

However, according to Finkelstein (2009), some challenges can be envisaged in this approach, among which for example the fact that the optimal level of insurance demand depends not only on how marginal utility varies with health state, but also on other parameters, among which for example the level of risk aversion: it can in fact be that the higher is the level of risk aversion, the less positive (or the more negative) is the state dependence related to a given coverage allocation.

The second approach described by Finkelstein et al. (2009) refers to the possibility of estimating state dependency of utility function by using utility proxies, such as SWB. As suggested by Finkelstein et al. (2009), a possible way could be estimating in a panel the way in which utility proxy can vary in response to health shocks, and how this change is different across individuals with different resource levels. As the authors observed, one positive aspect related to this approach is that – contrary to what is required by the first approach described above - it does not imply the individual's ability to forecast the shape of their utility function in a different health state (Finkelstein et al, 2009). In line with the second approach, Finkelstein et al. (2013) developed a model based on utility proxy, health and permanent income exploited on a panel of retired US citizens, and obtained evidence of declining marginal utility of consumption as health deteriorates. This led the authors to reject the null hypothesis of absence of health state dependence.

In this paper we refer to the basic concepts and the idea of Finkelstein et al. (2013). We also took as reference the paper of Kools and Knoef (2017), derived from the original contribution of Finkelstein, and described below.

For the sake of better comprehension of what follows, we provide a sketch of the Finkelstein's model.

Following Finkelstein et al. (2013) the individual is assumed to live two periods. In the first period she is supposed to be healthy, while in the second period a health shock is likely to happen, with probability p. Following an optimizing behavior, the individual derives his utility U(C(S),S) from consumption (C) and health (S). Health has a direct effect on overall utility, but can also have an indirect effect on utility through individual consumption.
This is also in line with what is stated in Viscusi and Evans (1990, 1991) who show that an adverse health shock may not only lead to a decrease in an individual's utility, but could also

modify the shape of the utility function, leading to a change in the marginal utility of consumption. In our work we will focus, in particular, on the different effect of health deterioration on consumption, i.e. how the change in health condition affects the marginal utility of consumption.

Concerning the description of individuals' preferences, Finkelstein (2013) follows the same approach as Epstein and Zin (1989) and Weil (1990), where lifetime utility aggregates first-period non-medical consumption C_1 and expected second-period utility:

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

equation (1) is a standard additively separable CRRA where γ is the coefficient for risk aversion, δ the discount rate and $1/\theta$ reflects the elasticity of intertemporal substitution. According to this framework, utility of the second period is stochastic from the point of view of the first period, because of uncertainty of health conditions in the second period.
Second period utility is given by:

$$U_2 = (1 + \varphi_1 S)\frac{1}{1-\gamma}C_2^{1-\gamma} + S\,\Psi(H) \qquad (2)$$

where C_2 is the second-period level of non-health consumption, H denotes consumption of health services (from which only sick individuals derive utility), and S is the indicator of sickness. As the author stated, the second-period utility function is a standard CRRA utility function for healthy individuals. The effect of a health shock on second-period utility is twofold. First, sickness multiplies the marginal utility of second-period consumption by a factor of $(1 + \varphi_1)$. The empirical analysis performed by the authors is finalized to recover an unbiased estimate of φ_1, evaluating the effects of a health shock on an individual's income level.

Rearranging the equation, to estimate the parameter φ_1 Finkelstein et al. (2013) used the nonlinear equation:

$$U = \beta_1 S \times Y^{\beta 2} + \beta_3 S + \beta_4 Y^{\beta 2} + \varepsilon \qquad (3)$$

The estimate of β_1 i.e. the coefficient on the interaction term between permanent income and sickness in equation (3)- measures whether (and in what direction) the marginal utility of

consumption is affected by health. The null hypothesis of state independence can be rejected if β_1 is different from zero. In particular, if β_1 is negative it is possible to infer that that marginal utility declines as health deteriorates, while a positive β_1 suggests that marginal utility increases as health deteriorates.

Finkelstein et al. (2013) run a fixed effects regression model as follows:

$$UtilityProxy_{it} = g\left(\beta_1 S_{it} \times \bar{Y}_i^{\beta_2} + \beta_3 S_{it} + X_{it}\,\Psi_1 + \theta_i\right) \qquad (4)$$

where *i* and *t* refer to individuals and time periods respectively. The explanatory variables consist of a measure of sickness (*S*), a measure of permanent income (*Y*), and demographic covariates (*X).*

Any direct effect of permanent income and any other time-invariant characteristics on utility are absorbed in the individual fixed effects (θ_i). Therefore, since the effect of permanent income on individual utility in the healthy state is absorbed by fixed effects in the equation (4), the authors recover it by running an auxiliary regression of the estimated fixed effects from equation (4) on permanent income and demographic controls:

$$\theta_i = \beta_4 \log(\bar{Y}_i) + X_{it}\,\Psi_2 + \eta_i \quad (5)$$

Equation (5) contains the same time-varying X_{it}'s from (4) and also includes additional time-invariant individual controls (i.e. nationality, gender) which are absorbed in (4) by the individual fixed effects.

Combining equations (3) and (4) the authors provided an estimate of the health state dependence parameter, evaluating individual utility changes after a health shock, for individuals with different levels of permanent income Y

Following this approach, the authors found evidence the that marginal utility of consumption declines as health deteriorates, and this allowed them to reject the null hypothesis of no state dependence. The authors showed that the utility proxy appears to be sensitive to change in the health status: it decreases with disease ($\beta_3 < 0$) and increases with permanent income ($\beta_4 > 0$).

As stated above, to develop our empirical model we took into consideration a second contribution, which is the work by Kools and Knoef published in 2017, in which the authors provided an extension of Finkelstein's model described above, to test for the existence of health

state dependency of utility function in Europe, by using the panel data drawn from the Survey of Health, Ageing and Retirement in Europe (SHARE). One of the main differences compared to Finkelstein's et al model (2013) is the choice of dependent variable: while Finkelstein et al. (2013) use happiness as a direct proxy for utility (and identify health state dependence by comparing the effect of a health shock on happiness for individuals with high and low permanent income, as described above) Kools and Knoef took the same starting point (relying on the same conceptual framework presented in previous pages), but instead of using a proxy for overall wellbeing, they investigate the effect of health shocks on financial wellbeing. In more detail, the authors derived a 'health equivalence scale' and show that health state dependence is a transformation of this parameter. The health equivalence scale is defined as 'the relative change in income needed to maintain the same standard of living after a health shock'2.

In other words, the aim of the study is to compare the financial wellbeing of an individual before and after a health shock and measure how much income is needed in unhealthy conditions in order to be as well as in the healthy state from a financial point of view.

Opposite to what emerged from Finkelstein's et al. (2013) empirical analysis, evidence from Kools and Knoef's work goes in the direction of indicating positive health state dependence of the utility function, in line with some other scholars such as Edwards (2008), Tengstam (2014), Gryd Hansen (2016).

These results suggest that with physical health problems day by day activities and leisure ones may become more expensive because of the extra help required, and this can explain the positive direction of the state dependency of the utility function.

The authors provided evidence that these findings are driven by medical expenditure. In fact, testing the model, including out of pocket medical expenditure, the authors excluded that the positive sign of state dependency could be driven by an increase in medical expenditure (rather than by an increase in marginal utility of non-medical consumption triggered by a deterioration in health conditions).

Moreover, the authors also stressed the importance of the institutional framework of European countries, which is of relevance in this context, given that health insurance coverage is universal

[2] The authors derived the health equivalence scale relying on the approach for the common 'income equivalence scale', which measures the relative change in income needed to maintain the same standard of living with additional household members. (Kools and Knoef, 2017)

in Europe and insured people tend to have negligible out of pocket (OOP) medical expenses[3], which makes the latter unlikely to drive results.

Furthermore, the results appeared to be robust against the use of different (physical) health measures and functional form assumptions.

Remarkably, Kools and Knoef (2017) - confirming evidence also obtained by Gyrd-Hansen (2016) on a Danish sample - highlighted the effect of increasing marginal utility of consumption since health deteriorates seem to be stronger when limitations are mild. This could be explained considering that as long as physical limitations do not reduce involvement in leisure activities, it may well be that the budget share for leisure activities increases with the upsurge of a health shock, because more assistance is required, or because costs for auxiliary activities (for example transport) increase.

In line with this evidence, the authors also showed that cognitive limitations are likely to lead to negative health state dependence. This is explained assuming that when cognitive health declines, the willingness to allocate time and resources to leisure activities may decline, and this may have an effect in terms of lowering expenditure.

3. Other theoretical and methodological issues

Following Finkelstein (2013), in our model we propose to estimate the effect of health deterioration on consumption choices by using as a dependent variable a proxy for subjective well-being.

The number of scholars' contributions investigating various aspects of SWB has increased a good deal in recent years (see for example Boyce, 2010, Ferrer I Carbonell, 2005, Frey, 2010), gaining increasing relevance also in the field of economics. The upsurge of research contribution in this direction sheds light on a series of methodological aspects which have to be taken into account in the study of determinants of subjective well-being.

One important contribution in this direction is provided by Ferrer I Carbonell and Frijters (2004), who in their paper '*How important is methodology for the determinants of happiness?*' addressed the main methodological concerns related to analysis of this aspect. One of the main

[3] This is in line with evidence form OECD survey (2015), which shows that especially in the north of Europe health care is mainly financed by social security and government, and private OOP medical expenses are low.

contributions of the work of Ferrer I Carbonell and Frijters (2004) is related to the fact that it clarifies the importance of the interpretation of SWB as cardinal vs ordinal.

In fact, it is well known that one of the main limits related to the use of subjective measures of well-being is connected to possible different interpretation of the different item included in the scale: different individuals, in fact, are in general likely to interpret scales in different ways. In particular, an individual who is very optimistic individual is deemed to be in general more keen to select the top ends of the scale (associated to more happiness and life satisfaction) while on the opposite more pessimistic fellows are more likely to select answers at the lower level of the scale (associated to lower level of happiness, life satisfaction). For this reasons, some economists have some doubts related to the reliability of this kind of measures, as underlined by a recent paper by Bond and Lang (2019).

In their paper, Ferrer-i Carbonell and Frijters (2004) analyzed the main findings from more than 3000 studies done over about thirty years, categorizing them according to the statistical methodology utilized, in order to test for reliability of the main findings.

As stressed by the authors, what appears to be very important to address this issue and deal with ordinal interpretation of the scale, is the fact of taking into account unobserved individual effects.

In more detail, as far as cardinal versus ordinal interpretation is concerned, what the authors underlined is that most of the psychologists have interpreted the possible answers to typical questions in the survey assessing quality of life as 'cardinal', i.e. that the 'difference in happiness between a 4 and a 5 for any individual is the same as between an 8 and a 9 for any other individual'. (p. 641). As the authors highlight, in economics cardinality has long been considered 'suspect' (as stated also by Ng.1997), and the ordinal interpretation is usually preferred. In other words, in economic studies the relative difference in answers factoring different levels of satisfaction are only ordinally comparable, i.e. that *'it is unknown what the relative difference between satisfaction answers is but that all individuals do share the same interpretation of each possible answer'*. (Ferrer I Carbonell and Frijters, 2004, pag.641)
This is to say, in other words, that ordinal rankings imply that moves from one category to the next constitute only qualitative statements (improvement/worsening, respectively) and that changes by one category are not quantitatively comparable across their starting levels. By

contrast, cardinality assumes that moving from e.g. 3 to 4 is an improvement as large as that when moving from 4 to 5, and that moving from 2 to 4 is an improvement double as large compared to that when moving from 2 to 3, or from 7 to 8.

However, Ferrer-i-Carbonell and Frijters (2004) demonstrated that for life satisfaction questions the assumption of cardinality or ordinality in the econometric model does not affect 1) direction and significance of influential explanatory variables and 2) the trade-offs between the decisive determinants. As the authors stated, what is of key relevance in explaining life satisfaction is the distribution of time-invariant factors related to observables. (Ferrer-i-Carbonell and Frijters, 2004)

With this regard, their main conclusion is that cardinality or interpersonal ordinality of satisfaction answers do not make a great difference to the results, while what is of great relevance is the presence of time-invariant factors related to observables, which play a key role in explaining happiness. Therefore, the authors stressed in their conclusion the importance of deep-diving these aspects in order to better explain the distribution of these time-invariant factors'. (Ferrer I Carbonell and Frijters, 2004, p.641)

This issue is still at the center of academic debate: although this conclusion is challenged by some scholars (e.g. Bond and Lang, 2014, 2019), other authors share the view of Ferrer i-Carbonell and Frijters (2004), among whom Boyce (2010) and Frey (2010), who stressed that the main issues in the econometric study of SWB is the presence of heterogeneity between individuals, which is largely deemed unobservable.

The latter in general refers to individual specific aspects which can have an impact in the way one person will assess the quality of life, which can be both constant over time (i.e. sex, race), or varying over time (i.e. educational level, marital status, country of residence and so on).

However, while controlling for the presence of heterogeneity among individuals is an issue studied by several scholars – as evidenced by Boyce (2010) - relatively little work has been aimed at understanding '*what is truly included within the set of fixed heterogeneous factors'*. (Boyce, 2010)

In fact, it appears that within the well-being literature there is no strong consensus on what exactly can be included under the definition of 'individual heterogeneity', and the term is often used to reflect aspects of an individual's character that researchers find difficult to measure. For example, some researchers have suggested that in part there is some bias in individual responses to subjective well-being questions due to processes such as 'anchoring' or whether the individual has an optimistic or pessimistic view of life (Clark et al, 2005; Ferreri- Carbonell,

2005; Winkelmann & Winkelmann, 1998). Moreover, other authors argued that an individual's health (Winkelmann & Winkelmann, 1998), their capacity to deal with adversities (Ferrer-i-Carbonell, 2005) and their ability or family background (Di Tella & MacCulloch, 2006) are important components of unobservable heterogeneity.

However, perhaps the most widely held consensus among authors nowadays goes in the direction of considering an individual's personality as the most important component of individual heterogeneity. Many subjective well-being researchers have in fact made the explicit assumption that the unobservable individual heterogeneity is mainly personality traits (Booth & van Ours, 2008, Ferrer-i-Carbonell & Frijters, 2004, Frijters et al., 2004, Senik, 2004, Cuesta et al, 2004, Vendrik & Woltjer, 2007, Fisher 2009, Frey 2010)

Hence, according to different scholars (among whom Cuesta et al, 2004, Ferrer I Carbonel, 2004, Boyce, 2010), the set of idiosyncratic variables simultaneously affecting SWB and explanatory variables are likely to be rooted in personality traits. As Cuesta et al (2004) stated, these variables are supposed to operate through three main channels: first, by biasing SWB scores, due to the correlation of specific personality traits (for example extroversion, neuroticism, self-esteem) with self-reported measures of satisfaction (as described also by Diener and Lucas, 1999; Judge et al., 2002); and second, by mediating the impact of comparison information on SWB. This concern is motivated by a corpus of field and laboratory studies in psychology examining the interplay between personality and the responsiveness to social comparisons (Wood and Van der Zee, 1997; Van der Zee et al., 1998). The third channel of correlation is with the right-hand side variables, especially income. If outgoing and extrovert people are more successful in life, then a higher income is a prize rather than a causal factor of satisfaction with life (Graham et al., 2004).

