Health, Happiness and Adaptation:  
an economic perspective
Health, Happiness and Adaptation: an economic perspective
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Abstract
In this paper we present a theoretical framework for the analysis of the economic relevance of adaptation as an "happiness engine" in bad health conditions. Positing that for a given individual the level of health is quite separate from the degree of adaptation and its effect on happiness, we aim to verify if gaps between health and happiness do exist and which factors can be connected to them. Having provided a general model of health related happiness determination structured on three happiness components, we define the adaptation process and the relevance of its monetary and non-monetary costs. We then test some features of the model using data from the SHARE survey of health, ageing and retirement in Europe (Release 2.0.1, 2007). We eventually conclude with some suggestions for future research and present a number of actual options for health policy.

Introduction
In the happiness literature there is a growing body of evidence about (partial) adaptation to bad health shocks/conditions: the corresponding psychological theory, frequently referred to either as the set point theory or as the hedonic treadmill, postulates that happiness adapts back to a given level of happiness: roughly, the one experienced before the shock. The issue is of paramount importance for health economics and for the economics of the law because it posits many crucial questions:
• Whose preference is to be used in resource allocation? The general population one (supposedly not adapted) or the ill people one (supposedly adapted)?
• How much should we compensate for disability? Over which time span?
• Are preferences changed by exogenous shocks?
The above puzzles, in fact, are closely linked to adaptation:
1. Adaptation is the main source of difference between the QALY’s scores stated by general population and by ill people: the use of ill people preferences may understate the concerns ex-ante about the illness by general population, while the use of general population’s scores might not represent the “sufferance burden” of a given illness (Menzel et al. 2002).
2. In legal litigations the fact that injured people adapt, can lead to reductions in compensations offered by judges (Bagenstos-Schlanger 2006, Oswald-Powdthavee 2006).

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1 With the collaboration of Isabella Tancorre. We thank Isa for her careful scrutiny of the literature on the psychological constructs that may govern relationships between happiness and adaptation (with special reference to health). We wants also to thank participants to two seminars held at Cassino University for their useful comments.
2 For the analytical differences between set point theory and hedonic treadmill theory see, for example Byrnes-Strohminger 2005
3. If the happiness is taken as a synonym of utility and the effect on it of an health shock is just dependent of time and adaptation, we might have an in-built changing of preference mapping.

The real issue, to our view, is not whether people adapt, but rather how and how much they adapt. In fact, it is natural for every living body to adapt to changed life conditions, but the pattern of adaptation may differ between humans and other living entities, and can also differ among individuals according to their characteristics and conditions: particularly, state of health. Our aim is to build a theoretical framework for the analysis of the impact of bad health conditions on happiness, taking account of the existence and persistence of adaptation. As far as “costs” are concerned, we will try to expose how costs (monetary and non-monetary such as cognitive, psychological and physical) may be viewed as relevant in connection with adaptation. In fact, as we will try to make clear in the next paragraph, we will propose a notion of adaptation considered as the result of a “costly” procedure. Thus we should model the underinvestment, i.e. the achievement of only a partial adaptation, as partially due to monetary adaptation costs, while there could be an optimal substitution strategy between monetary and non pecuniary costs.

Our work will proceed through the following steps. We first present a targeted review of the economics and psychology of adaptation. After that we introduce the rationale of the research and we make an easy introduction to our model using a Tale. Then we provide a general model of health-related happiness determination, stressing happiness components, the analytics of the adaptation process and its costs and some implications of the model. We shall then proceed to test some and only some features of the model, using data from one wave of SHARE survey of health, ageing and retirement in Europe: this will entail both the definition of a measurable notion of adaptation and a tentative (in some cases heroic…) association of other survey variables (such as socio-demographic and relationship variables, individual characteristics, type and duration of illness, some non-pecuniary costs and a self-reported liquidity constraint as a proxy of monetary costs) with the above defined measure of adaptation. We conclude with tentative policy indications and with proposals for future research.

**Adaptation in health economics and psychology theory**

Adaptation is a multidimensional concept; it is made of many different processes interacting each other, moderated by specific factors and varying with time.

There are at least three different concepts of adaptation. The first is called *Cognitive adaptation* and is focused on three dimensions (Taylor 1983): looking for a reason, effort of control, potentiating self-esteem. Cognitive adaptation is also linked to the so called “Principle of reduction of cognitive dissonance”, introduced by (Festinger 1957).

The second concept is the *Psychosocial Adaptation* (Bishop 2005) and can be seen as a dynamic or “stage model”(Livneh 2001), built around eight process variables consisting in emotive reactions to illness, in turn clustered in three temporal stages: immediate, intermediate, late reactions: 1) Shock, anxiety, negation; 2) Depression, anger, hostility; 3) Knowledge, adaptation. To such a model, a number of criticisms have been raised, spanning from the doubtful unavoidability of reactions, to the cicaility and discontinuity of reactions (recurrent models).

The third is called *Hedonic adaptation/treadmill* and is substantially a blend of physiological adaptation such a diminished perception of a stimulus or, say, an increase of muscular mass of
arms for a disabled on a wheeling-chair, and of changes in cognitive process, such as values, interests, goals.

Many factors act as moderators-regulators of adaptation, i.e. as factors magnifying or reducing its strength and impact on well-being feelings and health assessment. Among them the literature stresses the role of uncertainty, of contacts with people having experienced the same illness/shock, of intrusive thoughts and remembrances, of causal attribution (search for responsibilities of illness), of the research of a meaning for what happened.

In practice adaptation can be seen as the composition of different processes: habituation, contrast, change of goals, coping. The first is reflected in a passive behaviour, driving individuals, just due to the elapsing of time, towards the inbuilt set point: in this sense it is a time-relevant process. Habituation is a learning process of biological nature, and does not imply consciousness, awareness or active choice, (I put my shirt on: after a while I do not feel it anymore). On the contrary, a typical short term phenomenon is contrast, consisting in a change of significance of some life aspects because of the comparison with other more intrusive aspects like the onset of the illness (after an accident the simple pleasure deriving from daily living is enhanced by the contrast with the negative well-being effects of the illness). Change of goals has to do with the reshaping of individual’s goals after an illness, abandoning those that are now unattainable, and giving preference to those that can in fact be grasped. The most studied and important process though is “coping,” defined as an integrated approach, having both dispositional traits (personality of individuals) and context (contingent strategies). Coping can be studied as a problem of: 1) Focus: we distinguish a coping centered on the problem, centered on emotions, and seen as an avoidance strategy (denying/avoiding the problem) Zeidner-Endler 1996, Livneh-Antonak 2000; 2) Dynamic interaction: among personal sources (we stress the role of self-efficacy, of hardiness of optimism and of locus of control), among social sources such as social networks and help received both inside the family and outside, and among types of efforts of the individuals; 3) Personality traits: the model of five factors (Zeindler and others

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3 According to Kanehman (2000) in Kanemann-Tversky (2000), phenomena that would normally be explained as due the s.c. Hedonic treadmill, in the sense of Brickman and Campbell (1971) could ALSO be explained by a different cause that has nothing to do with adaption. That is, while adaption is the main cause of what can be reported as going back to the set-point along the hedonic treadmill, the same apparent result can be explained by what K. defines satisfaction treadmill, that has nothing to do with adaptation. Satisfaction treadmill produces treadmill effects that are due, however, to a shift in “aspirations”. The point presents apparent similarities with the notion of positional goods. Here we will not dwell further on this point.

4 A different way of dealing with adaptation is contained in Menzel et al. 2002, that define 8 costitutive elements of adaptation: 1) Cognitive denial of functional health state, 2) Suppressed recognition of full health; 3) Skill enhancement; 4) Activity adjustment; 5) Substantive goal adjustment; 6) Altered conception of health; 7) Lowered expectations; 8) Heightened stoicism. According to the authors the different elements should be backed by different normative considerations.

5 Note, however that the distinction between habituation and adaptation is not, in the literature at large, always so neat and clear-cut as it appears from the discussion above. Kaneme (2000) in Kanemann-Tversky (2000), to recall the notion of adaptation in the sense used by Brickman and Campbell(1971) adopts as an example ”bathing in a warm sea”, that in our view should be considered a physical and physiological automatic response (untouched by volition). We will discuss habituation as physical passive adaptation to bad health on page 16.
1996) looks at Neuroticism, Extraversion, Openness, Agreeableness, Conscientiousness as stimulators or obstacles to coping; 4) Illness type: chronic conditions are the most studied (a model of coping for chronic diseases has been formulated as a cognitive and emotional appraisal of illness characteristics, treatment type, other life circumstances, demographic traits of individuals, that interacting with internal and external sources at disposal leads to a coping behaviour entailing psychological, social and physical consequences, Lazarus-Folkman 1984)), but attention is also devoted to sudden illnesses/accidents and to degenerative illnesses. The last two aspects (alone and in interaction) are of great interest when studying the existence of adaptation in health field.

The importance of personality traits is well documented: 1) conscientiousness, seen as a style of discipline and self-control, is associated to illness acceptance and compliance to treatments, and has been proven as coping enhancing for kidney diseases and dialysis; 2) neuroticism is negatively associated with coping, though the association seems to be dependent on time according to an inverse U shape; 3) optimism (in all its dimensions as positive expectations, self-confidence, and neglect of negative events) has always a positive effect, proven for diabetes (Macrodimitris-Endler 2004), for multiple sclerosis (though decreasing when attacks are underway) and for cancer (Carver et al. 2005).

The literature on the impact of different chronic illnesses and on the successful adaptation strategies is far from conclusive: 1) hypertension is successfully associated to two styles of coping, monitoring and blunting (Miller et al. 1989); 2) diabetes is closely linked to self-efficacy, in that it requires self-control (diet, physical activity) to prevent its worsening with time (Maddux 1995); 3) the most studied among chronic illnesses is cancer, characterized by an ambiguous prognosis and strong social consequences: at least five different coping strategies have been proven their efficacy in some respects: social support, optimism, distancing, cognitive or/and behavioral avoidance, and evidence shows that self-efficacy, internal locus of control, time since the onset of illness and age are all important explanatory factors; 4) heart attacks coping is positively influenced by self-efficacy (less incentive to reducing social activities and more rapid recovery), but also a two stage strategy, with denial at first and active problem solving later on, seems to be effective; 5) asthma is negatively associated to loss of emotional control and on narrow focus on the problem. Coming to sudden illnesses and accidents we can say: 1) in the case of paralysis (Kendal-Buys 1998), social comparison and change of reference group is often a successful strategy (a paradox, reported by Buunk et al., 2006 is that sometimes the more the gravity the more the adaptation because individuals are forced to change reference group), as is upward identification (my future is like that of individuals with less severe conditions) and downward contrast (I contrast my present conditions with those suffered by a more disadvantaged group); 2) amputation: looking for a significance and active problem solving are the most important explanatory factors, though a change of coping strategies across the time is envisaged. Positive individual characteristics such as an internal locus of control, self-efficacy, mastery and optimism lead to successful coping, in a first stage through an increasing resort to humor and only later on through active problem solving (Dunn 1996).

Degenerative illnesses such as multiple sclerosis, often associated with strong uncertainty, depression, anxiety and distress are hardly amenable to adaptation, though religious and spiritual variable are sometimes associated to better results (McNulty et al. 2004). Finally, there are works (Oaksford et al. 2005) studying the effect of the exposition to multiple stressors: the main findings are that the benefits of such complexity are the increased resiliency (capacity to absorb or resist to shocks, disturbance, insult: in some way a notion of psychological “elasticity” of personality, and capacity to transfer acquired coping competences among different illnesses),
the increased mobilizing of resources (already available when a new illness come), the increased reappraisal (perception of own coping ability), while the costs of such complexity are a stereotyped coping, fatigue, helplessness, behavioural constraints, limited reappraisal (inability to understand menaces).

To our knowledge, the less developed theoretical field, due to its complexity, is the measurement of adaptation. Up to now the efforts of measurement have been mainly unidimensional, focusing on the residual gap in (only) one of the following dimensions: pathological traits of personality (anxiety, depression), physical/beavioural components of illnesses, functional performance, grade of acceptance of illness\(^6\). In principle and from our point of view the measurement of adaptation could be pursued by computing the success in filling the gap between happiness and health\(^7\): in the next paragraph we will dwell on this issue.

**The rationale of our research**

First of all we want to be clear about our perspective on the term and the notion of Adaptation. We derived our notion reflecting upon some of the main commonsense meanings of the word and “adapting” to our particular context: that is, casting the notion as an operative concept having drawn its components from fragments of the semantics of commonsense and of relevant psychological theories. These latter we surveyed in the last section. For the semantics of commonsense we asked ourselves: what do we talk about when using the word “adaptation”, “adapt”? So we looked up the Dictionaries: first the Vocabolario della Lingua Italiana (Istituto della Enciclopedia Italiana - Treccani 1986), second we cross-checked with the Oxford Dictionary (these meanings correspond, besides, to those assigned to the word “adaptation” as derived from “adapt” in the cited reference).

Among the first three meanings ranked in order, number one refers: to make apt to a particular scope, make suitable to or for a purpose (same as in the Oxford Dictionary). As examples: make a room suitable as a study; modify a suit; adapt music to a text...Number two refers to: set something in an appropriate manner. As examples: set the shield at the arm; glasses on the nose...Only in the third place we find the meaning as: to accustom (biologically or spiritually), to habituate (also in the Oxford Dictionary) to given conditions of environment, life, reality, reducing progressively one’s own reaction or resistances to these conditions. At the end, in a restrictive sense of the third meaning is also mentioned: to resign oneself, to submit, to accept the inevitable without repining (Oxford Dictionary).

Now in this summary exposition of our frame of reference on the “commonsense” meanings of the term, it is in strong evidence a notion of “adaptation” that refers primarily to some kind of “active” intervention to modify something or somebody in such a way as to make it appropriate to some purpose or scope or function. While the meaning/notion of “adaptation” in the sense of “habitation” or “submission” are assigned a secondary role. For the former, in the absence of

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\(^6\) A more complex strategy could consists in computing a multidimensional measure, focusing on the health/well being domains still affected by the illness and on their relative importance for the individual. Among the domains often studied we find psychological well-being, physical well-being, social-interpersonal and materialwell-being, occupation, physical functioning: this is the case for the IIRS index (Illness Intrusivity Rating Scale) based on 13 domains (Devins et al.1983).

\(^7\) We shall give shortly our definition of adaptation, making also clear the difference between our definition and that of Borghesi-Vercelli (2007) that in quite a different framework, suggest the importance of distinguishing the objective level of health from the subjective assessment of happiness.
intervention, inactivity or the “natural” state of things would not allow to reach the scope. This, consequently, implies to recall some idea of “opportunity-cost”, in as much as resources could need to be used in the “active” intervention. This line of reasoning has led us to propose a notion of “adaptation” that distinguishes itself sharply from “habituation”, although we will allow the latter a relevant role in our model essentially through the role of “time”, because of its emphasis on a inner content of “betterment” to modify what otherwise would be unsuitable or not satisfying. The notion of adaptation/ habituation is mainly used when we face an happiness increasing event: winning a lottery, marriage, etc. In the case of a negative shock, such an illness it is just a sum of fading away sufferance and of naturally increased tolerance for the illness. We call adaptation rather, any activity, entailing effort, fatigue and costs, that is directed to a contrast to the illness and to a speed-up of recovery, either physical or psychological. A way to conceptualize adaptation is to use the well-established health production function. For a generic individual i (i is not reported for ease of notation), we have:

\[ H_t = f(SH_t, HS_{t-1}, Env_{t-1}, Con_{t-1}, Prev_{t-1}, Gen_{t-1}) \]

The onset of illness at period t, that is the health status at t, is characterized by a function of the current health shock SH, and by arguments of the previous period: HS are health services used in the past, Env are the environmental factors, Con are the consumption habits, Prev are the prevention actions and Gen are the genetic inbuilt endowments. The after care period, the health status at t+1, is a simple function of the health services utilized when ill, a function both of the compliance and of his ability to utilize the health services, proxied by his level of education Ed, of the inbuilt genetic capacity of reaction of the individual, of passive habituation to the condition Hab and of a factor Ada, namely adaptation, including all physical, psychological and monetary adaptation efforts of the individual.

The main hypothesis we set forth is that not only the above HS, Ed, Gen, Hab, Ada, factors have a different productivity in terms of health gains, but also that they behave very differently from the point of view of their impact on the happiness of the individual: adaptation, to our view, may have a lower productivity in terms of health gains than HS but it nonetheless has a very high productivity in terms of gains in happiness (we will give our definition of happiness later on).

The above hypothesis is coherent with the observation that shocks in health conditions such as disability, do not reflect in appreciable fall of happiness: individuals having strong adaptation activity could not solve health problems (as measured by physical and physiological data) but they could overcome them, by regaining an acceptable level of happiness.

Though adaptation could be rather happiness enhancing, it is nonetheless costly, both in the efforts it requires and in terms of unsatisfactory health gains. Sometimes adaptation efforts have a direct money cost, in other cases a money equivalent of efforts can be obtained (giving a value to time lost in adaptation activity); finally, it should be considered that using time and resources in adaptation activities could imply an opportunity cost of adaptation in terms of the benefits forgone if those time and resources would have been alternatively used directly in health services. The individual is then confronted with a choice: is the marginal cost of adaptation lower or equal to its marginal utility?

8 The genetic endowment considered here is only considered relavant in the production of “health” and does not coincide with the genetic factors that are considered, in happiness literature, as the main determinants of individual’s level of happiness or set point (according to the review by Lyubomirsky et al. 2005 about 50% of the so called chronic happiness level is genetically determined)
“Aglio, olio e peperoncino” as a metaphor of adapted happiness: the story

We want to tell you a story:

Jack is a rich young man, active and quite happy. On November, Friday 13, a bad car accident brings him in intensive care unit. When he wakes up he discovers having lost many of the legs and arms functionings. They tell him he will recover 20% of previous abilities but it will take time...

After a first period of absolute depression, he realizes that he has to fight if he wants to recover a sense of dignity and of interior calm.

He was an amateur cook, and he loved italian “pasta aglio olio e peperoncino”: he used to fetch hot pepper from a plant he was growing on his balcony, but among the other things he has lost there is the ability to open the window himself. If he wants to continue to eat the pasta, he has two alternatives: either to ask someone to buy the hot pepper for him or to try to overcome his inability.

The first alternative is a low cost one, and it satisfies entirely his feeling of taste: the hot pepper bought is satisfying for quality and the pasta is good.

The second alternative is rather messy: for a while he cannot eat what he would like to, he has to do tiring and costly exercises, may be he faces deception. But, at the end, with the hot pepper in the hand he could feel happy for having succeeded, and, of course, the pasta would taste very good.

If the first alternative gives the same utility and is less costly than the second one why should Jack follow partially or totally the second alternative?

Our answer is (obviously) that the second alternative must contain more utility than the first: although “more costly” it can therefore be rationally pursued. In our example the hot pepper bought and the one grown are different in substance (or characteristics in the sense of Lancaster), in that the first does contain only a “feeling” component, while the second contains both the feeling and the “will” component: the latter confers to the picked hot pepper a greater utility/happiness.

It is now three years since the accident occurred. Jack has acquired the predicted 20% of previous abilities: he is rather satisfied and he is finding a sense to his bad luck. Sometimes he thinks back to the first period of his disability, when he was striving for opening the window: a warm sense of satisfaction flows when he reminds of the first time the hot pepper of his balcony gleamed in his hand.

He is quite happy.

The model

The model is as follows: let’s define happiness as a threefold concept.

The first aspect of happiness has to do with the pursuit and attainment of will: people strive to obtain something, they are happy when they succeed in; but even if they don’t succeed in fully attaining their will they still retain some degree of positive feeling for the sake of it. Recently Lyubomirsky et al. (2005) termed “intentional activity” an argument very similar to the one we set forth. Attainments may be seen as causing a flow of positive feelings (happiness), that we call HF1: such a flow is then a function of a (either partly or fully) successful undertaking, like

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9 In the words of Emmons (1986), individuals whose life satisfaction is high “perceive their strivings as important, valued..”. See, for this citation: Mehnert, Krauss, Nadler, Boyd (1990)
gaining love, money, glory, but also attaining capabilities such as mobility, ability to use and do things properly (such as caring after oneself, dressing, cooking, washing by himself, etc after an accident). Adaptation, to our view, is strongly linked to that aspect of happiness: people whose health has been damaged strive to get back to their old level of physical and psychological abilities and capabilities.

The second aspect of happiness, has rather to do with feelings of well being (named H2). Every individual tries to enjoy his life, organizing it in order to be satisfied and rewarded. Illness breaks this, by reducing, because of its impact, the stock of well being opportunities, WBO, available to each individual in a given moment: we call this process depletion of well being opportunities. Adaptation affects this well being aspect in a negative way, because performing an adaptation activity causes monetary and non pecuniary costs: the WBO stock may then decrease, because of adaptation costs; nonetheless, if adaptation activity reduces the impact of illness on well-being opportunities it has also a positive effect.

The third aspect of happiness has to do with thoughts, or remembrances of past positive experiences: every past attainment, springing up from past H1, deposits in the mind, and can be recalled. The act of recalling implies positive feelings connected to the establishment and maintenance of personal identity, a sense of affirming oneself through temporal continuity, bolstering self-esteem and coping with negative experiences: this act we can call (Bryant et al. 2005) positive reminiscence or H3. We assume that only past H1 can be recalled easily, while past H2 flows away without marking the mind. Setting the point back has partially to do with this aspect of happiness, in that reminds become an inbuilt feature of individuals, and affect future response to life shocks, fostering adaptation.