From a methodological point of view, most of these authors agreed in underlining that the confounding influence of personality traits, giving rise to potentially spurious correlations between two subjective measures, (such as self-assessed health and SWB), can be addressed through the use of household panels (longitudinal studies) that observe the same person over some years. These panels allow the effects of personality traits to be directly partialled out so that partial correlations between SWB and its determinants (correlations conditional to these unobserved individual characteristics) can be obtained. Technically speaking, this can be achieved through calculating first differences (relating changes in SWB to changes in its determinants) or inclusion of so-called individual fixed effects.

The estimation strategy that seems to be favored in subjective well-being studies to deal with individual heterogeneity is in fact, also according to Boyce, a fixed effect (FE) estimation, which is also the technique Finkelstein (2013) exploited in providing estimates of state dependency for utility function.

In detail, based on the assumption that the unobservable heterogeneity is correlated with explanatory variables, the FE model exclusively focuses on explaining the within-person variation. As a result, the individual heterogeneity, which is considered fixed across time, contains no within-person explanatory power. In fact, all of the between-person information is not essential for estimation and is grouped together into what is referred to as the individual fixed effects and mostly ignored.

However, as Boyce underlines, focusing only on the within-person variation can be considered inefficient and the resultant loss of between-person information has been described by Beck and Katz (2001) as "*throwing the baby out with the bath water*" (Boyce 2010). It is therefore not possible to obtain reliable estimates on characteristics that have zero or low within-person variation using an FE estimation (Plumper & Troeger, 2007).

An alternative that overcomes the problem of obtaining reliable estimates on characteristics with low within-person variation is a random effects (RE) estimation. The use of this kind of model requires a different assumption to be made about individual heterogeneity, i.e. that the heterogeneity is uncorrelated with explanatory variables of interest.

This is a strong assumption and, although the RE model is more efficient than the FE model, since it uses both within and between person information, it is likely to produce biased estimates if this core assumption is violated. In other words, using RE model reasonable estimates can be obtained as long as the error structure is recognized using an estimator such as generalized least squares (GLS). However, the reliability of these estimates depends on the strength of the assumption that observable characteristics are not correlated with the individual heterogeneity. In studies of subjective well-being it would be difficult to argue convincingly that this was the case. Some researchers have therefore proposed the use of the RE model incorporating the solution proposed by Mundlak (1978), i.e. the random effect model with Mundlak term (REMT).

Mundlak (1978) proposed a solution for the problem of reliability of estimates obtained with RE being dependent on the strength of the assumption that observable characteristics are uncorrelated with the individual heterogeneity by allowing for correlation between the unobservable heterogeneity and some of the observable characteristics. The random effects

model with a Mundlak (1978) transformation (REMT) overcomes the inefficiency problems associated with the FE model but still maintains many of the key FE assumptions.

The REMT circumvents the problem by allowing the error structure to take account of the correlation, in a similar fashion to the FE model, by including the time-mean values of the observable characteristics that are thought to be correlated with the unobservable heterogeneity. An example of the REMT's use in subjective well-being research can be seen in Ferrer-i-Carbonell (2005).

An issue with such a technique, however, is that there is no clear-cut way of choosing which variables are correlated with the unobservable heterogeneity. There are some individual characteristics that it would be difficult to argue were not correlated with the unobservable heterogeneity; as Boyce (2010) underlined, the correlation between the unobservable heterogeneity and observable characteristics is a key factor determining a subjective well-being researcher's choice of estimation strategy.

Taking account of what is stated above, in our empirical analysis we estimated a REMT model, as described in paragraph 4. However, in order to check for robustness of our results, other econometric techniques (and various model specifications) have been tested. The main results can be found in table 5.

4. Data

We estimated our model using data from five waves of the Survey of Health Aging and Retirement in Europe (SHARE) – 1, 2, 4, 5, 6 - collected over the period 2004-2016 (the third wave - SHARELIFE - was not included because retrospective, and focused on information on people's life history. Therefore, the collected information in that wave are very different compared to the other regular waves taken into account for the analysis (i.e. wave 1, 2, 4, 5, 6) in structure and content. In that wave, information on income were not collected, and information on health status are not comparable to other waves. Being income and health status among the main regresslos of our model, we decide to exclude wave 3 from the analysis.

SHARE is a multidisciplinary and cross-national panel database of micro data, which contains rather detailed information on demographics, socioeconomic characteristics, health status and family relationship of the over 50s in Europe. The survey information for each wave of SHARE was collected through Computer-Assisted Personal Interviews (CAPI) supplemented by a self-completion paper. The interviews were carried out in twenty-seven European countries.

However, this study only uses data from nine countries present in all the available waves: Austria, Belgium, Denmark, France, Germany, Italy, Spain, Sweden and Switzerland. In this study, we also restrict the sample of analysis to retired individuals to avoid potential first order effect on income of the health shock. After deleting records with missing values, we obtained a final sample of 17,509 observations.

5. Model description and methodology

In our empirical analysis, we tried to replicate the analysis proposed by Finkelstein (2013), in order to test for the existence of state dependent utility function in a European context.
As in Kools and Knoef (2017), we run the analysis on a European panel dataset, with the aim to evaluate the existence of health state dependency of utility function. We used as a dependent variable a proxy for SBW for quality of life for individuals living in Europe, trying to factor in the model individual heterogeneities which can play a role affecting both SWB and some of the variables used as regressors.
As anticipated, we estimated our model by using different econometric techniques, in order to check for robustness of results. For the reasons stated above, our reference model is however the Random Effect model with Mundlak term, described as follows:

In detail, sharing the same conceptual framework introduced by Finkelstein and described above, we started from estimating a linear random effect model, based on the following equation:

$$UtilityProxy_{it} = \beta_1 S_{it} \times Y + \beta_2 \ln Y + \beta_3 S_{it} + \Psi_1 X_{it} + \nu_{it} + \mu_i \qquad (6)$$

Regressors include a measure of sickness (S), a measure of permanent income ($\bar{Y}$), and an ample set of covariates (X), which in the interest of parsimony are not all modelled in the theoretical equation, but are all included in the empirical models we tested. In the latter, we controlled for main sociodemographic aspects variables (i.e. age, years of completed education, household size and composition, and additional dummy variables for gender, marital condition, house properties, nationality, region, year fixed effects) and other variables related to body and mind functionality aspects (in equation (6)) factored in the vector X_{it} . $S_{it}xY_{it}$ is the term factoring the interaction between income and health, and the sign associated to this interaction is the one

indicating the existence of state dependency of the utility function. As described at pag 37, the parameter associated to this interaction, β_1, measures whether and in which direction the marginal utility of consumption is affected by health. The null hypothesis of state independence can be rejected if β_1 is different from zero.

The term v_i is a time-invariant effect and u_{it} is an independent error term.

An implicit assumption of RE models is that the random component v_i is uncorrelated with the explanatory variables. According to some scholars, among whom Cuesta (2004), this may be seen as a rather strong assumption insofar as the dependent as well as the right-hand side variables may be driven by omitted characteristics. For example, as Cuesta et al. (2004) highlights, more optimistic or 'predispositionally happy' individuals are more likely to marry and form larger households (Stutzer and Frey, 2006) and be more successful in life (Graham et al., 2004), and this may lead them to higher scores in the evaluation of the quality of life.

In other words, many scholars, among whom for example Ferrer I Carbonell and Frijters (2004) and Cuesta et al. (2004), highlighted the problem of unobserved heterogeneity that surrounds the use of self-reported data: that is to say, a common concern with this kind of data is the existence of omitted individual characteristics that simultaneously influence the dependent and the explanatory variables.

In this context, and in line with Kools (2017), we assume that socioeconomic status (i.e. family background, education, household wealth level) may play a role in influencing both health status and overall perception of quality of one's own life. Moreover, we also assume that answering styles might not necessarily be fixed over time and, for example, a health shock may change an individual's perception of scales when called to provide an assessment of the quality of his life. Another assumption, as stated above, is that personality can play a significant role in this context.

In order to control for these issues, and in line with Kools and Knoef (2017) and Cuesta et al (2004), we propose to estimate a random effects model extended to include: (i) a Mundlak term (Mundlak, 1978), in order to correct the potential correlation between the errors and the explanatory characteristics; and (ii) explicit variable to control for the respondents' personality

traits (by including in the model a specific variable, built relying on EUROD depression scale). (Cuesta et al., 2004)

In more detail, following Mundlak (1978), the individual specific effect can be parametrized as a linear function of the average time-varying explanatory variables over time plus a random individual specific effect, that is assumed to be independent of the explanatory variables.

The Mundlak term is therefore intended to control for correlations and consists of a vector X_i^M (factoring the time-averaged values of a subset of M explanatory variables) plus the error term. With this strategy the unobserved heterogeneity of the standard RE model is thus assumed to consist of the two following parts:

$$v_i = X_i^M + u_i \qquad (7)$$

The first is the vector collecting time-averaged values of a subset of M explanatory variables, and it is assumed to vary linearly with the within-group means; whereby, a possible correlation between the independent variables and the idiosyncratic characteristics is accounted for. The second part, u_i, is a pure error term, assumed to be i.i.d. normally distributed with mean zero and variance σ.

Hence, equation (6) can be rewritten as:

$$UtilityProxy_{it} = \beta_1 S_{it} \times Y + \beta_2 \ln Y + \beta_3 S_{it} + \Psi_1 X_{it} + \varphi X_i^M + \mu_i + \varepsilon_{it} \quad (8)$$

Therefore, in light of the above-mentioned shared assumption that personality is the most important component of individual heterogeneity in SWB equations, we include in the model of explicit controls for the respondent's personality, which in equation (8) is included among variables factored by the vector X.

In this context, our assumption is that there are no unobserved characteristics that are correlated with health or income and have an effect on the change in the utility proxy.

In order to replicate the analysis performed by Finkelstein on a US panel sample, in line with the originally proposed setting (and also with the contribution from Kools), we assume that wealth in the sick state is predetermined. We, therefore, limit our analysis to retired people, so that a health shock does not lead to first order effects on income.

As in Finkelstein (2013) and in Kools (2017), since all individuals in our sample are older (mean age 72) and out of the labor force, we consider the time periods in the empirical analysis as repeated observations on an individual in period 2 of the theoretical model.

The dependent variable is a proxy of subjective well-being, which in the SHARE database is factored by the variable CASP-12, an index of quality of life fit on elderlies, ranging from 12 to 48, where higher scores reflect higher quality of life. CASP-12 is based on the following four dimensions: Control, Autonomy, Self-realization, and Pleasure.

In more details, CASP-12 is a revised measure obtained by the originally developed CASP-19 indicator, specifically introduced by Higgs and Hide (Higgs et al., 2003; Hyde et al., 2003) with the aim to factor issues driving well-being in old age, exploiting an explicit and well-defined theoretical framework. The authors developed specific indicators to factor quality of life (QoL) in old age to overcome what they identified as a methodological gap as, for example, health indicators are frequently used as proxies for QoL. However, according to Higgs et al. (2003), health is a factor which may influence people's QoL and should therefore not be used as an indicator of QoL. In general, in using health as a proxy for QoL, researchers rely on strong normative assumptions, namely that QoL is high when people are in good health and low when they are in bad health. However, people – especially very old people – have efficient strategies to adapt to health deterioration and more generally losses associated with old and very old age. Therefore, older people may often report a good quality of life despite the decline in health. starting from the evidence that most people living in the third age are in good health and able to participate in a variety of activities, while most of the general QoL index do not specifically refer to those dimensions which can induce a worsening trend in the quality of life at this age. For example, people at this age could be more likely to experience negative events that jeopardize their autonomy and more generally the quality of their everyday life (e.g. hospitalization, institutionalization, disease, death of friends and family members). Higgs and colleagues identify the following four dimensions of needs from which they derive the CASP items (Higgs et al., 2003; Hyde et al., 2003): Control, Autonomy, Self-realization, and Pleasure. Control is defined as the perception of being able to shape one's own life, to have control over one's environment through one's own behaviors (Rotter & Mulry, 1965). Autonomy refers to self-determination and the absence of unwanted interference from others. In the words of Deci and Ryan (1987), the concept of autonomy refers to "an inner endorsement of one's actions, the sense that they emanate from oneself and are one's own". Pleasure refers to the pursuit of

enjoyable activities. And finally, self-realization describes the fulfillment of oneself. According to Higgs and colleagues (2003), these two last dimensions measure a new feature of the young-old individuals born after World War II. This generation benefited from favorable life conditions (e.g. progress in medicine, expansion of retirement systems), that improved their general health conditions and contributed to the increase in life expectancy. They reach, in general, retirement age with several healthy years ahead of them. Relieved from professional responsibilities, they have time to pursue new interests and enjoy life. Retirement age is seen by the authors as a period for self-realization, because people have time to invest in new interests or develop sleeping interests they always neglected during their professional life. They can flourish in activities they enjoy and that correspond best to their personality.

The explanatory variables consist of a measure of sickness (S), a measure of permanent income ($\bar{Y}$), and an ample set of covariates (X), capturing demographic aspects, and other variables related to body and mind functionality aspects.

We chose as a measure of permanent income the average across all waves of the total annual impute net household level. (*thinc_m*). Average income in our sample is about Eur 26,700.

In line with Finkelstein (2013), our baseline measure of health status (S_{it}) is the number of chronic diseases that individual i in wave t has ever been told by a doctor that she has had (*chronic_mod*).

This variable is based on the multiple answer question that asks which of the listed chronic conditions the individual had according to their doctors based on the following question: "*Has a doctor ever told you that you had ...").*

Based on standard practice, and including option choices available in all the waves we focused on, the following items have been considered:

1.A heart attack; 2.High blood pressure or hypertension; 3.High blood cholesterol; 4.A stroke or cerebral vascular disease; 5.Diabetes or high blood sugar; 6.Chronic lung disease; 7.Cancer or malignant tumor; 8.Stomach or duodenal ulcer, peptic ulcer; 9.Parkinson disease; 10 Cataracts; 11.Hip fracture or femoral fracture.

In line with Finkelstein, we selected this measure as our baseline because of its widespread prior use and because it is not subjective (which reduced the risk of spurious results due to correlated measurement error in the subjective variables, which is, however, partialled out using Mundlak correction in the RE model).

Given that the two main variables among regressors – i.e. *thinc_m* and *chronic_mod* - have been collected only in waves 1,2,4,5,6 this led us to exclude wave 3 (Sharelife) from our analysis.

We focused on a panel of retired individuals who participated in all four waves. The introductions of these restrictions left us with a total of 17,509 observations, collected over five periods and distributed over the following countries: Austria, Germany, Sweden, Spain, Italy, France, Denmark, Switzerland, Belgium. Summary statistics can be found in table 1.