Define the first component of happiness (the will aspect,) at time t as:

\[ H1_t = f(\Delta_{AA} |FG_t| / |FG|) \]

\[ |FG_t| = g(Ill_{kmt}) \]

\[ \Delta_{AA} |FG_t| = h(AA_{p}, ICh_{z}) \]

\[ H1_t = f\left( h(AA_{p}, ICh_{z}) / g(Ill_{kmt}) \right) \]

In the above equations, we observe that health related happiness flow of type 1 H1, i.e. happiness springing from the process of will posited as adaptation, is a function of \( \Delta_{AA} |FG_t| / |FG| \), the last notation to be intended as the success in contrasting the “functioning gap” (FG) generated by the illness (Ill) of type k and gravity m, i.e. the reduction in usual abilities and capabilities of the individual. \( \Delta_{AA} |FG_t| \) is a function of \( AA_{p} \), for the illness k, performed by the individual, and of individual’s characteristics (ICh) of type z. By substituting \( \Delta_{AA} |FG_t| / |FG| \) in H1, we get the final function 1.

We make assumptions on the derivatives of function 1. with respect to AA:

\[ f' \]

\[ g' \]

\[ h' \]

\[ i' \]

\[ j' \]

\[ k' \]

\[ l' \]

\[ m' \]

\[ n' \]

\[ o' \]

\[ p' \]

\[ q' \]

\[ r' \]

\[ s' \]

\[ t' \]

\[ u' \]

\[ v' \]

\[ w' \]

\[ x' \]

\[ y' \]

\[ z' \]
We assume that an increase in adaptation activity, brings about a success in reducing the functioning problems and increases H1 but at a nearly constant rate, as we assist to a compensation of diminishing marginal returns to AA in closing the functioning gap and to increasing responsiveness of H1 to the degree of success.

Moreover, we can safely assume that:

\[
\frac{\delta H_{1t}}{\delta ICh_{zt}} \leq 0
\]

individual characteristics can affect H1 in both directions, positively and negatively. A discussion on the likely effect on this component of individual characteristics will follow after the model.

A special discussion is due for the effect of illnesses on the functioning gap. We could make the hypothesis that specific dimensions of health as related to quality of life are responsible for the functioning gap, namely mobility, ability to perform usual activities, etc. while some others are only affecting other aspects of well-being feelings (pain, anxiety, ecc.)\(^{12}\). In this respect some types of functioning limitations are more easily contrasted with adaptation, while some others are unresponsive to adaptation. In our opinion this is mainly connected to different prospects (prognosis) of the illness. We shall discuss this issue later on.

Coming to the second component of global happiness, namely well-being feelings H2, that is the feeling of satisfaction and enjoyment of life, we can model it in the following way:

\[
H_{2t} = m \left( WBO_{t}, WBO_{ik} \right)
\]

\[
WBO_{t} = WBO_{t-1} \left( 1 - \beta_{1t} - \beta_{2t} \right)
\]

\[
\beta_{1t} = s(\Delta Inc_{t-1}, H2_{t-1})
\]

\[
\beta_{2t} = r \left( \sum_p CAA_{pt}, FG_{t}, \Delta_{HS}, FG_{t}, \Delta_{AA}, FG_{t} \right)
\]

\[
CAAP_{pt} = q(AA_{pt})
\]

\[
H_{2t} = m \left[ WBO_{t-1} \left( 1 - s(\Delta Inc_{t-1}, H2_{t-1}) - r \left( \sum_p q(AA_{pt}), FG_{t}, \Delta_{HS}, FG_{t}, \Delta_{AA}, FG_{t} \right) \right) \right] \left( WBO_{ik} \right)
\]

\[3.\]

\(^{12}\) Alternatively, we could hypothesize that all the dimensions of HRQL are involved: an usual measure of utility, as QALY’s could then be used to measure the impact of the illness on the functioning gap.
We see\(^{13}\) that H\(_2\) is a positive function of the stock of well-being opportunities available at the end of previous period WBO\(_{t-1}\), a negative function of two coefficients of depreciation \(\beta_{1t}\) and \(\beta_{2t}\). \(\beta_{1t}\) depends on income variations \(\Delta Inc\) - that could be represented by \(\Delta Inc = - wDL_t - CAA_{kt}^M - CHS_{kt}^M + V\), in which \(w\) is the daily salary, DL\(_t\) work days lost because of illness, CAA\(_{kt}^M\) is the monetary cost of adaptation activity for the k type illness, CHS\(_{kt}^M\) is the monetary cost of health services, V is any exogenous variation of income - and it depends also on the flow of well-being in the previous period. \(\beta_{2t}\) is a function of Illness’ gravity and type reflected in the FG term defined before and in the success in contrasting it due to both Adaptation Activity (\(\Delta AA[FG]\), already defined) and to the health services utilized (\(\Delta HS[FG]\))\(^{14}\). Adaptation activity, moreover, is costly in terms of pain, effort, and many other non-pecuniary components (\(p=1,2,...\)) namely physical activity, psychological activity and time costs); we call the cost of adaptation activity CAA\(_{kt}^M\) and its effect runs through an increase in the depreciation rate \(\beta_{2t}\)\(^{15}\).

Finally, there is a direct effect connected with the problem of the “reference group”. Our assumption is that when an individual is struck by an illness he experiences a “shift” relevant in two aspects. In the first aspect the illness imply a shift in the category connected with the dichotomy healthy-unhealthy\(^{16}\). The second refers to the fact that within the unhealthy specific illness group our individual may confront his actual WBO as he perceives it, with what he thinks may be the typical WBO for that type of illness. Individuals realize they have a “new” WBO, and confront this with the typical WBO of people with the same illness. They will be more happy if they have a WBO greater than the typical one. The effect is simply modeled as a ratio between the current stock of well being opportunities and the expected stock of a representative individual of the same reference group \(\text{WBO}_{kt}^\Delta\); a ratio greater than 1 implies a positive effect on actual well-being, while the opposite is true for ratios less than 1\(^{17}\).

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\(^{13}\) We could substitute FG and \(\Delta AA[FG]\) by the functions defined before.

\(^{14}\) \(\Delta HS[FG]\) can be assumed to be a function of HS and ICh, as adaptation activity

\(^{15}\) From a theoretical point of view, illness’ impact and the contrasting actions could also be modeled in a different way. We could think to the effect of illness on well-being as mainly expectations’ driven; in this case the individual compares his expected QALY’s at the onset of illness (ExQALYs) and after any contrasting action (\(\Delta ExQALYs\)) with the expected QALY’s of an individual with his same characteristics but enjoying full health FHExQALYs. We have: \(1 - \frac{ExQALYs + \Delta ExQALYs}{FHExQALYs}\). This approach is more hard to treat because of high data requirements.

\(^{16}\) We will not dwell further on this point. It implies a discussion of what we call the “handicap problem” (mainly connected with the homogeneity of happiness in making interpersonal comparisons in different health conditions), an issue that deserves an in depth analysis that we reserve for another work.

\(^{17}\) The crucial point is how the individuals set their expected values on \(\text{WBO}_{kt}^\Delta\). We are conscious that our treatment of reference group effect is here analytically poor: in principle the typical value could be measured as an average taken from the scoring system adopted for example in the EuroQol measurement studies. We shall forgo the measurement of the reference
It holds:
\[
\frac{\delta H2}{\delta WBO} > 0 \quad \frac{\delta^2 H2}{\delta WBO^2} < 0 \quad \frac{\delta \beta_{1t}}{\delta \Delta \text{Inc}} < 0 \quad \frac{\delta^2 \beta_{1t}}{\delta \Delta \text{Inc}^2} < 0
\]
\[
\frac{\delta \Delta \text{Inc}}{\delta CAA^M} < 0 \quad \frac{\delta^2 \Delta \text{Inc}}{\delta CAA^M^2} \cong 0
\]
\[
\frac{\delta \beta_{1t}}{\delta H2_{t-1}} > 0 \quad \frac{\delta^2 \beta_{1t}}{\delta H2_{t-1}^2} \cong 0 \quad \frac{\delta \beta_{2t}}{\delta CAA^p} > 0 \quad \frac{\delta^2 \beta_{2t}}{\delta CAA^p^2} \cong 0
\]
\[
\frac{\delta \Delta_{AA} \text{FG}}{\delta AA_{p,t}} > 0 \quad \frac{\delta^2 (\Delta_{AA}[\text{FG}])}{\delta (AA_{p,t})^2} < 0
\]
\[
\frac{\delta H2}{\delta AA} = \frac{\delta m}{\delta WBO} \left[ \frac{\delta WBO}{\delta \beta_{1t}} \frac{\delta \Delta \text{Inc}}{\delta CAA^M} \frac{\delta CAA^M}{\delta AA} \right] + \left[ \frac{\delta WBO}{\delta \beta_{2t}} \frac{\delta CAA^p}{\delta AA} \right] + \left[ \frac{\delta \Delta_{AA} \text{FG}}{\delta \Delta_{AA} \text{FG}} \right]
\]

According to the last condition, adaptation activity affects H2 in a threefold way:

(i) Negatively, through the monetary costs of adaptation that deplete the WBO stock (first term in square bracket);
(ii) Negatively, through the non-money costs of adaptation, and their effect on WBO stock (second term in square bracket);
(iii) Positively, thanks to the success of adaptation in contrasting the well-being effects of illness (third term)
(iv) Possibly positively by changing the reference group\(^\text{18}\).

More tentative is the analysis of second-order effects: increasing returns are often compensated by decreasing returns, and there are also constant returns; probably the constant return hypothesis (linear relationship) could be accepted as a first approximation.

The third component of global happiness is H3, due to the flow of pleasant thoughts generated by the Happiness stock that accumulated in the years for every successful attainment, as a byproduct of every will-generated happiness flow:

\[
H3_t = p \left\{ v_t \left[ \sum_{i=1}^{k} H1_{t-i} \right] \right\}
\]

The function \(v\) is probably a decreasing parameters one, in that the effect of past attainments fades away for distant periods, while the function \(p\) has probably, together with the moving sum of \(k\) last years’ attainments, a constant term measuring the “cornerstone” successes of past life; we assume that:

\(^{\text{18}}\) This effect is not explicitly modelled as a function of AA
\[
\begin{align*}
\frac{\delta H_3}{\delta v} &> 0 & \frac{\delta^2 H_3}{\delta v^2} &< 0 \\
\frac{\delta v}{\delta (\sum \delta)} &> 0 & \frac{\delta^2 v}{\delta (\sum \delta)^2} &\approx 0
\end{align*}
\]

Let’s summarize now. Global Happiness \( HAP \):

\[ HAP = \theta (H1, H2, H3) \]

How our story is linked to the model we just sketched?
Suppose Jack chooses the alternative: buy the hot pepper. We see that the accident had depleted his stock of well being opportunities \( WBO \) (ability to eat pasta aglio, oglio e peperencino), but he may react increasing again his stock, rapidly and at a very low cost, by substituting grown up hot pepper with bought hot pepper: this entails only an effect on \( H2 \) component, in that the functioning gap of \( H1 \) is unaffected and there is no happiness \( H3 \) because there is nothing to recall after three years.

Suppose Jack chooses the second alternative: the \( H2 \) component for a while stay very low, because the well being opportunities stock is still depleted, but after a costly and a long adaptation, he succeeds in counteracting accident’s effect on \( WBO \). Moreover he succeeds also in reducing the functioning gap, raising happiness due to \( H1 \) component, and after three years he has a warm flow of happiness \( H3 \) from the recall of the success in adaptation.

The choice to adapt was the right one in terms of happiness: of course his health will lag for the remaining of his life behind his happiness. \textit{The more he chooses to adapt the more the lag.}

\textbf{Implications}

The model proposed entails some consequences:

- **Ad-happiness: adaptation and the production of happiness.**
  Individuals, by their very nature, tend to contrast illness or disability. The issues at stake are then: could we predict the amount of effort made by individuals? Do they perform \( AA \) up to the full cancellation of the negative impact of the illness on happiness? Is there full adaptation? By deriving the global happiness with respect to the adaptation activity \( AA \), we get:

\[
\frac{\delta HAP}{\delta AA} = \frac{\delta H1}{\delta AA} + \frac{\delta H2}{\delta AA} + \frac{\delta H3}{\delta AA} = \frac{\delta f}{\delta h} + \frac{\delta m}{\delta WBO} \left( \frac{\delta WBO}{\delta \beta_1} \frac{\delta \Delta Inc}{\delta CAA^{W}} \frac{\delta CAA^{W}}{\delta AA} \right) + \left( \frac{\delta WBO}{\delta \beta_2} \frac{\delta \Delta Inc}{\delta CAA^{W}} \frac{\delta CAA^{W}}{\delta AA} \right) + \left( \frac{\delta WBO}{\delta \beta_3} \frac{\delta \Delta Inc}{\delta CAA^{W}} \frac{\delta CAA^{W}}{\delta AA} \right) + \frac{\delta \Delta \Delta [FG]}{\delta AA} + \frac{\delta \Delta \Delta [FG]}{\delta AA} + \frac{\delta \Delta \Delta [FG]}{\delta AA} + \frac{\delta \Delta \Delta [FG]}{\delta AA} + \frac{\delta \Delta \Delta [FG]}{\delta AA}
\]

The interpretation of the equation is as follows:

1. the first term in the right hand side is a benefit of \( AA \) through \( H1 \), and has a positive sign, in that the more adaptation activity the more the reduction in the functioning gap (positive sign, second derivative), the increased contrast of the functioning gap increases happiness flow \( H1 \) (positive sign, first derivative) that in turn increases general happiness;
2. the second term in the right hand side is the effect of \( AA \) on \( H2 \) through its costs and its productivity: we have already discussed the signs. The first two
terms (parenthesis) in the square bracket represent the cost of adaptation activity and have negative impact on H2 and on HAP, while the third term in square bracket is positive; the global effect of AA is uncertain (may be negative);

3. the third, forth, k terms in the right hand side, finally, have each a positive sign, in that they represent the past effects of the successful reduction of functioning gap due to the adaptation activity (positive fourth derivative), the following effect of this reduction on the past happiness flow H1 (positive third derivative), the subsequent positive effect of the increased past happiness flow H1 on the stock of happiness (positive second derivative), the positive effect of the increased stock on the remembering possibilities (positive first derivative) and the increased general happiness.

Maximization of HAP, after the illness shock has occurred, requires that we equate the above equation to zero, obtaining the condition:

\[
\frac{\delta f}{\delta h} + \frac{\delta m}{\delta WBO} \left[ \frac{\delta WBO}{\delta \beta_{2,1}} \frac{\delta \Delta_{AA}}{\delta \Delta_{FG}} \right] + \frac{\delta p}{\delta v} \frac{\delta v}{\delta AA_{t+1}} + \frac{\delta p}{\delta v} \frac{\delta v}{\delta AA_{t+2}} + \ldots = 0
\]

The above condition can be interpreted as: the individual should equate at the margin the costs of adaptation activity (right hand side) with the benefits (left hand side). The problem is to understand: 1) if there is any certainty that the equilibrium position is reached and the level of adaptation activity implied by the above condition at equilibrium; 2) if there is any room for a policy intervention leading individuals towards their optimal level of adaptation activity.

The first point has to do with time and with different types of illnesses. In our specification there is not any certainty of the attainment of the equilibrium: for some illnesses whose impact remains stable in time (see next paragraph) the longer lasts adaptation, the higher is the marginal benefit of successful adaptation activity (because of H3), the higher is the probability that, beginning from a situation in which marginal costs were higher than marginal returns, we reach the equilibrium: beyond that point there is no further incentive to adaptation activity. We predict that adaptation activity comes to an end. For some other illnesses, worsening in time, the more the passing of time the worse the benefits of adaptation: increasing costs and decreasing benefits may reach an equilibrium only if costs were lower than benefits at the beginning.

The second point is a policy one. Costs are a key variable in the equilibrium conditions and they are in part policy determined. In fact as compared to health services' consumption that is frequently publicly provided (at zero monetary price on the point of services or with a relatively low copayment), adaptation activity appears neglected. As adaptation activities costs are mainly faced privately by individuals, there seems to be a policy bias towards the most effective (HS>AA) policy tool in terms of health and against the least effective (AA>HS) policy tool in terms of happiness.

- **Illness’ type and gravity and adaptation**

In principle, we expect that some kind of illnesses are suitable for a contrast with adaptation activity, while for some other any effort of adaptation, if ever undertaken, is destined to be unsuccessful.

The analytical effect of illnesses on happiness is:
\[
\frac{\delta HAP}{\delta III_{km}} = \frac{\delta H}{\delta III_{km}} + \frac{\delta H2}{\delta III_{km}} + \frac{\delta H3}{\delta III_{km}} = \frac{\delta f}{\delta g} + \frac{\delta g}{\delta III_{km}} + \frac{\delta m}{\delta WBO} \left[ \frac{\delta WBO}{\delta \beta_{1}} \frac{\delta \Delta Inc}{\delta DL} \frac{\delta DL}{\delta III_{km}} \right] + \left[ \frac{\delta WBO}{\delta \beta_{2}} \frac{\delta |FG|}{\delta III_{km}} \right] + \frac{\delta p}{\delta v} \frac{\delta f}{\delta g} \frac{\delta g}{\delta III_{km(t-1)}} + \frac{\delta p}{\delta v} \frac{\delta f}{\delta g} \frac{\delta g}{\delta III_{km(t-2)}} + \ldots + \frac{\delta p}{\delta v} \frac{\delta f}{\delta g} \frac{\delta g}{\delta III_{km(t-k)}}
\]

In the preceding condition the first term on the right hand side represents the effect of the illness on happiness of type 1 through the Functioning gap: the more important the illness and its gravity the greater the functioning gap and the lower the happiness flow, given a certain level of contrast of it. The second term on the right represent the effect of the illness on happiness through the channel of well-being opportunities: the double negative effect is due to the income-effect of illness (a reduction of days of work) on the depreciation rate \( \beta_{1} \), and to the functioning-gap effect on the depreciation rate \( \beta_{2} \). The last t-1 terms on the right represent the negative effect on happiness due to the remind-flow of sufferance, malaise, etc. due to the past illnesses.

We can usefully distinguish at least four typical illnesses, with different implications regarding the adaptation activity needed to face them:\textsuperscript{19}

1. \textit{Once for all Impairing Illnesses (OAI):} accidents, and disability generating illnesses are the main components of this group, characterized by a once for all health shock (paralysis, amputation). This is to say that we have a once for all decrease of functioning FG, constant depletion \( \beta_{1}, \beta_{2} \) of opportunities WBO, and also a probable once for all shift in the reference group leading to changes in \( \overline{WBO} \delta \) so that the global impact of illness is easy to catch and time invariant:

\[
\left( \frac{\delta HAP}{\delta III_{km(t)}} \right) = \left( \frac{\delta HAP}{\delta III_{km(t-1)}} \right) . \text{ Adaptation activity can contrast the} \ |FG| \text{ (we assumed constant marginal returns). The more} \Delta |FG| \text{ approaches} \ |FG|, \text{ the more it causes costs that probably worsen H2 component through the depletion of WBO. Last to discuss is the effect of successful AA on the building of the happiness stock HS, and then on the recalling function H3: we believe that, given the long period required to adapt, the effects on H3 are lasting, though spread in the future. Graphically:}
\]

\textsuperscript{19} We recall that though we acknowledge that habituation and adaptation are closely linked, nonetheless the automatic nature of the first makes its cost negligible, while the intentional activity needed for the second requires important costs that are (excluding cases of grave lack of information) predictable but far from automatic.
At time $t$ the impact of illness is on the three dimensions of $H_1$, $H_2$ and $H_3$\textsuperscript{20}. The adaptation take place between the period $t$ and $t+n$, the $H_1$ improves, as does $H_3$, while $H_2$ worsen: the global effect is represented by the ticker line. Given the above elements we predict that the effect of AA for OAII is quite high leading to a level of happiness sufficiently close to that (SP= set-point) experienced before the onset of the illness.

2. *Ever Increasing Depletion Illnesses*(EIDI): included in the group are degenerative illnesses as sclerosis, cancers with unhappy prognosis, and most of the illnesses leading to death. A characteristic of the EIDI is that both $|FG|$ and WBO worsen in time so that the AA needed to face the illness is always increasing, though progressively less fruitful ($\Delta|FG|$ as a share of $|FG|$ is declining in time). We could say that there is not an “adaptation period” $n$: rather a never-ending struggle.

\textsuperscript{20} The latter is influenced probably more gradually
Moreover, the reference groups’ effect is not working, because there is no stable group to which compare himself and the likely impact of AA on H2 (through WBO) is increasing in time as more effort and resources are needed. Finally, these illnesses are not associated with a success, so that there is not an increasing stock of happiness H3 in formation and recalling activity adds sorrow to life rather than happiness\textsuperscript{21}. The picture shows that the effect of illness itself is to decrease happiness in time, while adaptation has still an initial positive effect on H1, though diminishing in time, and a diminishing one on H2 and H3: the final effect on happiness is driven by illness and the thickest line HAP is decreasing.

We predict in fact that such illnesses are not associated with increases in happiness though AA could in principle be high and costly: people experiencing such illnesses tend to have low happiness levels and to discourage himself; in some cases AA may drop to zero and death may be desired.

3. *Recovery Illnesses (RI)*: these is the typical group of acute illnesses, that come to an end and are followed by a full recovery. The transitory nature of such illnesses simplify the activity needed to face them: their only impact is through the reduction of WBO and H2. There is no change in reference group nor heavy investment in AA (though some short term activity is needed). May be the facing of the illness is encompassed in the mind, rising HS and H3, at least in the short-medium term\textsuperscript{22}.

4. *Random Hitting Illnesses (RMHI)*: mainly chronic illnesses with sudden acute episodes, as in the case of hearth attacks. This group is a blend of OAI\textsubscript{I} and RI. The basic chronic illness is faced with AA, with a high degree of adaptation,

\textsuperscript{21} In fact, by adding a decreasing yearly H1 (due to the worsened closure of functioning gap) to a decreasing parameter function, the final effect is a diminishing one

\textsuperscript{22} Overcoming a grave acute illness leads to a more positive attitude towards life.
while the acute episodes are faced with additional AA. The main difference with the pure OAII case is in the psychological impact of the acute attacks: if the satisfaction and certainty of recovery prevails\textsuperscript{23}, via the effect of HS and H3, we expect such individuals to be happier than the individuals hit by OAII, if to prevail is the fear and negative expectation about next sudden attack the global happiness is expected to be lower than in the case OAII. We predict that, for such individuals, the infra-group variability in happiness score is the greatest, and that shifts in happiness scores are unforeseeable.