Table 1 – Descriptive statistics on the balanced sample of retired, over 50 individuals (repeated observations on waves 1,2,4,5,6)

Survey of Health, Aging, Retirement — N. observations: 17509
Sample: Retired, over 50 — Groups : 4849
BALANCED PANEL — *Waves:1,2,4,5,6 by countries*

Country identifier	N. observations	% female	% living alone	% excel./very good self perc.health status	% bachelor	% high QoL (CASP)	average CASP	average age	average permanent income
Austria	1,260	57.06	36.98	29.68	8.81	63.73	39.83	70	26,484
Germany	1,596	49.37	20.49	15.41	35.84	60.96	39.39	71	28,437
Sweden	2,338	58.51	29.98	39.14	28.31	60.27	39.25	73	30,771
Spain	1,350	31.63	14.07	12.74	9.04	34.52	35.63	73	19,017
Italy	2,632	45.44	11.78	15.96	7.90	26.98	34.37	71	22,077
France	2,060	56.75	33.06	18.16	30.39	51.84	38.23	71	31,618
Denmark	1,598	57.45	37.11	51.38	67.02	75.03	41.19	72	20,951
Switzerland	992	53.43	34.27	38.51	21.47	75.10	41.16	73	49,932
Belgium	3,683	46.10	27.69	25.03	33.99	56.69	38.72	71	44,573
	17,509	50.33	26.43	26.42	27.63	54	38.38	72	30,775

6. Model results

Our preliminary results from estimating a random effect model with the Mundlak term are presented in table 2.

Our results point in the direction of suggesting the existence of positive health state dependence in the sample we are taking into account, meaning that deteriorating health leads to an increase in the marginal utility of non-medical consumption ($\beta_1 > 0$). It is statistically significant at the 5% level, which implies the possibility to reject the null hypothesis of absence of health state dependency of the utility function, i.e. $\beta_1 = 0$.

We checked for robustness of this result among different model specifications (and also different econometric techniques), and obtained rather stable outcomes, as presented in tables 6-7-8.

However, further analyses are needed to precisely assess the magnitude of state dependency.

Secondly, as expected - and in line with results from Finkelstein and Kools - the proxy of subjective well-being has turned out to be increasing in permanent income ($\beta_2 > 0$) and decreasing in number of diseases ($\beta_3 < 0$).

The coefficient associated with the variable EUROD is significant (in almost all model specifications we tested) and, as expected, enters with a negative sign, highlighting that people reporting a high score in EUROD (i.e. feeling depressed) tend to provide a more negative assessment of their quality of life than those who are not depressed.

7. Discussion and conclusions

As stated above, our evidence related to the sign of the parameter assessing the state dependency of utility function points in a positive direction, suggesting an increase in marginal utility associated with consumption when moving to an unhealthy state.

This is in line with what was obtained by Kools and Knoef (2017), as well as with the results obtained by Dorte Gyrd-Hansen (2016), who highlighted the same directionality as European data, and also with contributions made by Edwards (2008) and Tengstam (2014). Dorte Gyrd-Hansen, in a recent study published in 2016 described evidence provided by a sample of Danish citizens pointing to a positive direction of health state dependency of the utility function. The author highlighted that the marginal utility of consumption is likely to increase with poorer

health, because of 'increased reliance on costly entertainments and luxury in one's own home' (Gyrd-Hansen, 2016).

As Kools and Knoef (2017) highlighted, besides adapted leisure activities (to be able to keep up with ways of living experienced before sickness), other aspects may provide possible explanations, i.e. increased preference for assistance, not only in leisure time but also in house-work and higher transport costs.

Moreover, it could be the case that if physical limitations become too severe, an individual would rather give up on some of these increasingly costly activities. This is for example what Kools and Knoef (2017) obtained restricting the analysis to the surge of cognitive limitations. As anticipated above, for cognitive health limitations the authors found negative health state dependence, suggesting that when cognitive health declines, people's ability to plan, organize, and take initiatives becomes worse. These developments appear to have the effect of lowering the marginal utility of consumption.

More in general, Kools and Knoef (2017) and also Gyrd-Hansen (2016) underlined the fact that the increasing marginal utility of consumption as health deteriorates seems to be stronger when limitations are mild. This could be explained considering that as long as physical limitations do not take the fun out of leisure, it may well be that the budget share for leisure activities increases due to a health shock, for the reasons mentioned above. Gyrd-Hansen (2016) stated that the results obtained in his work indicate that for most Danish citizens inferior health states have a positive effect on the marginal utility of consumption, but this does not necessarily hold for higher levels of sickness. (Gyrd-Hansen, 2016)

As many of the scholars working on this topic underlined, the great variety in the results emphasises the need for more research to further investigate the direction of modification in the utility function as an effect of health deteriorating.

The health state dependence parameter is important for many economic questions such as the optimal savings rate and the optimal level of health insurance. Positive health state dependence means, for example, that both the optimal savings rate and the optimal level of increase in health insurance are relative to the situation where health state dependence is not taken into account.

Besides, our results, in line with Kools and Knoef (2017), suggesting the existence of positive health state dependency of the utility function, point in the opposite direction with respect to what was obtained by Finkelstein (2013), showing negative state dependency of the utility function in a US panel dataset. As Kools and Knoef (2017) suggested, a crucial issue in explaining controversial results is related to the presence of important heterogeneities in the

effect of health and ageing on financial needs so that the choice of sample and health measure may induce variability in the obtained outcomes. Besides, Kools and Knoef also suggested that differences in results can be mostly attributed to differences in the institutional and socio-economical context, as well as to cultural difference and differences in the consumption pattern among US and European countries. Some studies, among which for example the contribution of Banks et al. (2015), compare the life-cycle consumption pattern between US and UK[4]. What emerged from this analysis is that British citizens seem to allocate a higher budget share to recreation and leisure than Americans. Therefore, if the British find recreation a more relevant expenditure than US citizens, they are supposed to need more money to keep doing these activities in bad health (e.g. more health and assistance during a holiday).

Further investigation is needed in order to shed light on these issues. Remarkably, additional research is needed in order to explain health state dependence across individuals with different features.

[4] The authors refer to this work generalizing findings on UK in a European context, although UK is not included in SHARE

Table 2 – Model results

RANDOM EFFECT MODEL WITH MUNDLAK

Observations:	***17,509***	***Rsq-within=***	***0.007***
Groups:	***4,849***	***Rsq-bet.=***	***0.417***
Waves	***T=1,2,4,***	***Rsq-overall=***	***0.315***

Variables	REMT Parameter Estimate
Permanent income at household level	0.3375***
	0.047
Health status (n.of chronic diseases)	-4.4092***
	0.483
Interaction Income Diseases	0.4039***
	0.048
Gender (1=female; 0=male)	0.8172***
	0.117
Having a partner	1.0899**
	0.432
Widow	0.4908***
	0.131
Religion: Protestant	0.6785***
	0.178
Age	-0.02364**
	0.009
N. of years of education	0.07983***
	0.010
Having at least one child living in household /building	0.04581***
	0.013
Natural parent (mother) still alive	0.1202**
	0.044
High score in depr.scale eurod (i.e. being depressed)	-1.1858***
	0.033
Having difficulties in daily activities	-1.0279**
	0.303
Mobility index	-1.7998***
	0.094
cons	38.4066**
	0.805

Robust standard errors in italic (below estimated parameters); *** p<0.01, ** p<0.05, * p<0.1

Table 3: Other model specifications, Random Effect with Mundlak correction

RANDOM EFFECT MODEL WITH MUNDLAK			
		Observations:	***17,509***
		Groups:	***4,849***
		Waves	***T=1,2,4,5,6***
Variables		***REMT***	
Permanent income at household level	0.4023***	0.3556***	0.3350***
	0.0470	*0.0477*	0.0474
Health status (n.of chronic diseases)	-6.0662***	-5.1481***	-4.3033***
	0.4859	*0.4918*	*0.4840*
Interaction Income Diseases	0.5544***	0.4652***	0.3926***
	0.0481	*0.0486*	*0.0478*
High score in depr.scale eurod (i.e. being depressed)	-1.4055***	-1.3789***	-1.1404***
	0.0321	*0.0319*	*0.0327*
age		-0.0584***	-0.0277**
		0.0089	*0.0092*
N. of years of education		0.0995***	0.0792***
		0.0100	*0.0096*
Having a partner		1.2190**	1.1500**
		0.4486	*0.4332*
Widow		0.5503***	0.6631***
		0.1324	*0.1294*
Religion: Protestant		0.0995***	0.7123***
		0.0100	*0.1781*
Having at least one child living in household/building			0.0477***
			0.0130
Natural parent (mother) still alive			0.1176***
			0.0444
Having difficulties in daily activities			-1.1371***
			0.3036
Mobility index			-1.7535
			0.0944
Constant	37.8690***	41.2889***	39.0257***
	0.4853	*0.8176*	*0.803*

Robust standard errors in italic (below estimated parameters); *** p<0.01, ** p<0.05, * p<0.1

Table 4: Other model specifications (1)

	Parameter Estimates							
Variables	**Pooled OLS**		**FE**		**RE**		**MLE**	
Permanent income at household level	0.9029***	0.9029***	0.1010	0.0828*	0.4296***	0.4281***	0.4266***	0.4107***
	0.0741	*0.0741*	*0.0640*	*0.0612*	*0.0580*	*0.0538*	*0.0485*	*0.0472*
Health status (n.of chronic deseases)	-9.0507***	-9.0508***	-2.2720*	-1.9498*	-7.5063***	-6.9396***	-7.4739***	-6.8042***
	0.7600	*0.7600*	*0.8067*	*0.7820*	*0.6552*	*0.6229*	*0.5216*	*0.4949*
Interaction Income Deseases	0.8031***	0.8031***	0.1883*	0.162*	0.6843***	0.6385***	0.6814***	0.6261***
	0.0747	*0.0747*	*0.0797*	*0.0773*	*0.0646*	*0.0613*	*0.0516*	*0.0490*
High score in depr.scale eurod (i.e. being		-0.9624***		-0.3988***		-0.6221***		-0.6074***
		0.7619		*0.0289*		*0.0338*		*0.0162*
Intercept	30.4527***	33.3109	37.7943***	38.7358***	34.7779***	35.9828***	34.8058	36.1145***
	0.7619	0.6675	*0.6423*	*0.6184*	*0.5917*	*0.5570*	*0.4943*	*0.4813*

Table 5: Other model specifications (2)

	Parameter Estimates					
Variables	**Pooled OLS**		**RE**		**MLE**	
Permanent income at household level	0.6844***	0.4383***	0.3769***	0.2755***	0.3633***	0.2706***
	0.0635	*0.0582*	*0.0543*	*0.0518*	*0.0478*	*0.0469*
Health status (n.of chronic diseases)	-6.3617***	-4.1994***	-6.0760***	-4.1339***	-5.9717***	-4.1059***
	0.6836	*0.6171*	*0.6154*	*0.5655*	*0.4996*	*0.4776*
Interaction Income Diseases	0.5700***	0.3786***	0.5553***	0.3744***	0.5458***	0.3718***
	0.0669	*0.0606*	*0.0606*	*0.0557*	*0.0494*	*0.0472*
High score in depr.scale eurod (i.e. being depressed)	-0.9572**	-0.7805***	0.1125***	-0.5655***	0.1132***	-0.5593***
	0.0416	*0.0371*	*0.0119*	*0.0313*	*0.0102*	*0.0156*
age	-0.0319	-0.0351***	-0.0227***	-0.05279***	-0.0219***	-0.0535***
	0.0081	*0.0082*	*0.0072*	*0.0081*	*0.0065*	*0.0078*
N. of years of education	0.0959***	0.0168*	-0.6191***	0.0248**	-0.6051***	0.0250**
	0.0117	*0.0100*	*0.0336*	*0.0101*	*0.0162*	*0.0099*
Having a partner	0.9750**	0.7309*	1.4092***	1.0177**	1.4332***	1.0287**
	0.4563	*0.4414*	*0.4385*	*0.4302*	*0.4673*	*0.4270*
Widow	0.6253*	0.2204	0.4103***	0.2211*	0.4071***	0.2250**
	0.1637	*0.1460*	*0.1505*	*0.1377*	*0.1376*	*0.1275*
Religion: Protestant	0.2794	0.2390	0.3716*		0.3742**	
	0.2373		*0.2049*		*0.2046*	
Having at least one child living in household/building		0.0174*		0.01788*		0.0177**
		0.0109		*0.0099*		*0.0089*
Natural parent (mother) still alive		0.0804**		0.0621**		0.0617***
		0.0319		*0.0265*		*0.0214*
Having difficulties in daily activities		-0.9796***		-0.8195***		-0.8153***
		0.1930		*0.1720*		*0.1320*
Mobility index		-1.4184***		-1.1457***		-1.1351***
		0.0752		*0.0634*		*0.0482*
Waves						
2		0.1296		0.1504		0.1515***
		0.1444		*0.1352*		*0.1231*
4		0.5809***		0.5711***		0.5713***
		0.1492		*0.1403*		*0.1267*
5		1.1028***		1.0734***		1.0730***
		0.1518		*0.1447*		*0.1303*
6		1.1822***		1.1388***		1.1381***
		0.1544		*0.1479*		*0.1351*
Country						
Germany		-0.6703**		-0.6634**		-0.6616***
		0.2601		*0.2691*		*0.2816*
Sweden		-0.9990**		-0.8712***		-0.8650***
		0.2423		*0.2502*		*0.2627*
Spain		-3.2465***		-3.3023***		-3.3046***
		0.2679		*0.2788*		*0.2811*
Italy		-4.5095***		-4.7568***		-4.7643***
		0.2353		*0.2441*		*0.2522*
France		-1.1944***		-1.3100***		-1.3123***
		0.2472		*0.2548*		*0.2622*
Denmark		1.0017***		1.0543***		1.0568***
		0.2505		*0.2588*		*0.2818*
Switzerland		0.2214		0.3352		0.3426
		0.2657		*0.2753*		*0.3049*
Belgium		-1.3997		-1.3937***		-1.3912***
		0.225		*0.2356*		*0.2445*
Intercept	35.4136***	39.3294***	36.8434***	41.6214***	36.8714***	56.8500***
	0.8744	*0.8260*	*0.7641*	*0.7751*	*0.6843*	*0.7335*

3

CHAPTER 3

‘*Decision Making under Uncertainty: State-dependent Utility Functions and Applications on Health Outcomes: Evidence from England’s population*

1. Introduction

Economic theory assumes that in decision-making individuals generally follow a rational approach, with the goal of maximizing their utility under a given budget constraint. According to Rabin (2003) there are several main assumptions that economists generally make about human nature, among which: individuals are Bayesian information processors; they maximize their expected utility; they exponentially discount future well-being; they are self-interested; they have preferences over final outcomes, not over changes in such outcomes; they have only “instrumental/functional” taste for beliefs and information; they have well-defined and stable preferences, independent of the underlined state of the world.