- **Of individuals’ characteristics**

The analytical effect of individuals’ characteristics in the model is very similar to that of adaptation activity, with the difference that, pertaining to inbuilt features of the individual, they have no costs. We can write:

\[
\begin{align*}
\frac{\delta HAP}{\delta ICh} & = \frac{\delta H1}{\delta ICh} + \frac{\delta H2}{\delta ICh} + \frac{\delta H3}{\delta ICh} + \frac{\delta f}{\delta h} + \frac{\delta m}{\delta WBO} \left[ \frac{\delta WBO}{\delta \beta_{21}} + \frac{\delta HAP}{\delta \AA|FG} + \frac{\delta ICh}{\delta \AA|FG} \right] \\
\frac{\delta p}{\delta v} + \frac{\delta f}{\delta h} + \frac{\delta h}{\delta ICh_{t-1}} + \frac{\delta p}{\delta v} + \frac{\delta f}{\delta h} + \frac{\delta h}{\delta ICh_{t-2}} + \ldots + \frac{\delta p}{\delta v} + \frac{\delta f}{\delta h} + \frac{\delta h}{\delta ICh_{t}}
\end{align*}
\]

We expect that the main channel through for individuals’ characteristics to affect happiness is a cognitive-behavioural one, via their effect on H1 and H3, while the contrast to the reduction in well-being opportunities, being mediated mainly by the improvements in physical health dimensions may, in some cases, be negligible.

According to the literature we recognize that among individuals’ characteristics more conducive to happiness the optimism, openness, conscientiousness, agreeableness, extraversion, while neuroticism should have a negative effect.

**Verifying the theory**

**Specification**

A provisional attempt to verify the theory is based on the following steps. First, we do not dispose of any information on *direct adaptation activity* as such, so we cannot test neither its amount nor its responsiveness to costs. Nonetheless, if we are ready to assume that indirect informations on adaptation can be guessed by both happiness function and health function, we can proceed with the analysis. Let’s consider *conditional* distributions of happiness and health: our analysis will be confined to potentially adapting/adapted individuals, i.e. individuals that we suppose may be performing/have already performed some unknown type and amount of adaptation activity\textsuperscript{24}.

\textsuperscript{23} The fear associated with new episodes is lower if the recovery from a preceding episode has been full and sufficiently rapid.

\textsuperscript{24} We assume in our empirical analysis that all individuals experiencing illnesses or disabilities are candidates for adaptation and do perform some amount of AA: we can then treat the variable AA as a discrete random variable assuming the value 1.
We can write, starting from equation 7 representing global happiness function, the conditional function:

\[
HAP | AA_{pk} = \varphi (ICh_{it}, Ill_{km} | FG_{t}, \Delta_{AA} | FG_{t}, WBO_{it}/WBO_{ik}^{I}, WBO_{it}, \Delta Inc_{it}, \sum CAA_{it}^{p}\Delta_{HS} | FG_{t}, \sum H_{i,k}^{t} + \varepsilon_{it} \text{ with } \varepsilon = N(0,1)
\]

\[
HEALTH | AA_{pk} = \psi (ICh_{it}, Ill_{km}, | FG_{t}, \Delta_{AA} | FG_{t}, \sum CAA_{it}^{p}\Delta_{HS} | FG_{t}) + \varepsilon \text{ with } \varepsilon = N(0,1)
\]

In 8, call AD.Happiness the happiness conditional on Adaptation activity, and AD.Health the same for health. Do consider that we dispose only of cross-sectional data\(^{25}\); we cannot consider any past variable such as WBO, H2, H1. We should, moreover, express health components such as: \(Ill_{km}, FG_{t}, \Delta_{AA} | FG_{t}, \sum CAA_{it}^{p}\Delta_{HS} | FG_{t}\) with measurable items blending at time \(t\) initial illnesses, disabilities, symptoms and the effects on health of contrasting actions such the effects of health services utilized and of adaptation activity. We add a further impossibility: we are at the moment unable to take account of our notion of “reference group” effect\(^{26}\), as expressed for each illness/disability group by the ratio between the individual and the average WBO sets. Coming to income variation, we are not able to measure it correctly because we could not compute the monetary costs of health services, and because we have only used an approximate ordinal measure for the monetary costs of AA. Finally, we consider individual characteristics relevant from the point of view of health (socio-demographics) to be a subset of those relevant for happiness.

The restrictions we have now mentioned imply that we can estimate only a limited portion of our original model: we can then write a more compact version of the above functions (8.):

AD.HAPPINESS* = f(Socio-Demographic, Relationship factors, Individual Characteristics, Adaptation costs, Ad-Health) + e

AD.HEALTH* = g(Socio-Demographic, Chronic Illnesses, Disabilities, Symptoms, Adaption costs) + v

As a second step we assume that the same unknown amount of adaptation activity, after controlling for some covariates, has different effects on happiness function and on health: as we said in page 4, we believe that adaptation has a greater productivity or success in terms of happiness than in terms of health. Let’s now define the success in (active) adaptation as the difference between self-reported happiness score and self-reported health score: the greater the difference the wider the success of adaptation. For us adaptation widen (increases) the gap, partially or totally, between health conditions, as subjectively assessed, and happiness conditions as expressed by individual evaluations contained in reports\(^{27}\). Our empirical task in this paper will be to assess which factors/variables are positively or negatively associated with such a success. Our test is then to be viewed as an assessment of factors helping/damaging successful adaptation: individual characteristics, illnesses types, illness duration, costs (approximated) of adaptation.

To be more precise, the idea behind such a metric is the following. Assume that the negative impact of an illness on health conditions (as stated in the survey responses) remains stable or

\(^{25}\) See the paragraph of data

\(^{26}\) See p. 7

\(^{27}\) Thus differing, among others, from Borghesi, Vercelli 2007, that seem to consider health states physiologically defined as objective measures of (un) happiness and individuals’ responses (assessed directly or indirectly) as subjective measures of (un) happiness.
just slowly decreases over time because of physical adaptation and habituation. Assume also
that the negative impact of the same illness on happiness (as stated), because of physical,
cognitive and behavioural adaptation, is either lower or faster decreasing over time as compared
to that on health. The difference in scores gives a broad idea of, at least, cognitive and
behavioural adaptation, that we call active adaptation. It should be noticed that our measure of
results of cognitive/behavioural adaptation works even with illnesses that are worsening in time:
in such a case adaptation cannot prevent health conditions and happiness from worsening, but
possibly adapted happiness worsen less than health.
Let’s now compute \( \text{AD.HAPPINESS* – AD.HEALTH*} \): by substituting adapted health in the
adapted happiness function, we get:

\[
\text{AD.HAPPINESS* – AD.HEALTH*} = f(\ldots) - g(\ldots) + z
\]

We derive the expected results of adaptation activity by looking at the likely magnitudes of
adaptation effects on the two functions: as an example, if there is active adaptation the negative
impact of health factors affecting \( g(\ldots) \) on happiness is attenuated with respect to their negative
impact on health: the resulting function will then show positive coefficients for Chronic Illnesses,
Disabilities and Symptoms.

In particular:
\[
\text{AD.HAPPINESS* – AD.HEALTH*} = h(\text{Socio-Demographic}, \text{Relationship Factors}, \text{Individual
Characteristics}, \text{Adaptation costs}, \text{Chronic Illnesses}, \text{Disabilities}, \text{Symptoms}) + z
\]

The coefficients of Socio-Demographic variables will be positive if their impact on happiness is
higher with respect to their effect on health; the coefficients of Relationship factors and
Individual Characteristics variables are just only those expected from the estimate of happiness
function alone. Coming to the coefficients of Adaptation costs, they will be positive if their
negative impact on happiness is lower than their negative impact on health \( |f(-) - g(-)| \) with
\( |g(-)| > |f(-)| \): this is the case probably for physical and non pecuniary costs (fatigue, effort,
etc.), while the reverse may be true for monetary costs, affecting mainly happiness and to a
minor extent health. Finally, we expect that the coefficients for Chronic Illnesses, Disabilities
and Symptoms, negative for happiness but lower in absolute value than for health will be
positive, resulting from \( f(-) - g(-) \) with \( |g(-)| > |f(-)| \).

A positive coefficient for health variables implies then active adaptation, while a negative
coefficient implies lack of active adaptation.

Moreover if we add to the specification the variable “Time since the health shock occurred”, we have:
\[
\text{AD.HAPPINESS**} = f(\text{Socio-Demographic}, \text{Relationship factors}, \text{Individual Characteristics},
\text{Adaptation costs}, \text{Time since health shock}, \text{Ad.Health}) + e
\]
\[
\text{AD.HEALTH**} = g(\text{Socio-Demographic}, \text{Chronic Illnesses}, \text{Disabilities}, \text{Symptoms},
\text{Adaptation costs}, \text{Time since health shock}) + \nu
\]

The elapsing of time can be assumed to produce habituation, namely passive physical adaptation
to bad health conditions: if we can safely assume that the passive elapsing of time has just a low
impact on happiness while it has a stronger effect on self-assessed health (see for a test of
elapsing of time on health Wu, 2001), then if the elapsing of time has a positive effect on
health, we expect a negative coefficient for the time variable of a specific illness, while the
reverse is true for a negative effect of time on health conditions, i.e. for illnesses that increase
their gravity. We will compute the ** version in our second specification.

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28 We are assuming that the illness is either a chronic one, or implies disabilities, such that
a “cure” cannot bring to a full recovery, and to perfect health.
Data
The Data base utilised in the empirical analysis is the first wave (version 2.0.1) of the SHARE Survey of health, ageing and retirement in Europe, an inclusive cross-section sample of people aged over fifty in many European countries (www.share-project.org). This survey permits to analyze all the factors specified above (we shall give a detail of the variables used discussing the results of econometric analysis): a preliminary stage is the construction of the dependent variable Adaptation=Ad.Happiness-Ad.Health. Having in the survey the happiness variable a four item coding, while health variable has a five item coding, we first homogenize the two by joining in a same category the two answers very good-good for health conditions. We then selected, in the sample of people aged over fifty, all individuals experiencing an illness or disability: we coded increased happiness and health variables from 1 to 4 (lower values correspond to lower happiness and lower health) and we subtracted health code from happiness code. The resulting variable assumed to represent adaptation has the maximum value of 3 - very satisfied with life (4) minus very bad health (1) - and its scale is an interval one, irresponsive in the parity cases to the absolute levels of the different variables. A further restriction - being interested in adaptation among ill people - is that we dropped all cases in which health is better than happiness, i.e. negative values of the generated dependent variables.

Results
The estimating method is an usual ordered probit, obtained by a linearized version of the above defined equation: we assume that the values of the dependent variable obtained represent an ordered discrete categorical variable. The results of the first specification are reported below:

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29 We began the empirical analysis when only SHARE longitudinal data were available. We are considering the possibility of further testing the model with the now available panel data.

30 This paper uses data from Release 2.0.1 of SHARE 2007. The SHARE data collection has been primarily funded by the European Commission through the 5th framework programme (project QLK6-CT-2001-00360 in the thematic programme Quality of Life). Additional funding came from the US National Institute on Ageing (U01 AG09740-13S2, P01 AG005842, P01 AG08291, P30 AG12815, Y1-AG-4553-01 and OGHA 04-064). Data collection in Austria (through the Austrian Science Foundation, FWF), Belgium (through the Belgian Science Policy Office) and Switzerland (through BBW/OFES/UFES) was nationally funded. The SHARE data collection in Israel was funded by the US National Institute on Aging (R21 AG025169), by the German-Israeli Foundation for Scientific Research and Development (G.I.F.), and by the National Insurance Institute of Israel. Further support by the European Commission through the 6th framework program (projects SHARE-I3, RII-CT-2006-062193, and COMPARE, 028857) is gratefully acknowledged. The SHARE data set is introduced in Börsch-Supan et al. (2005); methodological details are contained in Börsch-Supan and Jürges (2005).

31 The happiness variable is more precisely a life-satisfaction one: the question is framed “How satisfied are you with your life in general?”, and the possible answers are: Very satisfied, Somewhat satisfied, Somewhat dissatisfied, Very satisfied. To the possible objection that satisfaction does not coincide with happiness, we observe that no data connecting directly happiness and health were available to us. Moreover, the correlation between life satisfaction and happiness in other surveys (ESS version 2, scores from 0 to 10 for each variable) appear satisfactory (though with exceptions such as Italy) reaching a value of 0.55 (Italy excluded).

32 Very good, Good, Fair, Bad, Very bad.
Ordered probit regression

| Term          | Coef.   | Std. Err. | z     | P>|z|  | [95% Conf. Interval] |
|---------------|---------|-----------|-------|------|----------------------|
| new_g34r1     | 0.107668| 0.042366  | 2.60  | 0.009| 0.0259047 - 0.183629|
| new_g38_al    | 0.2491428| 0.042836  | 5.88  | 0.000| 0.1660666 - 0.3322191|
| ph006d01      | 0.0795102| 0.0406749 | 2.40  | 0.017| 0.017789 - 0.1772315|
| ph006d02      | -0.0711301| 0.0336333 | -2.11 | 0.034| -0.1370503 - 0.00521|
| new_co007_3   | -0.1782387| 0.0406773 | -4.38 | 0.000| -0.2579648 - 0.0985126|
| q4md          | 0.106225 | 0.0446458 | 2.38  | 0.017| 0.0187209 - 0.193779|
| q2id          | 0.2010971| 0.0394477 | 5.10  | 0.000| 0.123781 - 0.2784132|
| q2hd          | 0.109216 | 0.0442786 | 2.45  | 0.014| 0.0215072 - 0.1950761|
| ph006d07      | 0.1967337| 0.0612548 | 3.21  | 0.001| 0.0766764 - 0.316791|
| new_lsecd_r2  | -0.1327517| 0.0400506 | -3.31 | 0.001| -0.2112493 - 0.0542541|
| new_dno14_1   | -0.1045198| 0.037911  | 2.76  | 0.006| 0.0302155 - 0.178824|
| new_g34r6     | 0.4839676| 0.1425588 | 3.39  | 0.001| 0.2045045 - 0.7634307|
| new_ep005_1   | -0.1183038| 0.0398177 | -2.85 | 0.004| -0.191645 - 0.0355626|
| q4jd          | -0.110179 | 0.0493733 | 2.23  | 0.026| 0.0314091 - 0.2069479|
| ph006d13      | -0.2870831| 0.0518744 | -5.53 | 0.000| -0.3887551 - 0.1854111|
| ph006d14      | 0.1878715| 0.0863612 | 2.18  | 0.030| 0.0186065 - 0.3571364|
| numeracy      | -0.0696928| 0.0158896 | -4.39 | 0.000| -0.1008358 - 0.0385498|
| new_ep005_2   | -0.3864747| 0.0624262 | -6.19 | 0.000| -0.5082729 - 0.2641215|
| eurod         | 0.039751 | 0.0084313 | 4.03  | 0.000| 0.0174501 - 0.0605027|
| q4hd          | 0.2831152| 0.0620026 | -4.57 | 0.000| -0.404638 - 0.1615924|
| aiufam        | 0.162854 | 0.0445502 | 3.64  | 0.000| 0.0705686 - 0.2497022|
| q4dd          | -0.1159528| 0.0402053 | -2.88 | 0.004| -0.1947538 - 0.0371518|
| symptoms      | 0.0860921| 0.0104219 | 8.26  | 0.000| 0.0565672 - 0.1061586|
| q2ad          | -0.2180277| 0.0431533 | 5.07  | 0.000| 0.1342237 - 0.3033816|
| nb_hlp        | 0.0578503| 0.0152206 | 3.80  | 0.000| 0.0280185 - 0.0876821|
| q4nd          | 0.1170111| 0.0364329 | -3.07 | 0.002| -0.1831082 - 0.040294|
| phactiv       | -0.3824946| 0.0456587 | 8.38  | 0.000| 0.2930052 - 0.4719844|
| q2gd          | 0.1554394| 0.0397173 | 3.91  | 0.000| 0.077595 - 0.2352838|
| maxgrip       | -0.0096114| 0.0015089 | -6.37 | 0.000| -0.0125689 - 0.006654|
| q4ad          | -0.1375558| 0.0622245 | -2.21 | 0.027| -0.2595136 - 0.015598|
| q2jd          | -0.2130506| 0.0445034 | -4.79 | 0.000| -0.3002749 - 0.1258263|
| q2fd          | -0.1746669| 0.0428076 | -4.08 | 0.000| -0.2584682 - 0.0906656|
| ac002d3       | -0.1091292| 0.0488792 | -2.23 | 0.026| -0.2049306 - 0.0133279|
| new_g34r5     | -0.671332| 0.31904  | -2.10 | 0.035| 1.2986639 - 0.460251|
| new_co007_1   | 0.1390585| 0.0571887 | 2.43  | 0.015| 0.0269708 - 0.2511463|
| q3cd          | 0.1789374| 0.0387531 | 4.62  | 0.000| 0.1029828 - 0.2548921|

Number of obs = 6151
LR chi2(36) = 1097.73
Prob > chi2 = 0.0000
Pseudo R2 = 0.1097

Log likelihood = -4454.9712

33 We used a backward stepwise approach, so that the included variables are only those significant at the 5% level, among the many more encompassed in the original specification. Not significant, first stage, variables' coefficients may represent the theoretical case of very close effects of such a variable on both happiness and health. Further specifications, differing only for the treatment of the variable education (expressed as less than 10 years of education), very similar to those proposed, are available upon request.
The second specification, instead, gives the following results:

| piuflenu        | Coef.     | Std. Err. | z      | P>|z|      | [95% Conf. Interval] |
|-----------------|-----------|-----------|--------|----------|----------------------|
| q3cd            | 0.1775601 | 0.0388844 | 4.57   | 0.000    | 0.103402             | 0.25378               |
| new_q38_a1      | 0.2491088 | 0.0425591 | 5.85   | 0.000    | 0.1656945            | 0.332523              |
| ph006d01        | 0.0909733 | 0.0407389 | 2.21   | 0.027    | 0.012235             | 0.159917              |
| q2fd            | -0.174542 | 0.0428933 | 4.07   | 0.000    | -0.2586117           | -0.090472             |
| q4md            | 0.1031871 | 0.0447458 | 2.31   | 0.021    | 0.015487             | 0.1908871             |
| new_dn014_1     | 0.1044734 | 0.0379518 | 2.75   | 0.006    | 0.0300891            | 0.1788576             |
| q4hd            | -0.2929226 | 0.0621753 | -4.71  | 0.000    | -0.4147841           | -0.1710612            |
| ph006d06        | -0.1579343 | 0.0757699 | 2.08   | 0.037    | 0.009428             | 0.3064406             |
| ph006d07        | 0.1859911 | 0.0632203 | 2.94   | 0.003    | 0.0620815            | 0.3099005             |
| ph006d08        | -0.1778889 | 0.0512508 | -3.47  | 0.001    | -0.2783387           | -0.0774391            |
| new_ep005_1     | -0.1145293 | 0.0397824 | -2.87  | 0.004    | -0.1926777           | -0.0363808            |
| new_q34r5       | -0.7055464 | 0.3230605 | -2.18  | 0.029    | -1.3387333           | -0.0725396            |
| q4nd            | -0.1075574 | 0.036444  | -2.95  | 0.003    | -0.1789785           | -0.0361363            |
| q2ad            | 0.2103344 | 0.0433076 | 4.86   | 0.000    | 0.1254521            | 0.2952148             |
| ph006d13        | -0.2877995 | 0.0521785 | -5.52  | 0.000    | -0.3900674           | -0.1855316            |
| ph006d14        | 0.1924812 | 0.0685764 | 2.22   | 0.026    | 0.0272906            | 0.3621718             |
| ac002d3         | -0.1098273 | 0.0489482 | -2.24  | 0.025    | -0.2057639           | -0.0138907            |
| phactiv         | 0.3752213 | 0.0457453 | 8.20   | 0.000    | 0.2855531            | 0.4648715             |
| q2gd            | 0.1518565 | 0.093776  | 3.82   | 0.000    | 0.073897             | 0.229816              |
| new_ep005_2     | -0.3701145 | 0.0623324 | -5.94  | 0.000    | -0.4922837           | -0.2479452            |
| q2hd            | 0.1050565 | 0.0443344 | 2.37   | 0.018    | 0.0181634            | 0.1919496             |
| yph09_6         | -0.0690080 | 0.0289877 | -2.38  | 0.017    | -0.1258008           | -0.0012215            |
| q4ad            | -0.1257419 | 0.0623453 | -2.02  | 0.044    | -0.2479363           | -0.0035474            |
| yph04_8         | 0.0020216 | 0.0062672 | 0.22   | 0.013    | 0.0020216            | 0.0010548             |
| maxgrip         | -0.0100543 | 0.0015185 | -6.62  | 0.000    | -0.0130305           | -0.0070782            |
| q2id            | 0.2013146 | 0.0395472 | 5.09   | 0.000    | 0.1238036            | 0.2788257             |
| q4jd            | 0.1154537 | 0.0494193 | 2.34   | 0.019    | 0.0185937            | 0.2123136             |
| new_q34r6       | 0.4672072 | 0.1428402 | 3.27   | 0.001    | 0.1872455            | 0.7471689             |
| new_q34r1       | 0.0990236 | 0.0404264 | 2.45   | 0.014    | 0.0197894            | 0.1782578             |
| new_co007_3     | -0.1902327 | 0.0408061 | -4.66  | 0.000    | -0.2702113           | -0.1102542            |
| aiufam          | 0.1509896 | 0.0447002 | 3.38   | 0.001    | 0.0633789            | 0.2386003             |
| numeracy        | -0.069837 | 0.1588981 | -4.39  | 0.000    | -0.1099968           | -0.0386773            |
| new_isced_r2    | -0.1307351 | 0.0410645 | -3.25  | 0.001    | -0.2094561           | -0.0520142            |
| eurod           | 0.0347576 | 0.0084526 | 4.11   | 0.000    | 0.0181907            | 0.0513244             |
| q4dd            | -0.1188049 | 0.0402687 | -2.95  | 0.003    | -0.1977302           | -0.0398796            |
| nb_help         | 0.0568604 | 0.0152361 | 3.73   | 0.000    | 0.0259981            | 0.0867226             |
| q2jd            | -0.2115282 | 0.0445613 | -4.75  | 0.000    | -0.2988666           | -0.1241897            |
| symptoms        | 0.0848407 | 0.0107434 | 7.90   | 0.000    | 0.0637848            | 0.1058974             |
| new_co007_1     | 0.1473387 | 0.057267  | 2.57   | 0.010    | 0.0350975            | 0.259585              |