In recent years, a relevant number of studies started to challenge some of the above mentioned assumptions, and propose a possible evolution of the classic theory of choices by relaxing one or more of these assumptions, in most cases to capture some psychological insights which might play a role in the individual’s making decision process. In this context, as stated above, Drèze and Rustichini (2000) proposed a model in which they allowed preferences to be state-dependent, and not stable across all different states of the world. In their seminal paper, they suggested that applications of decision theory with state-dependent preferences deal in particular with problems involving states of ‘life and death’. Moreover, they also envisaged a number of other problems that can be deemed as formally equivalent to those involving life and

death, and therefore can be exhaustively explained relying on a model allowing for state dependence of the utility function. Among these, for example, they mentioned those related to the loss of an irreplaceable object, as in Cook and Graham (1978) or those involving two alternative states of health, as in Zweifel and Breyer (1997), or in Finkelstiein et al. (2013).
Allowing for preference structure to vary as a response to a change in the health status can have several implications in terms of implied economic policy: Hangen (2015) suggests that if marginal utility of consumption is increased or decreased by deteriorated health, this is likely to have an effect on the theoretical predictions on demand for health insurance products. However, so far the number of studies dealing with the topic of health state dependence is still relatively limited; most of the papers proposing an analysis of the demand for health-related insurance products in general assume state independence of the utility function, stating that - in line with the classic theory - the marginal utility of consumption remains constant whether the individual is ill or not.
In other words, this implies that, according to the previous literature (see, for example, Feldman and Dowd, 1991) rational individuals, in their optimizing behavior, act on the basis of a preference structure which is not affected by the underlying state of the world: the choice between different goods or activities is based on the evaluation of different options which reflects a structure of preferences which is assumed to be stable and not affected by any variations in the state of the world (as, for example, variation in the health status). In this context, the decision about consuming a certain amount of non-medical consumption goods is not impacted by whether an individual is well or sick and, consequentially, the marginal utility of consumption goods is supposed to be equal across different health status, in good and bad health.
Nevertheless, this is not always in line with what empirical evidence often suggests, as a decline in health is likely to trigger different evaluation of consumption choices. As Harris and Khon underlined (2015), an individual who is experiencing a deteriorating trend in health is likely to get more or less utility from the consumption of some specific goods (for example travelling, a tennis racket, or a prepared meal).

As described in Chapter 2, following Finkelstein et al. (2009), we define health state dependence as the impact of health on the marginal utility of nonmedical consumption. As Finkelstein (2009) stated, from a theoretical point of view, the sign of health state dependence is indefinite, and cannot be specified a priori. On one side, the marginal utility of consumption could decrease with bad health, as in the case of many consumption goods – for example

travelling, car, sport – which are deemed as complements to good health. On the other side, the marginal utility of consumption could increase with deteriorating health, as happens with other consumption goods – among which prepared meals or home-based assistance in self-care – deemed instead to be substitutes for good health.

This paper aims to investigate how the structure of preference may change as a response to a health shock. Specifically, this study aims to analyze whether potential shocks in the health status may lead to a change in an individual's preference structure and decision-making approach and to understand whether, and in what direction, the utility function may vary in response to such health shocks.

After having analyzed these dynamics on a panel dataset drawn from a set of European panels (see chapter 2), the element of novelty of this paper is related to the fact that we test the existence of health state dependency on a panel sample from England's population (i.e. the English Longitudinal Study on Ageing – ELSA), in order to examine if different individual values, beliefs and typical consumption patterns can influence the results we obtained in the second chapter.

In more detail, our aim is to explore whether living in a very different country in terms of institutional settings, with different beliefs and habits would imply a different approach to decision making and, in particular, to dissimilar behavior in terms of consumption decisions after a health shock, compared to what was observed in other European countries (and described in the second Chapter of this thesis).

For many reasons in fact, England is perceived as a region quite different from the other Continental European regions. Although there are a lot of common characteristics, England is located in the United Kingdom, which is geographically relatively small (it has a population of around 65 million people). Its insularity has contributed to forging a particular culture, creating a unique society, characterized by a quite stable group of individuals for more than a thousand years, with a strong sense of national identity, having spoken a common language for a very long time. This, in turn, has led to great institutional centralization since the XIII Century, quite in advance of other European countries. This process has led to the development of a society which has some specific features, which makes it quite singular in the context of Europe. According to the 2019 edition of the British Social Attitudes report (BSA, 2019), which provides an analysis of data on belief, religion, habits, sex, and gender, what emerges is broadly a picture of a secular nation, which is becoming more and more dominated by principles of social liberalism and by scientific rationalism. Higher levels of education, scientific knowledge

and occupational status are in fact associated with more positive views of science with respect to the past. In parallel, what emerges is as well clear evidence of a steady decline in religion and belief among British individuals (BSA; 2019). This decline is thought to be not simply a private matter for individuals and families, but it is instead perceived as a broader trend, which can have relevant implications on social norms, habits, and the development of public institutions. Besides, the report highlights the fact that in modern Britain national identities continue to matter profoundly, although in some areas these identities are changing quickly and in unpredictable ways. This is evident, for example, in the political arena, in which the scenario is highly dominated by the debate on Brexit, i.e. leaving or staying in Europe. In this regard, in particular, the 2019 BSA report underlines the existence of two different political and social lines, i.e. the 'Leaver' and the 'Remainer', which did not exist before the 2016 referendum, and now forms significantly stronger alliances than traditional political parties (with 74% of individuals describing themselves as having a "fairly strong" (34%) or "very strong" (40%) identification with either Leave or Remain, and just 12% who do not identify with either of the two lines- BSA, 2019).

This could be of possible interest, for further development of research, because, according to the authors of the 2019 BSA report, it is possible to identify a clear profile of individuals who are more likely to feel themselves Leavers or Remainers. In other words, according to the authors, the fragmentation of the population among people who tend to support Europe and people who prefer to leave might be underpinned by different attitudinal preferences too. This, therefore, can possibly also be reflected in different approaches to consumption decisions, in particular after a health shock.

Therefore, in the future, it could be that, having more waves of the Survey available with more recent data, we can test if this different perception of national identity can also be reflected on consumption choices.

In this paper we investigate consumption decision making after a health shock in the UK. We follow the original contribution of Finkelstein (2013) and the same approach we adopted in the second chapter, i.e. the theoretical framework of the state dependent utility function. We develop an empirical model in which the impact of health on the marginal utility of consumption is estimated by using data on permanent income, health and a proxy of utility function as a dependent variable, i.e. an indicator of subjective well-being (from now on SWB).

Our findings, which again appear to be robust under different specifications of the model, confirmed what we observed in the second chapter and support the existence of a positive health

state dependence utility, i.e. the marginal utility of consumption increases after a health shock, relative to the situation where health state dependence is not taken into account. Our results are in line with the previous empirical literature which focused on European data (see for instance Kools and Knoef, 2017). Moreover, evidence obtained from the English population are in line with what we observed on a sample drawn from a set of European countries and discussed in Chapter Two. A potential explanation of an increasing marginal utility of consumption in response to a health shock is related to the fact that a deterioration in the health status is likely to trigger a rise in expenditure to cover everyday activities, also including leisure activities. To be able to keep up with ways of living experienced in good health, one may need more money after the health shock, as extra help may become necessary, or ordinary activities may require to be adapted for them to be continued.

In our opinion, this is of particular interest in the case of England, in the light of what is highlighted by a study by Banks et al. (2015), which proposed a comparison in the life-cycle consumption pattern between the US and the UK. What emerged from this study was that British citizens tend to allocate a higher budget share to recreation and leisure than Americans. Therefore, our result pointing in the direction of positive health state dependency of the utility function can be interpreted in the sense that if the British find recreation a more relevant expenditure than US citizens, they are supposed to need more money to keep doing these activities in bad health (e.g. more health and assistance during a holiday): therefore they may be willing to withstand higher spending, with a consequent increase in the level of the marginal utility of consumption.

This paper is organized as follows: Section 2 describes the background and main topics related to the methodological and empirical approach. Section 3 describes data, while Section 4 describes dependent and independent variables. In Section 5 model results are presented, while Section 6 concludes with a discussion of the results obtained

2. Background

2.1 Methodological Issues

The empirical studies of subjective well-being have gained relevance in literature in recent years, with a growing number of studies focusing on how to handle from a statistical perspective the several methodological problems related to this topic (see, for example Ferrer i- Carbonell and Frijters (2004), or other scholars, as Boyce (2010), and Frey (2010)).
Despite the increasing attention on this topic, main methodological aspects are still to be addresses, and object of discussion among scholars (see par 1.6, and pag 91 onwards for details)

Moreover, one of the methodological issues which attracted lot of attention, as highlighted also by Schurer et al. (2012), refers to the presence of unobserved heterogeneity, mostly related to the unexplained component of self-reported well-being. The presence of unobserved heterogeneity poses critical methodological concerns as far as it is supposed to be potentially correlated both to the dependent variables and the right-hand side variables. As also stated by Boyce (2010), this unexplained component in general refers to specific individual aspects which can have an impact on the way one person will assess the quality of his own life; in general, it is supposed to be referred to omitted variables factoring personality or cognitive ability, or other personal aspects, which can be both constant over time (i.e. sex, race), or varying over time (i.e. educational level, marital status, country of residence and so on).

To handle this matter, in a paper of 2004 Ferrer-i-Carbonell and Frijters proposed a fixed effect (FE) model to detect a causal effect of income on well-being, and as Schurer (2012) underlined, since then the Fixed (FE) model has become the 'gold standard' in the literature studying subjective well-being from an empirical perspective. The major strength of the FE model is that it allows for correlation of traditionally unobserved factors and the right-hand-side variables of interest. In fact, based on the assumption that the unobservable heterogeneity is correlated to explanatory variables, the FE model exclusively focuses on explaining the within-person variation from the data (therefore not allowing for estimating the individual-specific effect).

Under this framework, the individual heterogeneity, which is assumed to be fixed across time, is supposed to contain no within-person explanatory power, and is factored into the between-

person variation. The between-person information is deemed inessential for estimation and grouped together into what is indicated as the individual fixed effects, and generally not taken into account.

However, as Schurer (2012) suggested, if on one side this allows the FE model to provide unbiased parameter estimates, it does not deliver any clues about the determinants of heterogeneity. Moreover, some authors, among which Boyce (2010), underline that although this approach delivers unbiased estimates, it can be considered limited, and inefficient, given the relevant loss of information which it implies. In fact, as mentioned in the second chapter, relying only on the within-person, and excluding all the between-person variations entails a substantial loss of information.

An alternative approach that can be taken into account in order to solve the problem of obtaining reliable estimates on characteristics with low or a limited within-person variation is utilizing a random effects (RE) model to compute estimation. However, the use of this kind of model implies the adoption of a different (stringent) assumption related to individual heterogeneity, i.e. it requires the individual's heterogeneity to be uncorrelated to explanatory variables of interest.
This is a strong assumption and, although the RE model is more efficient than the FE model, since it uses both within- and between-person information, it is likely to produce biased estimates in case this main hypothesis is violated. In other words, using the RE model leads to more reliable and efficient estimates compared to what is obtained with the FE model, as it allows for the use of a wider set of available information. However, the reliability of these estimates depends on the fact that a strong assumption is respected – which requires that observable characteristics are not correlated with individual heterogeneity. A limit of this approach is related to the fact that in studies of subjective well-being it would be difficult to sustain convincingly that this was the case.

Some researchers have therefore proposed the use of the RE model incorporating the solution proposed by Mundlak (1978), i.e. the random effect model with Mundlak term (REMT).

As described in the second chapter, (see paragraph 3 for reference) Mundlak (1978) proposed a solution for the problem of the reliability of estimates obtained with RE being dependent on the strength of the assumption that observable characteristics are uncorrelated with the

individual heterogeneity by allowing for correlation between the unobservable heterogeneity and some of the observable characteristics. The random effects model with a Mundlak (1978) transformation (REMT) overcomes the inefficiency problems associated with the FE model but still maintains many of the key FE assumptions. The REMT approach allows the problem to be solved as the individual specific effect can be parametrized as a linear function of the average time-varying explanatory variables over time, plus a random individual specific effect, which is assumed to be independent of the explanatory variables.
An example of the REMT's use in subjective well-being research can be seen in Ferrer-i-Carbonell (2005).
An issue with such a technique, however, is that there is no unambiguous way of selecting which variables are correlated with the unobservable heterogeneity. There are some individual characteristics that it would be difficult to argue were not correlated with the unobservable heterogeneity; as Boyce (2010) underlined, the correlation between the unobservable heterogeneity and observable characteristics is a key factor in determining a subjective well-being using the researcher's choice of estimation strategy.

Finally - as described in paragraph 2.3- given the particular feature of the dependent variable we introduced in this chapter (i.e. truncated variable distributed only in a limited range of values) we also extended the analysis to include a Tobit specification of the model (Tobit, 1958).

The Tobit model has been widely used in empirical studies in a variety of fields, such as labor or industrial organization. For cross-sectional data, the Tobit model has been largely studied (for ref. Amemiya (1973), Nelson and Olsen (1978), Chen and Zhou (2011)). Recently, with panel dataset becoming more extensively available, growing literature on panel data using the Tobit model has been developed (for ref. Honorè et al. (2000), Hu (2002), Li and Zheng (2008), Khan et al (2016) to name a few). In particular, recently some evidence has been envisaged in literature about the application of the Mundlak correction to the Tobit model (see, for example, Kalwij 2003, Mavromaras et al, 2014, Kalwij, Brown et al 2013, and Gimienez-Nadal et al 2016).

2.2. Empirical Approach

In this chapter we employ the same empirical approach we used in the second chapter of this thesis: we replicate again the analysis proposed by Finkelstein (2013), but this time we test for the existence of the state dependent utility function in England, then we compare England to the rest of the European countries included in the SHARE database on which we conducted the analysis in the second chapter. In order to test the existence of the health state dependency of the utility function and in order to obtain results which are comparable to those obtained in the previous chapter, we use, as a dependent variable, a proxy for SBW which captures the individual's quality of life.

As stated in chapter 2 – to which we refer for an extensive description of the background and methodological aspects (see Ch. 2 par. 4 for details) - we started relying on the same conceptual framework introduced by Finkelstein (2013): we started from estimating a linear random effect model, based on the following equation:

$$UtilityProxy_{it} = \beta_1 S_{it} \times Y + \beta_2 \ln Y + \beta_3 S_{it} + \Psi_1 X_{it} + \nu_{it} + \mu_i \qquad (1)$$

S_{it} is a measure of sickness, Y_{it} is the level of permanent income, and X_{it} refer to the vector of socioeconomic variables (among which age, gender, years of completed education, household size and composition, marital status, house properties, year fixed effects) and index for body and mind functionality we controlled for. (more details are provided in par. 4.1).

$S_{it}xY_{it}$ is the term factoring the interaction between income and health, and the sign associated to this interaction is the one indicating the existence of state dependency of the utility function. As described in previous sections (see pages 37 and 47), the parameter associated to this interaction, β_1, measures whether and in which direction the marginal utility of consumption is affected by health. The null hypothesis of state independence can be rejected if β_1 is different from zero.