We also tried a third and a fourth specifications with country indicator variables included.³⁴

³⁴ The omitted country is Israel. We also drop Denmark for estimation problems.
## Ordered probit regression

| puifeu | Coef. | Std. Err. | z      | P>|z|   | [95% Conf. Interval] |
|--------|-------|-----------|--------|--------|----------------------|
| q4ad   | -0.1438249 | 0.062398 | 2.30   | 0.021 | -0.2661226           |
| new_q34r5 | -0.789163 | 0.313673 | 2.52   | 0.012 | -1.403957            |
| q4dd   | -0.1114174 | 0.0404218 | -2.76  | 0.006 | -0.190655            |
| q7d   | -0.1666935 | 0.0429545 | -3.88  | 0.000 | -0.2508828           |
| ac02d5 | -0.1047157 | 0.05117 | -2.04  | 0.042 | -0.204467            |
| new_country6 | -0.438261 | 0.093035 | -4.89  | 0.000 | -0.5348941           |
| new_country7 | -0.5793829 | 0.064701 | -8.46  | 0.000 | -0.7135818           |
| new_country9 | -0.2413612 | 0.0962505 | -2.51  | 0.012 | -0.4300283           |
| new_count-10 | -0.5200648 | 0.148222 | -3.51  | 0.000 | -0.8105746           |
| new_count-11 | -0.2026049 | 0.0948146 | -2.14  | 0.033 | -0.388438            |
| q2jd   | -0.1664432 | 0.0447976 | -3.72  | 0.000 | -0.2524448           |
| new_q38_a1 | 0.2183421 | 0.0408247 | 5.35   | 0.000 | 0.1383272            |
| ph006d01 | 0.1163675 | 0.0407405 | 2.86   | 0.004 | 0.0365177            |
| ph006d02 | -0.0696536 | 0.0338447 | -2.06  | 0.040 | -0.13599            |
| q2id   | 0.1968527 | 0.0394445 | 4.99   | 0.000 | 0.1195428           |
| q2cd   | 0.1623215 | 0.0650044 | 2.50   | 0.013 | 0.0349153           |
| new_ep005_2 | -0.3069911 | 0.0560552 | -5.48  | 0.000 | -0.4168572           |
| new_co007_1 | 0.1269327 | 0.0575717 | 2.20   | 0.027 | 0.0490423           |
| ph006d07 | 0.2138394 | 0.0615743 | 3.47   | 0.001 | 0.093156             |
| q4nd   | -0.1125944 | 0.0365674 | -3.08  | 0.002 | -0.1842652           |
| new_cn014_1 | 0.1175611 | 0.037939 | 3.10   | 0.002 | 0.043202             |
| new_q34r6 | 0.4104114 | 0.1426172 | 2.90   | 0.004 | 0.1344868            |
| q4md   | 0.1490553 | 0.043387 | 3.44   | 0.001 | 0.0640183            |
| q3cd   | 0.1786839 | 0.0386855 | 4.62   | 0.000 | 0.1028617            |
| ph006d13 | -0.3100814 | 0.0520444 | -5.96  | 0.000 | -0.4120865           |
| phactiv | 0.4134892 | 0.045698 | 9.05   | 0.000 | 0.3239227            |
| numeracy | -0.0637848 | 0.0156548 | -4.07  | 0.000 | -0.094667            |
| new_co007_3 | -0.1823859 | 0.0408456 | -4.47  | 0.000 | -0.2624419           |
| euro05 | 0.0331346 | 0.0084296 | 3.95   | 0.000 | 0.0167967            |
| maxgrip | -0.009591 | 0.0015158 | -6.35  | 0.000 | -0.012552            |
| aiufam | 0.1813898 | 0.046871 | 4.06   | 0.000 | 0.0939046            |
| nb_help | 0.0587138 | 0.0152282 | 3.86   | 0.000 | 0.028867            |
| symptoms | 0.0832136 | 0.0104485 | 7.96   | 0.000 | 0.062735             |
| q4hd   | 0.1628287 | 0.0426628 | 3.82   | 0.000 | 0.0792651            |
| q4hd   | -0.2840395 | 0.0618402 | -4.59  | 0.000 | -0.4052441           |
| q2ad   | 0.2036281 | 0.0437519 | 4.65   | 0.000 | 0.1178759            |

```
Number of obs   =   6151
LR chi2(36)     =   1186.36
Prob > chi2      =   0.0000
Pseudo R2        =   0.1185
```

Log likelihood = -4410.6563
Ordered probit regression

| Variable       | Coef. | Std. Err. | z     | P>|z| | [95% Conf. Interval] |
|----------------|-------|-----------|-------|-----|---------------------|
| q2jd           | -.1635884 | .0448849 | -3.64  | 0.000 | -.2515612 to -.0756156 |
| new_co007_3    | -.1770787 | .0409926 | -4.32  | 0.000 | -.2574227 to -.0967347 |
| new_dn014_1    | .124977  | .0381011 | 3.28   | 0.001 | .0503002 to .1996538 |
| alufam         | .1802307 | .0449871 | 4.01   | 0.000 | .0902576 to .2684037 |
| maxgrip        | -.0096117 | .0015222 | -6.31  | 0.000 | -.0123592 to -.0066281 |
| new_country6   | -.4551394 | .0499158 | -9.12  | 0.000 | -.5529716 to -.3573058 |
| new_country7   | -.5941977 | .0690253 | -8.61  | 0.000 | -.7294848 to -.4589106 |
| new_country9   | -.2557759 | .0966194 | -2.65  | 0.008 | -.4451465 to -.0664053 |
| new_count-10   | -.5230573 | .1487573 | -3.52  | 0.000 | -.8146163 to -.2314983 |
| new_count-11   | -.2062648 | .0940009 | -2.17  | 0.030 | -.3922449 to -.0202445 |
| q2id           | .1937666 | .0396693 | 4.88   | 0.000 | .1160162 to .2715169 |
| new_q38_a1     | .208904  | .0416191 | 5.02   | 0.000 | .127332 to .290476   |
| q2ad           | .1807407 | .0536489 | 3.37   | 0.001 | .0755909 to .2858906 |
| ph006d01       | .400814  | .1429372 | 2.80   | 0.005 | .1206622 to .6809657 |
| q4md           | .1448229 | .0434713 | 3.31   | 0.001 | .0588205 to .2322449 |
| q4nd           | -.1064   | .0366654 | -2.90  | 0.004 | -.178263 to -.0354371 |
| q2cd           | -.1745099 | .0651714 | -2.68  | 0.007 | .0467711 to .3022488 |
| q2ad           | .203087  | .0440583 | 4.61   | 0.000 | .1167344 to .2894397 |
| ph006d07       | .2066881 | .0617772 | 3.35   | 0.001 | .0856070 to .3277692 |
| ph006d08       | -.1316426 | .0519271 | -2.54  | 0.011 | -.2343174 to -.0289707 |
| ph006d09       | -.1910324 | .0725381 | -2.64  | 0.008 | -.3334745 to -.0491303 |
| ph006d10       | .2307767 | .0970248 | 2.92   | 0.003 | .0758911 to .3856624 |
| q2f            | -.157744 | .0430474 | -3.66  | 0.000 | -.2421112 to -.0733687 |
| new_ep005_2    | -.2917122 | .0561712 | -5.19  | 0.000 | -.4018144 to -.1816285 |
| ph006d13       | -.3278531 | .0525376 | -6.16  | 0.000 | -.4267572 to -.2208143 |
| nb-help        | .6062012 | .0152451 | 3.95   | 0.000 | .0303213 to .0900811 |
| yph009_1       | -.0055215 | .00265 | -2.08  | 0.037 | -.0107154 to -.0003277 |
| phactv         | .3985135 | .0459416 | 8.67   | 0.000 | .3084696 to .4885575 |
| new_co007_1    | .131976  | .0576873 | 2.29   | 0.022 | .0183939 to .2450131 |
| symptom        | .0100856 | .007771  | 1.31   | 0.095 | .0003041 to .0204501 |
| q4ad           | -.1386974 | .0627006 | -2.21  | 0.027 | -.2615883 to -.0158065 |
| eurod          | .032304  | .0084644 | 3.82   | 0.000 | .0157142 to .0488938 |
| q2hd           | .1528255 | .0428159 | 3.57   | 0.000 | .0689078 to .2367431 |
| yph009_8       | .0066975 | .0020627 | 3.25   | 0.001 | .0026548 to .0107402 |
| yph009_9       | .0092216 | .0041098 | 2.24   | 0.025 | .0011672 to .0172762 |
| yph009_10      | -.0131474 | .0062439 | -2.11  | 0.035 | -.0253853 to -.009095 |
| q4d            | -.1091332 | .0406479 | -2.68  | 0.007 | -.1888015 to -.0294649 |
| ac002d5        | -.1169547 | .0512989 | -2.28  | 0.023 | -.2174988 to -.0164107 |
| q3cd           | .0389001 | .0108578 | 3.75   | 0.000 | .0282000 to .0496079 |
| q4hd           | -.2820585 | .0621491 | -4.54  | 0.000 | -.4033868 to -.1602485 |
| yph009_15      | -.003491  | .0014876 | -2.35  | 0.019 | -.0064065 to -.0005754 |
| numeracy       | -.0636164 | .0157084 | -4.05  | 0.000 | -.0944042 to -.0328286 |
| new_q34r5      | -.7840966 | .1362413 | -5.78  | 0.000 | -.1040481 to -.1641127 |

Log likelihood = -4394.1844

The legend of the variables and their effect on active adaptation is as follows:\textsuperscript{35}

\textbf{Socio-Demographic Variables:}

\textsuperscript{35} In parenthesis the numbers refers to the specifications in which the variable is present. From now on we shorten the term \textit{active adaptation} using just \textit{adaptation}. The variables starting with New_..=indicator variables and their interpretation is with respect to one or more omitted variables, ex. New_q38_a1: the positive effect is with respect to females. The omitted variables are: New_co.=refusal to answer or do not know; New_isced.=more than 10 years of school; New_dn.=separated, single, divorced, etc.; New_ep.=unemployed, homemaker,etc.; New_q34.=Non religious; New_country.=Israel.
New_q38_a1 = Male; Positive effect on adaptation (1,2,3,4)
New_co007_1 = Making ends meet with great difficulty; Positive effect on adaptation (1,2,3,4)
New_co007_3 = Making ends meet fairly easily; Negative effect on adaptation (1,2,3,4)
New_isced_r2 = Education level isced2 (max 10 years school); Negative effect on adaptation (1,2)
New_dn014_1 = Married and living with spouse; Positive effect on adaptation (1,2,3,4)
New_ep005_1 = Retired; Negative effect on adaptation (1,2)
New_ep005_2 = Employed or self-employed; Negative effect on adaptation (1,2,3,4)