The term v_i is a time-invariant effect and u_{it} is an independent error term. X is the vector of demographic and socioeconomic variables.

As stated, following Finkelstein (2013) we assume that wealth in the sick state is predetermined, which led us to limit our analysis to retired people, in order to exclude those cases in which a health shock would lead to first order effects on income.

For the reasons stated in paragraph 2.2, our reference model is the Random Effect model with the Mundlak term, described specifically here below. However, we estimated the model by using also other different econometric techniques, in order to check for the robustness of results.

In this context, in line with Kools (2017), and in accordance with the approach we followed in the second chapter, our assumption is that that socioeconomic status (i.e. family background, education, household wealth level) may play an important role in influencing both health status and the overall perception of the quality of one's own life. Moreover, we also assume that answering styles might not necessarily be fixed over time and, for example, a health shock may change an individual's perception of scales when called to provide an assessment of the quality of his life. Another assumption, in line with what was also suggested by Boyce (2010), is that personality can play a significant role in this context.

Therefore, in line with the rest of the literature (see for instance Kools and Knoef, 2017; Cuesta et al., 2004), we estimate a random effects model extended to include: (i) a Mundlak term (Mundlak, 1978), in order to correct the potential correlation between the errors and the explanatory characteristics; and (ii) an explicit variable to control for the respondents' personality traits. (which in equation (3) is included among the variables factored by the vector X.)

The Mundlak term assumes that the individual specific heterogeneity is a linear function of the time-varying regressors of the model. It is therefore intended to control for correlations and consists of a vector X_i^M (factoring the time-averaged values of a subset of M explanatory variables) plus the error term. With this strategy the unobserved heterogeneity of the standard RE model is thus assumed to consist of the two following parts:

$$v_i = X_i^M + u_i \qquad (2)$$

The first is the vector collecting time-averaged values of a subset of M explanatory variables, and it is assumed to vary linearly with the within-group means; whereby, a possible correlation between the independent variables and the idiosyncratic characteristics is accounted for. The

second part, u_i, is a pure error term, assumed to be i.i.d. normally distributed with mean zero and variance σ.

Hence, equation (1) can be rewritten as:

$$UtilityProxy_{it} = \beta_1 S_{it} \times Y + \beta_2 \ln Y + \beta_3 S_{it} + \Psi_1 X_{it} + \varphi X_i^M + \mu_i + \varepsilon_{it} \quad (3)$$

In this context, our assumption is that there are no unobserved characteristics that are correlated with health or income and have an effect on the change in the utility proxy.

Finally, as stated above, in order to take into account the censored nature of the dependent variable - observed on a limited range of values, as continuously distributed between 0 and 1 - we extended our analysis in order to include a Tobit specification of the model, to take into account the fact that the dependent variable can be observed only on a limited range.
In line with Brown et al (2013), and Gimienez-Nadal et al (2016), in the Mundlak Tobit, the RE Tobit model is extended in the same way as Mundlak (1978) extended the linear RE model. Following this approach, we estimated the RE Tobit model as specified in (1) - and with the individual effects specified as (2).
As stated by Gimienez-Nadal et al (2016), the RE Tobit model can be estimated by Maximum Likelihood (ML) under the assumption that the error term is i.i.d. normally distributed with mean zero and variance σ.

3. Data

The dataset we employed is the 'English Longitudinal Study on Ageing' (ELSA), an on-going longitudinal household survey which contains rather detailed information on health, socioeconomic status, and quality of life of the people aged 50 and over living in England.

ELSA design is based on the American Health and Retirement Study (HRS). Since the inception of the study in 2002, the ELSA sample has been re-surveyed biennially: 11,392 individuals took part in the first wave, run in 2002-2003, where the original ELSA sample was drawn from households whose head was interviews in the Health Survey for England (HSE) in the years 1998, 1999 and 2001. Individuals were eligible if they were born before 1 March 1952 and were, at the time of the ELSA 2002–03 interview (i.e. ages 50 and over), still living in a private residential address in England. In addition, partners under the age of 50 of eligible participants were included (and also new partners who had moved into the household since the HSE).
The participants who were recruited for the first wave of ELSA (or have since become partners of such people) are known as Cohort 1. These individuals formed the 'core sample' which was re-interviewed biannually (see Table 1 for details).

Data collection is based on face-to-face interview and a self-completion questionnaire; moreover, on alternate waves ELSA also include a 'nurse visit' to participants' homes, with the aim to collect biomarkers and measures of physical function.

To start with, we focus on seven waves, collected over the period 2002-2015 (as described in table 1). As explained at page 74, given that some main variables which we tested have been rescaled among wave 1-2 and wave after 4, and some are not available for wave 3, this led us to reduce the focus of our analysis on waves from 4 to 7, covering the period 2008-2015, in order to be able to consider homogeneous regressors, based on comparable scales.

Table 1 – ELSA database description

Year	Modality	Sample size			Source of sample
		Full Sample	Core Sample	Nurse Visit	
Wave 1 (2002-03)	CAPI	12,100	11,391		Original sample from HSE 1998, 1999, 2001
Wave 2 (2004-05)	CAPI+ nurse visit	9,432	8,780	7,666	
Wave 3 (2006-07)	CAPI	9,771	8,810		Refreshment from HSE 2001-2004
Wave 4 (2006-07)	CAPI+ nurse visit	11,050	9,886	8,643	Refreshment from HSE 2006
Wave 5 (2010-11)	CAPI	10,274	9,090		
Wave 6 (2012-13)	CAPI+ nurse visit	10,601	9,169	7,730	Refreshment from HSE 2009- 11
Wave 7 (2014-15)	CAPI	9,666	8,249		Refreshment from HSE 2011-12
Wave 8 (2016-17)	CAPI+ nurse visit	8,445	7,223	3,479	

CAPI= Computer Assisted Personal Interview; HSE=Health Survey for England; Harmonized Elsa Data Description, 2017

4. Dependent and independent variables

In this study we use as a dependent variable a proxy for utility function, i.e. a proxy for subjective well-being.
In fact, after decades in which the study of happiness and life satisfaction remained under the domain of other disciplines, recently research on subjective well-being has gained increasing ground also in economics.
As stated above (see page 12 for details), measure of SWB scores have been increasingly used in economics literature in recent years, with the aim of studying the determinants of individuals' quality of life (see e.g., Easterlin, 1973, 1974, for early contributions, and Frey and Stutzer, 2002; Di Tella and MacCulloch, 2006; and Clark et al., 2008 to quote some of the available surveys on this topic).
According to Graham (2016), SWB in economics merges aspects related to economists' techniques with other elements specific for psychologists' techniques, in the attempt to provide a measure able to factor the determinants of quality of life, going beyond the standard notion of utility, generally adopted in conventional economic approaches.

In this study, we propose a new and more comprehensive measure of SWB, which jointly factors two components of individuals' quality of life, i.e. happiness on one side, and the attitude to enjoying life on the other.

In this chapter we introduced therefore a new formulation of the dependent variable, which is meant to be a utility proxy, factoring individuals' subjective well-being. To start with**,** in the first and second specifications of the model, we assumed as dependent variable two dummy variables - '*happy*' and '*enjoylife*' respectively - i.e. two yes/no (1/0) indicators of the respondent feelings over much of the time during the week prior to the interview. *Happy* is a dummy variable for the respondent being in line with the statement "Much of the time during the past week I was happy" and, similarly, *life* is a dummy variable for the respondent approving the statement "Much of the time during the past week I enjoyed life'.
The first and second specifications of the model, using a dummy as a dependent variable, were tested using logit estimations, and results are presented in table 6.

Moreover, in order to factor the joint effect of the two dummy variables mentioned above, we built a more comprehensive dependent variable, obtained through Principal Component Analysis (PCA), starting from the two original dummies, with the aim to having a one-dimension index to reflect SWB.
The obtained utility proxy resulted to be 80% correlated with the two original variables. Finally, in order to help the interpretation of results we normalized the obtained variable in a way that it becomes continuously distributed between 0 and 1.
Some descriptive statistics of the dependent variable obtained in this way and of the two original dummies are presented in table 3.

This represents one of the elements of novelty of our analysis performed on the ELSA database with respect to the analysis we performed in chapter 2, in which the information collected in the SHARE survey (on which our previous analyses were based) did not allow us to build such a kind of dependent variable. Therefore, in the second chapter we based our analysis on the CASP index, which is an indicator of subjective well-being specifically constructed with the aim of factoring specific aspects to assess the quality of life in old age. (see chapter 2, par. 4 for details).

As far as explanatory variables are concerned, the main regressors we consider to include in the analysis are a measure of sickness (S), a measure of permanent income ($\bar{Y}$), and an ample set of covariates (X), capturing demographic aspects, and other variables related to body and mind functionality aspects.

In line with what we did in the second chapter, following Finkelstein (2013) Kools and Knoef (2017), given that data on broad-based consumption are in general scarcely available and not widespread, we infer how the marginal utility of consumption varies with health status from estimates of how the marginal utility of permanent income (which is more widely available) varies as a response to health changes.
We chose as a measure of permanent income the average of the total annual net income at household level, calculated across all the waves we are focusing on. Average income in our sample is about £22,680.
In line with Finkelstein (2013), our baseline measure of health status (S_{it}) is the number of chronic diseases that individual i in wave t has ever been told by a doctor that she has had. The

variable is built taking into account answers to assess the presence of a number of chronic pathological conditions for which the individual received a diagnosis.
Based on standard practice, and including option choices available in all the waves we focused on, the following items have been considered:
1.A heart attack; 2. High blood pressure or hypertension; 4.A stroke or cerebral vascular disease; 5. Diabetes or high blood sugar; 5. Cancer or malignant tumor; 6- Chronic lung disease; 7- Artrits

Moreover, we also include among right-hand side variables a number of socio-demographic variables as age, years of completed education, household size and composition, and additional dummy variables for gender, marital condition, house properties, year fixed effects.
Age enters as a continuous variable; the variable factoring education level is a harmonized three-tier scale developed to compare the education level across countries, It is a simplified version of the 1997 International Standard Classification of Education (ISCED-97), which is part of the international subset of economic and social classifications of the United Nations.

In order to take into account personality traits, we include among the regressors a specific variable, factoring the presence of emotional problems and depression symptoms, (see Allerhand et al, 2014 for details).
Besides, we also included some specific controls for body and mind functionalities, which we deem to be relevant for people in older age. Among these, for example, we include a variable factoring the fact of having or not symptoms of cognitive or memory problems, the way in which individuals evaluated their own health status (i.e. self-perceived health status, assessed on a range of 1-5, where 1 stands for 'Excellent' and 5 for 'Poor') or the fact of experiencing limitations in every day activity (relying on the fact that in the Elsa survey, participants were also asked if they had experienced any functional limitation in doing any of the following six activities of daily living (ADLs): dressing, walking across a room, bathing, eating, getting in and out of bed and using the toilet. The variable derived indicates the number of difficulties with ADLs (range 0–3, with 0 indicating absence of difficulties).

Given that some main variables which we tested have been rescaled among wave 1-2 and wave after 4, and some are not available for wave 3, the analysis is focused on waves from 4 to 7, covering the period 2008-2015.

Besides, in order to replicate the analysis originally performed by Finkelstein on a US panel sample (and in line with what we performed on the European panel dataset and described in the second chapter), we assume that wealth in the sick state is predetermined. We, therefore, limit our analysis to retired people, so that a health shock does not lead to first order effects on income.

The introductions of these restrictions led us to concentrate on an unbalanced panel of individuals who participated in all the four waves, for a total of 22,741 observations, collected over four periods. Some descriptive statistics of the sample on which we tested the models are presented in table 2.

Table 2. Descriptive statistics

	N. obs	Average age	Average Permanent Income (Pound)	% Living in own home	% living alone	%no main health probs	% no main mental health probs	Average utiliy_norm
entire sample	**22,741**	**72.17**	**22,680**	**82.36**	**32.10**	**20.92**	**32.10**	**0.9101**
wave 4	5,543	71.67	20,874	80.41	32.82	24.80	32.82	0.9065
wave 5	5,676	72.03	22,128	81.97	32.77	20.86	32.77	0.9073
wave 6	5,898	72.25	23,222	83.06	31.85	20.21	31.85	0.9104
wave 7	5,624	72.69	24,446	83.96	31.43	17.85	31.43	0.9162

Table 3. Descriptive statistics on dependent variable and original dummies

DESCRIPTIVE STATISTICS		DEPENDENT VARIABLE	ORGINIAL DUMMIES	
	n./ % obs	Average utility_norm'	% 'was happy'	% 'enjoied life'
entire sample	**22,741**	**0.9101**	**90.70**	**91.17**
wave 4	5,543	0.9065	90.19	90.94
wave 5	5,676	0.9073	90.19	90.74
wave 6	5,898	0.9104	90.81	91.12
wave 7	5,624	0.9162	91.23	91.91
Gender				
male	44.6%	0.9269	10.5	10.34
female	55.4%	0.8965	89.5	89.66
Education				
primary /secondary school	43.2%	0.8952	89.62	89.35
high school	19.3%	0.9158	91.19	91.84
some college	20.8%	0.9194	91.36	92.21
college graduate and above	16.7%	0.9311	92.56	93.52
Religion				
Christian	83.8%	0.9208	91.72	92.32
Jewish	0.5%	0.8593	86.46	85.42
Muslim	0.4%	0.7746	77.46	77.46
Other non Christian	0.3%	0.8034	82.14	78.57
Buddhist	0.1%	0.9615	96.15	96.15
Hindu	0.4%	0.8618	91.3	81.16
None	14.5%	0.9048	89.52	91.08
Marital Status				
married	62.1%	0.9343	93.17	93.59
civil partner	0.3%	0.9116	92.65	89.71
divorced	9.2%	0.8653	85.66	87.32
separated	0.7%	0.8255	80.95	83.56
never married	5.2%	0.8881	86.69	88.53
widowed	22.4%	0.8689	88.56	86.93
Perceived health				
excellent	9.4%	0.9705	96.28	97.77
very good	27.4%	0.9593	95.43	96.36
good	33.3%	0.9291	92.43	93.25
fair	22.0%	0.8637	85.96	86.55
poor	7.9%	0.7186	73.85	69.80
	100.0%			

5. Model results

Our results from estimating a random effect model with the Mundlak (REMT) term are presented in table 3, while results from estimating RE Tobit, and RE Tobit with Mundlak (Tobit Mundlak) are presented in table 4 and 5 respectively.

Our results, stable across different specifications of the model and different econometric techniques, point in the direction of suggesting the existence of positive health state dependence in the sample we are here considering, which implies that a deteriorating trend in health status leads to an increase in the marginal utility of non-medical consumption ($1>0$).

Both in REMT and in Tobit Mundlak specifications the parameter turns out to be statistically significant at the 5% level, which allow us to reject the null hypothesis of the absence of health state dependency of the utility function, i.e. $\beta_1=0$.

Moreover, as expected - and in line with what was envisaged by Finkelstein and Kools - the proxy of subjective well-being has turned out to be increasing in permanent income ($\beta_2>0$) and decreasing in number of diseases ($\beta_3<0$).

The coefficient associated with the variable factoring emotional disorders/depression symptoms is significant (in almost all the model specifications we tested) and, as expected, enters with a negative sign, highlighting that people reporting the likelihood of feeling depressed tend to provide a more negative judgment of the quality of their life than those who are not depressed (in line with what has been observed by Allerhand et al. (2014)).

Table 4 – Random Effect Model with Mundlak correction (REMT)

Random Effect Model with Mundlak correction (REMT)			
		observations:	*18,308*
		groups:	*6,241*
		waves:	*4,5,6,7*
Dependent Variable: joint index (utility and life satisfaction)			
	Model 1	**Model 2**	**Model 3**
Permanent income at household level	0.0227***	0.0219***	0.0217***
	0.0055	*0.0057*	*0.0055*
Health status (n.of chronic deseases)	-0.1356***	-0.13689**	-0.135709***
	0.05856	*0.06100*	*0.05856*
Interaction Income Deseases	0.0117**	0.0119***	0.0118**
	0.00577	*0.00594*	*0.00594*
Gender (1.male; 2.female)		-0.0208***	-0.0206***
		0.0069	*0.0053*
Christian Religion			0.0314**
			0.0064
Age			0.0006***
			0.0003
N. of people living in the household			0.0183***
			0.0040
Living in own property house			0.03005***
			0.0071
Having difficulties in daily activities			-0.0908***
			0.0113
Having emotional /nevroticism			-0.2258***
			0.0388
Having ever drink			0.0405***
			0.0077

Robust standard errors in italic (below estimated parameters); *** p<0.01, ** p<0.05, * p<0.1

Table 5- Tobit Model with Mundlak correction

TOBIT Effect Model with Mundlak correction (TOBIT MUNDLAK)	
observations:	*18,308*
groups:	*6,241*
waves:	*4,5,6,7*
Dependent Variable: joint index (utility and life satisfaction)	
	Model 3
Permanent income at household level	0.01048***
	0.0058
Health status (n.of chronic deseases)	-0.1655***
	0.0586
Interaction Income Deseases	0.0166**
	0.0060
Gender (1.male; 2.female)	-0.0227***
	0.0050
Having primary school	0.0135*
	0.0054
Age	0.0012***
	0.0003
N. of people living in the household	*0.0225****
	0.0040
Living in own property house	0.0221***
	0.0070
Having difficulties in daily activities	-0.0614***
	0.0083
Having emotional /nevroticism /depression	-0.1094*
	0.0077

Robust standard errors in italic (below estimated parameters); *** p<0.01, ** p<0.05, * p<0.1

Table 6 – Logit models with dummy variables as dependent variable

XTLOGIT on original dummies				
	dependent variable		dependent variable	
	Was Happy (0,1)		Enjoyed life (0,1)	
Permanent income at household level	0.1621***	0.1372***	0.2289***	0.1984513***
	0.0420	*0.0414*	*0.0441*	*0.0434*
Interaction Income Deseases	0.1329**	0.11800**	0.1110**	0.0891*
	0.0500	*0.4776*	*0.0520*	*0.0511*
Health status (n.of chronic deseases)	-1.2856**	-1.1454**	-1.0901*	-0.8868*
	0.4867	*0.4776*	*0.5058*	*0.0511*
Self- perceived health status		-0.3554***	-0.4746***	-0.4594***
			0.0200	*0.0198*
Having emotional /nevroticism		-0.64596***		-0.6220***
		0.0551		*0.0572*
Gender (0.male, 1 female)		-0.1639***		-0.2501***
		0.0399		*0.0423*

Robust standard errors in italic (below estimated parameters); *** p<0.01, ** p<0.05, * p<0.1

6. Robustness checks

6.1. CASP as a dependent variable

For the sake of better comparability between England and the set of European countries on which we focused in the second chapter, we re-estimated the model by using as a dependent variable the one on which we based the analysis presented in the second chapter, i.e. the CASP indicator.

As explained in paragraph 3 in Chapter 2, the CASP is a. measure built with the specific aim of factoring subjective well-being in old age. The acronym stands for the four domains on which it is based, i.e. control, autonomy, self-realization and pleasure.

The original version of the indicator, introduced by Higgs et al (2003), is based on 19 items, following the theory of 'need satisfaction', according to which the quality of life in old age is related to the degree at which individuals can satisfy their needs in the four above-mentioned dimensions. The main element of novelty of this measure with respect to other indicators aiming at evaluating quality of life (QoL) in old age (see, for example 'objective QoL', 'Subjective QoL', ref. Power, M., et al. 2005) is related to the fact that it differs from the health-related measure and is independent from health and from other elements which can affect it. Instead, it takes into account positive aspects of quality of life at older age related the aforementioned dimensions.

The CASP-19 was included in the (English Longitudinal Study of Ageing) ELSA database, in which answers to the original questionnaire (including all the 19 items) are collected for each wave. The Survey of Health, Ageing and Retirement in Europe (SHARE) includes a revised version of the indicator, containing 12 out of the 19 original items, as described in paragraph. 2.1. Starting from the available answers to each of the single items included in the CASP-19 in the ELSA database, we derived the same version of CASP-12 we had in the SHARE database, in order to be able to estimate the model on the same dependent variable.[5]

[5] While in the SHARE database the calculated index is available for all the waves we focused on, the (English Longitudinal Study of Ageing) ELSA database does not provide the same calculated index, which is available just for wave 5, varying on a 0-57 range. However, it is possible to retrieve it starting from the answers to each of the 19 item entering in the CASP; which are instead collected for each wave.
In order to obtain the CASP19 index, following the syntax indication for the ELSA database available at www.casp19.it, we retrieved the calculated index, rebasing the underling items (on a 0-3 Likert scale), to be able to obtain the measure varying in the range 0-57. This allowed us to compare the measure we calculated with the index already available in the original database only for wave 5. To calculate CASP12, we started from the original

In the underlying questionnaire, respondents were asked to indicate how often they experienced certain feelings and situations on a 4-point Likert scale, ranging from 'never' to 'often' (i.e. 1. Often; 2. Sometimes; 3. Rarely; 4. Never). All items have then been recoded in such a way that higher scores indicate a higher level of QoL. As in the SHARE version, the obtained CASP-12 varies in a value-range from 12 to 48, with a higher score indicating better quality of life.

The results we obtained, stable under different specifications of the model, confirmed what we already observed by testing the model on the previous dependent variable. In detail, the obtained results confirm the existence of positive state dependency of the utility function on health shocks in England. This is in line with what we observed on the set of European countries on which we tested the model by using CASP-12 as a dependent variable.
Also in this case, the parameter associated with the interaction between sickness and income is positive and statistically significant, which allowed us to reject the null hypothesis of independency of the utility function suggesting an increasing trend in marginal utility of consumption as health deteriorates. Therefore, we can confirm also in the sample drawn from the England population the same tendency we observed in a subset of European countries, testing the model on the same dependent variable.
Main results are presented in Table 7.

answers (not rebased, varying from 1to 4 in the Likert scale) and we excluded the items not included in the CASP12 version available in the SHARE database.

Table 7 – Model results - CASP as a dependent variable

	POOLED OLS			RE			TOBIT			MLE		
Permanent income at household level												
	2.8278**	2.0365**	0.9150***	2.8443***	2.0860***	0.8895***	2.8778***	2.081	0.8877***	2.834***	2.081	0.8877***
	0.1628	*0.1699*	*0.1858*	(0.1748)	(0.1779)	(0.1902)	*0.1994*	*0.1710*	*0.1916*	0.168	0.171	0.192
Health status (n.of chronic diseases)												
	-5.0854**	-3.195**	-1.4197**	-4.3732**	-3.4901***	-1.6201***	-6.2417***	-3.4586	-0.1632**	-4.3419**	.458584**	-0.1632**
	2.0268	*2.0269*	*0.5080*	*0.3878*	*0.3901*	*0.3997*	*2.4064*	*0.3763*	*0.4020*	*0.3777*	*0.3763*	*0.0437*
Interaction Income Diseases												
	0.4277**	0.2914**	0.1415943***	0.3623***	0.3206***	0.1619***	0.5371**	0.3173	0.1631***	0.3600***	0.31734	0.1632***
	0.2054	*0.2054*	*0.0532*	*0.2439*	*0.0428*	*0.0434*	*0.2440*	*0.0416*	*0.0423*	*0.0421*	*0.0416*	*0.0437*
Age		-0.2123***	-0.1206***		-0.2210***	-0.1229***		-0.2194	-0.1231		-0.219	-0.1231
			0.0143		*0.0128*	*0.0127*		*0.0124*	*0.0128*		0.01238	*0.0128*
Education			0.1257*			0.1231*			0.1229**			0.1229**
			0.0702			*0.0695*			*0.0700*			*0.0700*
Christian Religion			-0.5017*			-0.4864*			-0.4854*			-0.4854*
			0.2544			*0.0695*			*0.2663*			*0.2663*
Self perceived health status			-0.16756**			-0.0158*			-0.158***			-0.158***
			0.1007			*0.0909*			*0.0911*			*0.0911*

Table 8 – Mundlak Model results - CASP as a dependent variable

RANDOM EFFECT MODEL WITH MUNDLAK

Dependent Variable: CASP-12

Variables	REMT Parameter Estimate
Permanent income at household level	0.7666***
	0.1924
Health status (n.of chronic diseases)	-1.9652***
	0.3760
Interaction Income Diseases	0.1833***
	0.0412
Gender (1=female; 0=male)	-0.3215*
	0.1950
N. of years of education	0.0510***
	0.0153
Age	-0.1662***
	0.0128
Living in own property house	0.5421**
	0.2739
Having ever drunk	0.8078***
	0.3035
Having difficulties in daily activities	-2.7222***
	0.3535
Everything is perceived as an effort	-0.8980***
	0.4506
Constant	25.7823***
	2.282

7. Discussion and conclusions

As stated above, our evidence related to the sign of the parameter assessing the state dependency of utility function points in a positive direction, suggesting an increase in marginal utility associated with consumption as long as health deteriorates.

This is in line with what we obtained estimating the same model on a European dataset (see second chapter), as well as being in line with contributions by Kools and Knoef (2017), and with the results obtained by Dorte Gyrd-Hansen (2016), both highlighting same directionality on European and Danish data respectively. Moreover, also the results provided by Edwards (2008), Viscusi and Evans (1991), and Tengstam (2014) attested the existence of positive state dependency of the utility function after a health shock.

As Kools and Knoef (2017) suggested, a possible explanation can be related to the fact that in case of deterioration of the health status, in order to continue with those usual activities performed in good health, people may be willing to accept higher costs, which can became necessary as far as they may need extra help, for example, or have these activities adapted, in order to continue them after the upsurge of sickness. This is supposed to hold not only as far as ordinary working activities are concerned but is also valid in relation to leisure activities.

For example, Dorte Gyrd- Hansen, as mentioned, in the recent study published in 2016 in which he described evidence provided by a sample of Danish citizens pointing to a positive direction of health state dependency of the utility function, suggested as a possible explanation of the likely increase in marginal utility after illness with the potential need to adapt the individuals' homes in order to go on with leisure activities. As the author suggested, what follows the oncoming of sickness is a higher reliance on costly entertainments and luxury in one's own home' (Gyrd-Hansen, 2016).

Moreover, the author also suggested the results obtained in his work indicate that for most Danish citizens deteriorated health conditions lead to a higher marginal utility of consumption, but this does not hold for higher levels of sickness. (Gyrd-Hansen, 2016). In fact, when physical limitations become too severe, it can happen that an individual would rather give up some of these increasingly costly activities. This is for example what Kools and Knoef (2017) obtained by focusing only on the upsurge of cognitive health limitations. In this case, the authors found negative health state dependence, suggesting that when cognitive limitation increases, people's willingness and ability to keep up with ordinary and leisure activities deteriorates. These developments appear to have the effect of lowering the marginal utility of consumption.

More in general, Kools and Knoef (2017) and also Gyrd-Hansen (2016) underlined the fact that the marginal utility of consumption as health deteriorates seems to be stronger when limitations are mild.

Besides, our results, in line with the evidence from the second chapter and from Kools and Knoef (2017), point in the opposite direction from what was obtained by Finkelstein (2013), who showed the existence of negative state dependency of the utility function in a US panel dataset. As Kools and Knoef (2017) suggested, a crucial issue in explaining controversial results is related to the presence of important heterogeneities in the effect of health and ageing on financial needs so that the choice of sample and health measure may induce variability in the obtained outcomes. Besides, Kools and Knoef also suggested that differences in results can be mostly attributed to differences in the institutional and socio-economical context, as well as to cultural difference and differences in the consumption pattern among US and European countries.

As far as the English population is concerned, what can be considered of relevance in explaining the existence of positive state dependence associated to consumption after a health shock is what is envisaged by Banks et al. (2016), who in a study recently published compare the life-cycle consumption pattern between the US and the UK.
The study is focused on analyzing consumption patterns in the span of life after retirement, taking into account a number of factors which can influence consumption choices, among which, for example, health, mortality, health expenses and shifts in housing expenditures and recreation – all factors on which, as the authors highlighted, the existence of large cross-country institutional differences play a significant role.
What emerged from this analysis is that in the span of life after retirement British citizens seem to allocate a higher budget share to recreation and leisure activities than US citizens.
This suggests that, if in England people find recreation a more relevant expenditure than US citizens, they are supposed to need more money to keep doing these activities in bad health (e.g. they may potentially be willing to spend more on health and assistance during a holiday) this leaves implications for patterns of nondurable consumption at older ages.

However, as many of the scholars working on this topic underlined, the variety in the results obtained in the estimation of the state dependence of utility function reflects to a great extent the effect of using different methods, dataset, as well as the presence of a high level of

heterogeneity in the way the individuals react to illness, and also the differences in the institutional framework of the countries in which the analysis is based. However, variety in results also emphasizes the need for more research to further investigate the direction of modification in the utility function as an effect of health deteriorating, and to explain health state dependence across individuals with different features.

Appendix

Table 9- - Other model specifications

Dependent Variable: joint index (utility and life satisfaction)

	POOLED OLS		RE		TOBIT		MLE	
Permanent income at household level	0.04198***	0.0202***	0.0434***	0.202***	0.0412***	0.0189***	0.0432***	0.0199***
	0.005	0.006	0.004	0.006	0.004	0.006	0.004	0.006
Health status (n.of chronic deseases)	-0.19433**	-0.1865**	-0.202***	-0.1865***	-0.206***	-0.1862**	-0.2046***	-0.1862**
	0.007	0.065	0.055		0.054	0.063	0.054	0.063
Interaction Income Deseases	0.01762**	0.0186**	0.018629	0.0186***	0.01862***	0.0187***	0.01852***	0.0186***
	0.007	0.007	0.005	0.007	0.006	0.006	0.006	0.007
Gender (1.male; 2.female)		-0.0319***		-0.0319***		-0.0318***		-0.0318***
		0.005		0.0054		0.0052		0.0052
Education		0.0102***		0.0102***		0.0101**		0.0101***
		0.005		0.006		0.006		0.007
Christian Religion		0.0351***		0.0351***		0.0352**		0.0351***
		0.01		0.01		0.01		0.01
Self perceived health status		-0.0452***		-0.0452***		-0.0452***		-0.0440***
		0.00		0.00		0.00		0.00

CONCLUSIONS

In this work we analyzed the concept of state dependency of the utility function, starting from the description of the key reference Drèze and Rustichini's model, which theoretically introduced the concept. Afterwards, in the second and third chapter, we investigated empirically the existence of state dependency of the utility function, with main reference to changes in consumption patterns after a health shock in old age.

As mentioned, as Finkesltein et al (2013) highlighted, if marginal utility of consumption is allowed to vary with health (assuming the violation of the P3 axiom on independency, underpinning the structure of preferences in the traditional economic framework, as explained in chapter 1), several economic problems can be affected, among which, for example, the level of insurance demand (Finkelstein, 2013), or the optimal profile of life-cycle savings (Finkelstein, 2013, Macè, 2015).

The results of our study suggest that health status has an impact on the marginal utility of consumption.
As stated above, we adopted the terminology introduced by Finkelstein, defining as positive state dependency of the utility function the case in which poorer health increases marginal utility of consumption and, on the opposite, negative state dependency of the utility function as the case in which deteriorating health leads to a decreasing trend in the marginal utility of consumption. As stated, the sign of state dependency is ambiguous and cannot be theoretically defined

As Finkelstein (2009) stated, there is more than one approach to estimate state dependency of the utility function. Among the available ones, we focused on the approach based on a proxy of the utility function, i.e. a variable factoring subjective well-being, and tested a model to investigate how the proxy of the utility function varies as a response to a change in the health status.

Our evidence, obtained on two different datasets and robust under different specifications of the model, points at suggesting the existence of positive state dependency of the utility function. What we observed is that the marginal utility of consumption tends to increase as a consequence of a health shock. In detail, our evidence related to the sign of the parameter assessing the state dependency of the utility function points in a positive direction, suggesting an increase in marginal utility associated to consumption when moving to an unhealthy state.

We found this result by testing our model on a sample drawn from retired people living in some European countries, using data from the Survey of Health, Ageing and Retirement in Europe (SHARE). These results are in line with other findings available in literature and based on European data, among which Khols and Knoef (2017), Gyrd Hansen (2016), and also with contributions from Viscusi amd Evans (1991), Edwards (2008) and Tengstam (2014).

Moreover, our evidence has also been confirmed by the results we obtained testing the model on England, on a sample drawn by the ELSA dataset, which as well led us to observe the existence of positive state dependency of the utility function after a health shock. Our purpose was to investigate if testing the model in a very different country, with other values and beliefs, as well as with a dissimilar institutional framework and social and cultural environment with respect to Europe, could lead us to a different impact on consumption patterns as a consequence of a change in the health status.

Although our results are stable on both samples, and suggest the existence of positive state dependency of the utility function in Europe and in UK, yet we acknowledge that this work suffers from some limitations, and that further research is needed to shed light on still controversial aspects related to this topic.

Among these limitations, one of the most relevant is the one related to the use of subjective measures for subjective well-being.

As stated above, (see par. 1.6 and 2.5 for details) from a methodological point of view, one of the main concerns in dealing with this topic is related to the possibility of the presence of individual heterogeneity.

As discussed in paragraph 2.5, this issue has been investigated by several scholars, among which Ferrer I Carbonell (2004, 2005) Di Tella et al (2006), Frey and Stutzer (2002), Frey (2009).

Among these, in our opinion particularly relevant is the contribution from Ferrer I Carbonell (2004, 2005) which addressed the issue of interpreting the measure of SWB as cardinal or ordinal. What the author concluded, after examining the main results coming from more than 3000 studies done over about thirty years - with the aim to assess the reliability of the obtained findings - is the fact that what really matters in the study of SWB is to take properly into account the presence of individual heterogeneity. In particular, the authors demonstrated that for questions assessing the level of life satisfaction, the assumption of cardinality or ordinality in the econometric model does not affect 1) direction and significance of influential explanatory variables and 2) the trade-offs between the decisive determinants. As the authors stated, what is of key relevance in explaining life satisfaction is the distribution of time-invariant factors related to observables. (Ferrer-i-Carbonell and Frijters, 2004).

In line with Ferrer I Carbonell (2005), Frey (2010), Kolls (2017), we dealt with the presence of unobservable heterogeneity choosing as baseline model for estimations the Random Effect Model with Mundlak correction, REMT (ref. par. 2.5-2.6).

However, methodological concerns related to the empirical estimations of SWB still animates the debate in this field of research, as attested by the recent publication of a paper by Bond and Lang (2019), which casts several doubts on the reliability of happiness scores. The authors suggested that mean comparisons of reported happiness across different groups is valid only under strong assumptions that are usually rejected by the data (i.e. in order to be able to compare the scores across different group the first order stochastic dominance (FOSD) of SWB across groups has to be maintained, which is not typically the case in data).

The consequences of these results are potentially relevant for most (if not all) of existing findings in well-being research, given that parameters from OLS and ordered probit and logit models, the typical regression models used for wellbeing estimations, are estimates of the average effects.

The authors took into account nine well known empirical findings in SWB academic literature (among which the Easterling paradox, i.e. that an increase in income for all does not improve the aggregate happiness in the US over time (Easterlin, 1974) and demonstrated the possibility to reverse them if this strong assumption does not hold.

In a subsequent paper, Chen et al. (2019) proposed a solution to this problem, focusing on the median, rather than on the mean. They claimed that the median, like the mean, is a centrality measure of a distribution. However, unlike the mean, the median respects the ordinal property of SWB data because it is equivalent to all increasing transformations. Therefore, this implies that the ranking of the medians is stable through any increasing transformation, thus freeing researchers from the burden of stochastic dominance conditions that they face when making mean comparisons across group. Then authors demonstrated that when focusing on the median of well-being data, the Easterlin Paradox still holds.

Different approaches are therefore on the table, the question is under vivid discussion, and further research in this topic is needed in order to shed light on all the methodological aspect related to the topic.

Furthermore, another aspect which can be considered as a limitation is the fact of having a sample characterized by an average age >70, which may affect results.
As stated above, in fact, in this work we took into account only people older than 50, retired from the job market. We acknowledge that having at disposal a wider span of age could have in fact yielded a better comprehension of how decision making on consumption can vary as an effect of a health shock.
However, in making this methodological choice, we followed the approach shared by some scholars in literature, among which Finkelstein (2008, 2013), Kolls (2017), and justified by the idea of limiting effects on decisions on consumption (and on associated estimated marginal utility) induced by the changes in labor income, potentially triggered by the health shocks. Consequently, by limiting the sample only to retired people, average age resulted to be above 70 in both samples.

To partially offset this limitation, we tried to factor in the dependent variable the specific aspects related to aging dynamics and well-being. For this reason, we performed our analysis (in chapter 2 and for comparability reasons we rebuilt the same variable in chapter 3) using as a dependent variable a specific indicator, CASP, which has been constructed with the precise purpose of factoring main aspects playing a pivotal role as determinants of well-being for elderly individuals (ref. par XX for details)

However, as mentioned above, the presence of heterogeneity among individuals, in the effects of aging, in the way people react at becoming older, is for sure an aspect we have to take into account, and which also plays a crucial role also from a methodological point of view. As stated, this aspect, among others, drove the choice of our baseline model (REMT), as discussed in paragraph 2.5 and 3.2.

Furthermore, other limitations may be connected with the choice of measure of sickness we adopted, which refers to the insurgence in a specific wave of a kind of chronic disease.
In line with Finkelstein (2008, 2013), our baseline measure of health status (S_{it}) refers to the number of chronic diseases that individual *i* in wave *t* has ever been told by a doctor that he has had. Following standard practice (see, e.g., Smith 1999, Finkelstein 2013, Kolls 2017) the following diseases are considered in the baseline[6]: *hypertension, diabetes, cancer, heart disease, chronic lung disease, stroke, and arthritis.*

The choice of using chronical conditions followed the approach shared by some authors, among which Finkelstein (2008, 2013) and Kolls (2017).
Besides being used widespread, we selected this measure because it is considered more objective than pure self-reported health status, because it is based on the fact of having received a medical diagnosis (*i.e. 'has a doctor have ever told you that you have the following illness…*').
However, among robustness checks[7], we also performed the analysis also substituting the measure of sickness both with measures of reported health status, and with another variable included in the database, factoring the change in health conditions form one wave to the following.
The results obtained were almost in line with those we had by using the main variable of sickness on which we based the analysis.

[7] For the sake of brevity, not all the model tested are reported in the thesis, but available to the author.

As stated, the health state dependence parameter is important because it can have several policy implications, among which, for example, the optimal savings rate and the optimal level of health insurance. Positive health state dependence means, for example, that both the optimal savings rate and the optimal level of demand for health insurance can be different with respect to the situations in which the health state dependence is not taken into account. In investigating these kinds of implications, Macè (2015) underlined that an element which can contribute in explaining the existence of positive state dependency of the utility function is related to the difficulties experienced by individuals in correctly estimating their ability to adapt to adverse circumstances (defined as 'hedonic adaption'). As the author underlined, in literature some evidence can be found confirming that individuals tend to basically overestimate the effect of bad health on their lives, and this can have some implication on consumption decision making. There is in fact a growing body of literature in psychology (see, for example Brickman et al. (1978), Ashby et al. (1994), Oswald and Powdthavee 2008) which highlights that individuals tend to have difficulties in anticipating their ability to adapt to a decline in some different life circumstances, like, for example, divorce or unemployment. This mis-estimation seems to be particularly evident in the case of the upsurge of a health problem. (Birkman et al 1978, Macè 2015).

According to Macè (2015) the fact that individuals in general tend to overestimate the duration and effective impact of negative health events may have an impact on decision on consumption and savings, affecting the directionality of the state dependency of the utility function.

Moreover, in addition to the issue of optimal demand of insurance, the question of the existence of state dependence of the utility function on health also relates to the validity of asking patients for their valuations of health improvements in stated preference studies when these are to guide the resource allocation of communal funds (Macè, 2015). In fact, some scholars, (among which Macè, 2015), showed that to the extent that patients are in poor health conditions and there is significant negative or positive state dependence, the marginal utility of income is likely to be not equal to that of the average taxpayer, and therefore derivation of societal net benefits will be biased. In particular, eventual evidence of negative state dependence could also provide, according to the author, a justification for transferring resources from non-healthy/disabled to health individuals (Sen, 1997; Roemer, 2001).

Hence, the presence of state dependence has relevant methodological as well as policy implications, an further research on this topic is need to overcome limitations and clarify the still controversial aspects, which mainly refer to the methodological approach.

Besides, as described in the previous chapters, what it is worth to underline is the fact that our results point in the opposite direction compared to evidence obtained by Finkelstein (2008, 2013), who demonstrated a decline in marginal utility of consumption following a deterioration in the health status, estimating the model on a sample drawn up on the US population. As mentioned and as various authors underlined, (see for example Gryd Hansen, 2016), a key issue which has to be taken into account to explain the variability in the results obtained is related to the presence of relevant heterogeneities in the effects of health and aging on individuals, so that the choice of different samples, data, approaches and methods for estimations can lead to a variability in the obtained evidence. Moreover, also dissimilar institutional frameworks and different social and cultural contexts can play a role in explaining this variability, as well as also different consumption patterns among US and European countries.

Therefore, what emerges is that further research would be needed in order to shed light on factors which can contribute to explaining this variability in the results. Moreover, it would be important to further investigate the implications on the state dependency of the utility functions of the health shock with different levels of intensity and gravity, as well as to evaluate the effects of different possible reactions to dissimilar kinds of illness.

As Kools and Knoef (2017) and Gryd Hansen (2016) suggested, evidence of positive state dependence tends to be more relevant if limitations induced by sickness are mild. In that case, in fact, it is more likely that people do not give up on their usual activities, which however become more expensive (or because they require extra help after the health shock or because they have to be adapted to the new conditions, as described in Gryd Hansen, 2016), thus increasing the marginal utility of consumption.
Moreover, it could be the case that if limitation becomes too severe, an individual would rather give up increasingly costly activities, thus with the effect of leading to the opposite sign of state dependency of the utility function.

Given the evidence in literature of a variety of results, suggesting a different conclusion on the sign of state dependency of the utility function, further attests the fact that in our opinion more research is needed in order to further investigate this topic, to deep dive implication in terms of preference modification as an effect of health deterioration, and to explain health state dependency across individuals with different features.

References

Alesina, A., Glaeser, E., Sacerdote, B. (2005). 'Work and Leisure in the United States and Europe: Why So Different?' In: Gertler, Mark and Kenneth Rogoff (eds.). NBER Macroeconomics Annual. Cambridge, MA: MIT Press

Allerhand, M, Gale, C. Deary, J. (2014) 'The Dynamic Relationship Between Cognitive Function and Positive Well-Being in Older People: A Prospective Study Using the English Longitudinal Study of Aging.', Psychology and Aging © Vol. 29, No. 2, 306–318

Banks, J., Marmot, M., Oldfield, Z., and James Smith. (2006). 'Disease and Disadvantage in the United States and England.' Journal of the American Medical Association 295(17): 2037-2045.

Banks, J., Blundell, R., Levell, P., Smith J.P. (2015) 'Life-Cycle Consumption Patterns at Older Ages in the US and the UK Can Medical Expenditures Explain the Difference?', RAND, Labor & Population, wp 1100

Becchetti, L., Pelloni, A., Rossetti, F. (2008). Relational goods, sociability, and happiness. Kyklos, 61(3), 343-363.

Bentahm, J. "An Introduction to the Principle of Morals and legislation", II edition, 1823

Becchetti, L., Corrado, L., Rossetti, F. (2011). 'The Heterogeneous Effects of Income Changes on Happiness'. Social Indicators Research 104:3, 387-406.

Bernoulli, D., (1738). 'Specimen Theoriae Novae de Mensura Sortis,' Commentarii Academiae Scientiatatum Imperalas Petropolitanae', 5; 175 - 192. (Translated as 'Exposition of a New Theory on the Measurement of Risk.' Econometrica 22 (1954): 23 - 26.)

Bond, T. N., Lang, K. (2019) 'The Sad Truth about Happiness Scales," Journal of Political Economy, vol 127(4), pages 1629-1640

Borsch-Supann, A., Brugiavini, A., Jorges, H., Makenbach, J., Siegrist, J., & Weber, G. (eds.). (2005). 'Health, ageing and retirement in Europe. First results from the survey of health, ageing and retement in Europe (SHARE)'. Mannheim Research Institute for the Economics of Aging (MEA)

Budria, S., & Ferrer-i-Carbonell, A. (2018). 'Life Satisfaction, Income Comparisons and individual Traits'. *Review of Income and Wealth*, *0*(0). https://doi.org/10.1111/roiw.12353

Boyce, C. J. (2010), 'Understanding fixed effects in human well-being', Journal of Economic Psychology, 31: 1-16

Boyce, C. J., & Wood, A. M. (2011). 'Personality prior to disability determines adaptation: agreeable individuals recover lost life satisfaction faster and more completely'. Psychological Science, 22(11), 1397-1402.

Brown, S., Garino, G. and Taylor, K. B. (2013) 'Household Debt and Attitudes towards Risk',. Southern Economic Journal, 74, 857-78.

Bruni, L., Porta, P. (2005). 'Economics and Happiness. Framing the Analysis'. Oxford: Oxford University Press.

Bruni, L., Sudgen, R., (2007). 'The road not taken: how psychology was removed from economics, and how it might be brought back'. The Economic Journal, 117, 146-173.

Camerer, C, (1999). 'Behavioral economics: Reunifying psychology and economics' Proc. Natl. Acad. Sci. USA, Vol. 96, pp. 10575–10577

Camerer, C. F., Loewenstein, G. (2002). 'Behavioral Economics: Past, Present, Future', introduction to the book "Advances in Behavioral Economics", edited by Camerer, C.F., Loewenstein, G.

Chen, L.-Y., Oparina, E., Powdthavee, N., & Srisuma, S. (2019). 'Have econometric Analyses of Happiness Data been futile? A simple Truth about Happiness Scales'. ArXiv Preprint ArXiv:1902.07696.

Curtice, J., Clery, E., Perry, J., Phillips M. Rahim, N. (eds.) (2019), 'British Social Attitudes: The 36th Report', London,: The National Centre for Social Research

de Finetti, B.,. (1937). 'La prévision: Ses lois logiques, ses sources subjectives', Annals de l'Institute Henri Poincare, Vol. 7, 1-68. (English translation, by H. E. Kyburg, appears in H. E. Kyburg and H. E. Smokler (eds.) (1964) Studies in Subjective Probabilities. New York. John Wiley and Sons.)

Deaton, A. (2008). 'Income, health, and well-being around the world: Evidence from the Gallup World Poll'. Journal of Economic Perspectives, 22(2), 53-72.

De Nardi, M., French, E., Jones, J.B. (2006). 'Differential Mortality, Uncertain Medical Expenses, and the Saving of Elderly Singles.' NBER working paper no. 12554.

De Nardi, M,, French, E.,. Jones J. B., (2010). 'Why do the Elderly Save? The Role of Medical Expenses.' Journal of Political Economy, 118, 37–75.

Di Novi, C., Marenzi, A., Rizzi, D. (2018). 'Do healtcare tax credits help poor health individuals on low incomes?' The European Journal of Health Economics, 19-293-307.

Di Tella, R., MacCulloch, R. J., & Oswald, A. J. (2003). The Macroeconomics of Happiness. The Review of Economics and Statistics, 85(4), 809-827.

Di Tella, R., MacCulloch, R., (2006) 'Some use of Happiness Data in Economics', Journal of Economic Perspective, Vol. 20, n.1, Pag. 25-46

Dolan, P., & Kahneman, D. (2008). Interpretations of utility and their implications for the valuation of health. Economic Journal, 118(525), 215-234.

Drèze, J. H., (1987). 'Decision theory with moral hazard and state-dependent preferences'. In Essays on economic decisions under uncertainty. Cambridge: Cambridge University Press.

Drèze, J. H., Rustichini, A. (2004). 'State dependent utility and decision theory'. In S. Barbera, P. Hammond, &C. Seidl (Eds.), Handbook of utility theory: volume 2 extensions (pp. 839–892). New York: Springer.

Edwards R.D.,. (2008). 'Health risk and portfolio choice'. Journal of Business and Economic Statistics 26(4): 472–485.

Evans, W. N. and W. K. Viscusi (1991, February). 'Estimation of state-dependent utility functions using survey data.' The Review of Economics and Statistics 73 (1), 94–104.

Feldman, R., Dowd, B., (1991). 'A New Estimate of the Welfare Loss of Excess Health Insurance.' American Economic Review, 81(1), 297–301.

Ferrer-i Carbonell, A. and P. Frijters (2004). 'How important is methodology for the estimates of the determinants of happiness?' The Economic Journal 114 (497), 641–659.

Finkelstein, A., Luttmer, F.P., and Notowidigdo M.J., (2008). 'What Good Is Wealth without Health? The Effect of Health on the Marginal Utility of Consumption.' National Bureau of Economic Research Working Paper 14089.

Finkelstein, A., Luttmer, F.P., and Notowidigdo M.J., (2009) 'Approaches to Estimating the Health State Dependence of the Utility Function', American Economic Review: Papers & Proceedings 2009, 99:2, 116–121

Fishburn, P. C., (1974). 'On the foundations of decision making under uncertainty'. In M. S. Balch, D. L. McFadden, & S. Y. Wu (Eds.), "Essays on economic behavior under uncertainty". Amsterdam: North- Holland.

Fischer, J. A. V. and A. Sousa-Poza (2008). 'Personality, job satisfaction and health- The mediating influence of affectivity'. Swiss Journal of Economics and Statistics 144, 379–435.

Frey, B. S., Stutzer, A. (2000). Happiness, economy and institutions. Economic Journal, 110(466), 918-38.

Frey, B. S., Stutzer, A. (2002). What can economists learn from happiness research? Journal of Economic Literature, 40(2), 402-435

Frey, B.S., Stutzer, A. (2003) 'Reported Subjective Well-Being:A Challenge for Economic Theory and Economic Policy', SOEP Anniversary Conference Berlin, July 7-9, 2003

Frey, B., Stutzer, A. (2010) 'Recent Advances in the Economics of Individual Subjective Well-Being', WWZ Discussion Paper 2010/04

Frey, B. S., & Stutzer, A. (2012). The use of happiness research for public policy. Social Choice and Welfare, 38(4), 659-674.

Hall, R. E.,. Jones, C.I. (2007). 'The Value of Life and the Rise in Health Spending.' Quarterly Journal of Economics, 122, 39–72.

Hacking, I., (1984). 'The Emergence of Probabilities'. Cambridge University Press

Higgs, P., Hyde, M., Wiggins, R. D., & Blane, D. (2003). Researching quality of life: The importance of the sociological dimension. Social Policy and Administration, 37, 239-252.

Hyde, M., Wiggins, R. D., Blane, D., & Higgs, P. (2003). A measure of quality of life in early old age: The theory, development and properties of a needs satisfaction model. Aging and Mental Health 7, 86-94.

Greene, W. (1999) 'Marginal effects in the censored regression model'. Economics Letters, 64, 43–50.

Greene, W. (2008). 'Econometric Analysis'. International Edition, Prentice Hall.

Gimenez-Nadal, J.I, Molina, J.A., and Zhu, Y. (2014). "Intergenerational mobility of housework time in the United Kingdom," IZA Discussion Paper No 8674.

Giménez-Nadal, J.I., and Sevilla, A. (2012). "Trends in time allocation: A cross-country analysis," European Economic Review 56: 1338-1359.

Gimienez-Nadal J.I.,, Mangiavacchi L., Piccoli, L. (2016), 'Mobility across generations of the gender distribution of housework', ECINEQ WP 2016 - 402

Gyrd Hansen, D. (2016). 'A stated preference approach to assess whether health status impacts on marginal utility of consumption' Health Economics. 26: 1224–1233 (2017), Published online 11 August 2016 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/hec.3393

Kalwij , A.S. (2003) 'A maximum likelihood estimator based on first differences fora panel data Tobit model with individual specific effects' , Economics Letters 81,165–172

Kaiser, C., Vendrik, M. (2019). 'How threatening are transformations of reported happiness to subjective wellbeing research?'. 10.31235/osf.io/gzt7a.

Kahneman, D. (1993) 'When More Pain is Preferred to Less: Adding a Better End', Psychological Science 13.

Kahneman, D., Tversky, A. (1972). 'Subjective probability: A judgment of representativeness'. Cognitive Psychology, 3, 430-454

Kahneman, D., Tversky, A. (1973). 'On the psychology of prediction' Psiychological Review, 80: 237-251.

Kahneman, D., Tversky, A. (1974). Judgment under uncertainty: Heuristics and biases. Science, 185, 1124-1131.

Kahneman, D., Tversky, A. (1979). 'A Prospect Theory: An Analysis of Decision Under Risk' Econometrica, vol. 47, n. 2, pp. 263-291

Kahneman, D., Tversky, A. (1981). "The Framing of Decisions and the Psychology of Choice." Science, 211(4481), pp. 453-58

Kahneman, D., Tversky, A. (1982). 'Subjective probability: a judgment of representativeness'. Judgment under uncertainty: Heuristcs and biases". Khaneman, D., Tversky A. Slovic, P. New York

Kahneman, D., Tversky, A. (1991). 'Loss aversion in riskier choices: A reference –dependence model' Quarterly Journal of Economics, (November, 1039-1061)

Kahneman, D., Tversky, A. (2000). 'Choices, Values, and Frames'. Cambridge University Press, Russell Sage Foundation, New York, Cambridge, UK.

Kahneman, D., Krueger, A. B., Schkade, D. A., Schwartz, N. (2004). 'A survey method for characterizing daily life experience: The day reconstruction method'. Science, 306 (5702), 1776-17

Kahneman, D., Diener, E., Schwarz, N. (2003) Well-being: Foundations of hedonic psychology. Russell Sage Foundation

Kahneman, D., Krueger, A.B., Schkade, D., Schwarz, N., and Stone, A. (2004). "A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method," Science 3: 1776-1780

Kahneman, D., and Krueger, A.B. (2006). "Developments in the Measurement of Subjective Well-Being," Journal of Economic Perspectives 20: 3-24.

Kahneman, D., Deaton, A. (2010). 'High income improves evaluation of life but not emotional well-being' Center for Health and Well-being, Princeton University, Princeton, NJ 08544

Karni, E., (1985). 'Decision Making under Uncertainty: The Case of State-Dependent Preferences'. Harvard University Press, Cambridge, MA.

Karni, E., (2005). 'Savage's Subjective Expected Utility Model'. Retrieved from https://pdfs.semanticscholar.org/1e42/3a8313f33b21b3d3e9b857fdcae9dfcfdf98.pdf

Karni, E., (2014) 'Axiomatic Foundations of Expected Utility and Subjective Probability' Handbook of the Economics of Risk and Uncertainty

Karni, E., & Schmeidler, D., (1980). 'An Expected Utility Theory for State-Dependent Preferences'. Working paper no. 48–80 of the Foerder Institute for Economic Research, Faculty of Social Sciences, Tel Aviv University.

Karni, E. and Schmeidler, D. (2016). ?An Expected Utility Theory for State-Dependent Preferences?, Theory and Decision pp. [12. 19, 137, 149]

Kools, L., Knoef, G.M. (2017), 'Health and the Marginal Utility of Consumption - Estimating Health State Dependence using Equivalence Scales', Netspar DP 04/2017-008

Levy M, Nir AR. (2012). 'The Utility of Health and Wealth'. Journal of Health Economics 31: 379–392.

Macè, S. (2015). 'Saving and Perceived Health Risks'. Review of Economics of the Household 13, 37–52

Mavromaras, L. K., U Oguzoglu, U. (2014) 'The effects of health status and health shocks on hours worked', Wiley Online Library

Mitchell, L., (2004) 'U.S. and EU Consumption Comparisons'. Economic Research Service, USDA, U.S.-EU Food and Agriculture Comparisons / WRS-04-04

Mundlak, Y. (1978). 'On the Pooling of Time Series and Cross Section Data'. Econometrica 46(1), 69–85.

Netuveli, G., Wiggins, R. D., Hildon, Z., Montgomery, S. M., & Blane, D. B. (2005). Functional limitation in longstanding illness and quality of life: Evidence from a national survey. BMJ, 331, 1382–1383.

Netuveli, G., Wiggins, R. D., Hildon, Z., Montgomery, S. M., & Blane, D. B. (2006). 'Quality of life at older ages: evidence from the English longitudinal study of aging (wave 1)'. Journal of Epidemiology and Community Health, 60, 357–363.

Ng, Y.K. (1996). 'Happiness surveys: some comparability issues and an exploratory survey based on just perceived increments.' Social Indicators Research, vol. 38, pp. 1-27.

Ng,Y.K (1997). 'A case for Happiness, Cardinalism, and Interpersonal Comparability.' Economic Journal, vol.107, pp. 1848-1858

OECD (2015). 'Health at Glance 2015', OECD indicators. OECD Publishing, Paris.

Oswald, A., Wu, S. (2010). 'Objective Confirmation of Subjective Measures of Human Well-Being: Evidence from the U.S.A.', Vol 327, Science 29-01-10.

Palumbo, M. G., (1999). 'Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle.', Review of Economic Studies 66(2): 395-421

Powdthavee, N., Stutzer, A. (2014) 'Eonomic Approaches to Understanding Change in Happiness', IZA Discussion Paper Series, N. 18301

Power, M., Quinn, K., Schmidt, S., & WHOQOL Group. (2005). 'Development of the WHOQOL-old module'. Quality of Life Research, 14, 2197–2214.

Rabin, M., (2002). 'A Perspective on Psychology and Economics', European Economic Review, 46 657–685

Ramsey, Frank P., (1931). 'Truth and Probability, In the Foundations of Mathematics and Other Logical Essays'. R. B. Braithwaite and F. Plumpton (Eds.) London: K. Paul, Trench, Truber and Co.

Ryan, R. M., & Deci, E. L. (2001). 'On happiness and human potentials: A review of research on hedonic and eudaimonic well-being'. Annual Reviews of Psychology, 52, 141–166. doi:10.1146/annurev.psych.52.1.141

Savage, L.J., (1954). 'The Foundations of Statistics'. New York: John Wiley.

Tengstam S., (2014). 'Disability and marginal utility of income: evidence from hypothetical choices'. Health Economics 23: 268–282.

Trevisan, E,. Zantomio F., (2016), 'The impact of acute health shocks on the labour supply of older workers: evidence from sixteen European countries' Working Papers 2016:09, Department of Economics, University of Venice "Ca' Foscari".

Viscusi, W. K. and W. N. Evans (1990). 'Utility functions that depend on health status: Estimates and economic implications'. The American Economic Review 80(3), 353–374.

von Neumann, J., Morgenstern, O. (1944). 'Theory of Games and Economic Behavior'. Princeton: Princeton University Press.

Wiggins, R. D., Higgs, P., Hyde, M., & Blane, D. B. (2004). 'Quality of life in the third age: key predictors of the CASP-19 measure'. Ageing and Society, 24, 693–708.

World Bank. (2017) 'World Development Indicators'.

Zaninotto P., Falaschetti E., Sacker A., (2009) 'Age trajectories of quality of life among older adults: results from the English Longitudinal Study of Ageing', Quality of Life Research 18:1301–1309 - DOI 10.1007/s11136-009-9543-6