Social support and religious network
Aiufam = Received effective help by family; Positive effect on adaptation (1,2,3,4)
Nb_help = Number of helps received from outside the family; Positive effect on adaptation (1,2,3,4)
Ac002d3 = Activity: provided help to family, friends, neigh.; Negative effect on adaptation (1,2)
Ac002d5 = Activity: gone to a sport, social or other kind of club; Negative effect on adaptation (3,4)
New_q34r1 = Religious affiliation: protestant; Positive effect on adaptation (1,2,3,4)
New_q34r5 = Religious affiliation: muslim; Negative effect on adaptation (1,2,3,4)
New_q34r6 = Religious affiliation: other religion; Positive effect on adaptation (1,2,3,4)

Individual Characteristics
Q2ad36 = My age prevents me from doing the things I would like to; Positive effect on adaptation (1,2,3,4)
Q2cd = I feel left out of things; Positive effect on adaptation (3,4)
Q2fd = Shortage of money stops me from doing the things I want to do; Negative effect on adaptation (1,2,3,4)
Q2gd = I look forward to each day; Positive effect on adaptation (1,2)
Q2hd = I feel that my life has a meaning; Positive effect on adaptation (1,2,3,4)
Q2id = On balance I look back on my life with a sense of happiness; Positive effect on adaptation (1,2,3,4)
Q2jd = I feel full of energy these days; Negative effect on adaptation (1,2,3,4)
Q3cd = I’m always optimistic about my future; Positive effect on adaptation (1,2,3,4)
Q4ad37 = I felt depressed; Negative effect on adaptation (1,2,3,4)
Q4dd = I was happy; Negative effect on adaptation (1,2,3,4)
Q4hd = I felt sad; Negative effect on adaptation (1,2,3,4)
Q4jd = I couldn’t get going; Positive effect on adaptation (1,2)
Q4md = I felt tired; Positive effect on adaptation (1,2,3,4)
Q4nd = I felt really rested when I woke up in the morning; Negative effect on adaptation (1,2,3,4)
Numeracy = Generated numeracy score; Negative effect on adaptation (1,2,3,4)
Maxgrip = Generated maximum of grip strength; Negative effect on adaptation (1,2,3,4)
Phactiv = Generated physical inactivity; Positive effect on adaptation (1,2,3,4)

36 All the Q2*d variables are dummies representing the Often and Sometimes answers to the question (ex. Q2ad= value 1 if often or sometimes age prevents me from doing the things I would like to)
37 All the Q4*d variables are dummies representing the Almost all the time and Most of the time (during the last week) answers to the question (ex. Q4ad= value 1 if Almost all of the time or Most of the time I felt depressed)
Chronic Illnesses
Ph006d01= Suffering from: Heart attack or other heart problems; Positive effect on adaptation (1,2,3,4)
Ph006d02= Suffering from: High blood pressure; Negative effect on adaptation (1,3)
Ph006d06= Suffering from: Chronic lung disease; Positive effect on adaptation (2)
Ph006d07= Suffering from: Asthma; Positive effect on adaptation (1,2,3,4)
Ph006d08= Suffering from: Arthritis or Rheumatism; Negative effect on adaptation (2,4)
Ph006d09= Suffering from: Osteoporosis; Negative effect on adaptation (4)
Ph006d10= Suffering from: Cancer or malignant tumour; Positive effect on adaptation (4)
Ph006d13= Suffering from: Cataracts; Negative effect on adaptation (1,2,3,4)
Ph006d14= Suffering from: Hip or femoral fracture; Positive effect on adaptation (1,2)
Eurod= Generated depression scale; Positive effect on adaptation (1,2,3,4)

Symptoms
Symptoms= Generated number of symptoms; Positive effect on adaptation (1,2,3,4)

Time since illness start
Yph009_1=Years since illness start: Heart attack ; Positive effect of habituation on health(4)
Yph009_6=Years since illness start: Chronic lung disease ; Positive effect of habituation on health(2)
Yph009_8=Years since illness start: Arthritis or Rheumatism ; Negative effect of habituation on health (2,4)
Yph009_9=Years since illness start: Osteoporosis ; Negative effect of habituation on health(4)
Yph009_10=Years since illness start: Cancer ; Positive effect of habituation on health(4)
Yph009_15=Years since illness start: Other conditions ; Positive effect of habituation on health(2)

Countries
New_country6= Italy; Negative effect on adaptation
New_country7= France; Negative effect on adaptation
New_country9= Greece; Negative effect on adaptation
New_country10= Switzerland; Negative effect on adaptation
New_country11= Belgium; Negative effect on adaptation

The relative strength of each factor can be grasped if we normalize the coefficients – in order to express them in the usual space 0-1 – by dividing their value by the distance between the upper and lower cut-points deriving by the ordered probit estimate\(^\text{38}\). As an example, take specification 1: the difference \(\text{cut}3-\text{cut}1=2.4975909\) can be used to divide the value of the coefficients. Taking for example the effect of the optimism variable \(Q3cd=\text{I’m always optimistic about my future}\), with coefficient 0.1789374, we have \(0.1789374/2.4975909=0.0716\): we conclude that being optimistic about the future increases adaptation by 7.16 percentage points.

Discussion
The four specifications are somewhat similar: the first and third specifications include, at the end of stepwise selection, 36 significant variables, while the second has 39 explanatory variables

\(^{38}\) Se for the procedure Cutler-Richardson 1997
and the fourth 43 significant variables (among many more included in the first step): specifications 2 and 4 have new variables included to represent pure habituation, i.e. the years since illness start, while specifications 3 and 4 include country variables.

The signs are often as expected (with some exceptions):

1. Males adapt more than females;
2. A great deal of illnesses are associated with positive adaptation: Heart attack, Chronic lung disease, Asthma, Cancer, Hip/femoral fracture, while there are some other showing negative adaptation: High blood pressure, Arthritis or Rheumatism, Osteoporosis, Cataracts. The rationale for this is that may be the treatment of high blood pressure or the bad expectations linked to the illness make difficult the adaptation; visual impairments (cataract) are among those difficult to fight against, and arthritis-rheumatism and osteoporosis are either very painful or socially limiting, without any prospect of improvement;
3. The elapsing of time produces habituation: by looking at the variable time since the illness start, we find that it confirms what we found for adaptation. For Heart attack, Chronic lung disease, Cancer, Other conditions, there is a positive effect of habituation (elapsing of time) on health conditions, while for Arthritis or Rheumatism, Osteoporosis the effect on health is negative;
4. Being married and living together has a positive effect on adaptation, as expected;
5. Having a mathematical mind is bad for adaptation (numeracy). Apparently a “scientific mind” as opposed to a “fideistic mind” (see also point 11) has more difficulties to accommodate to a situation perceived as “unmotivated”;
6. The more symptoms you have the more you adapt (in line with findings of literature about multiple stressors). It appears that, up to a certain limit within a linear analysis, there are scale economies in the production of adaptation;
7. Being depressed (Eurod index) seems to be associated positively to adaptation (the puzzling result is discussed later);
8. Physically strong individuals adapt less (Maxgrip);
9. Some social activities (giving help, sport/social) are associated with less adaptation. The result may reflect a wide range of situations: 1) a selection problem, in that to perform such activities you should have a good health; 2) an individual performing social activity could have less time to devote to adaptation activity (temporal cost of adaptation); 3) the impact of an health shock my be less easily accomodated by more active individuals that could use a “backward” looking strategy of coping (among the variables here discussed it is here evident the need for a panel data analysis);
10. The help network is important: having received effective help by the family, and number of helps received from outside the family, are both stimulating adaptation;
11. While religious activity is negatively associated to adaptation, praying by yourself is good for adaptation;
12. Religion affiliations more conducive to adaptation are: protestant and other, while muslims adapt less;
13. Making ends meet fairly easily apparently damages adaptation, while Making ends meet with great difficulty increases it. It could represent a different attitude of the rich and the poor. Suppose two individuals, one rich and one poor, having the same illness: one could argue that more income could induce for the first, better health but not the same for

39 Of course from a cognitive point of view, being cataract easily cured with surgical procedures.
adaptation; while the lack of income stimulates for the second, will and cognitive adaptation. In fact this result may be a composition of two positive effects of income on both happiness and health: being the effect of income on health stronger than that of income on happiness, the final sign is negative. (we discuss later on a cost variable more closely linked with adaptation);

14. Leaving school at young age (14-15 years) is a negative factor for adaptation. Adolescence seems to be a critical period to start working, renouncing to acquire a “technology” of taking care of oneself by education;

15. Being employed or self employed and Being a pensioner are conducive to a greater adaptation with respect to other inactive groups: the need for earning seems to be a powerful engine for adaptation, as is an age factor represented by pensions;

16. Physical inactivity is associated with more adaptation;

17. Individual characteristics (variables Q) are the most important explanatory variables in the adaptation process:
   a. Positively associated with adaptation are variables expressing good mood and expectations, optimism, self-centering, etc: I look forward to each day, I feel that my life has a meaning, On balance I look back to my life with a sense of happiness, I’m always optimistic about my future;
   b. Negatively associated with adaptation are instead variables of depression: I felt depressed, I felt sad. The apparent opposite result of point 7 could be explained hypothesizing that the eurod index captures depression as a result of adaptation costs (depression as a result of having used too many resources in adapting), while the present variables capture lack of adaptation because of depression (depression as a barrier/cognitive cost to adaptation);
   c. Many individual answers, point instead uniquely towards an important feature of adaptation activity, namely that it is **costly in terms of energies and also money.** This point could be detected in the negative sign of answers such as: I had a lot of energy, I felt really rested when I woke up in the morning, I feel full of energy these days, and in the positive signs of: I feel left out of things, I felt tired, I couldn’t get going. This could mean that energy has been burned out in the process of adaptation. The money cost is represented by the negative sign of: Shortage of money stops me from doing the things I want to do;
   d. Age burden seems to be associated to more adaptation (Q2ad);
   e. An apparently hard to fix contradiction is that happiness experienced in the last week seems to be negatively associated to adaptation (Q4dd). According to our notion, happiness is made of three components (H1,H2,H3); we then consider that the answer happiness experienced in the last week refers only to the component H2, being considered just a “feeling” of happiness. In the point a. we saw that reminiscences flow of happiness H3 is positively related to adaptation (On balance I look back to my life with a sense of happiness). In the case of point e. this happiness variable may reflect some sort of **hedonic cost** of adaptation activity: in this respect one could be “unhappy” because he has “adapted” (this could raise a methodological issue: a momentary assessment method of calculating happiness could give the wrong answers in terms of adaptation, showing no adaptation when in fact adaptation is there);

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40 Note that this effect qualifies the apparent contradiction due to point 12 on making ends meet.
18. There seems to be a country effect in adaptation: Italy, France, Greece, Switzerland and Belgium are countries with relatively low adaptation (with respect with the omitted country Israel) while the other countries seem to behave in a similar way as the reference country.

Conclusions
Our empirical results seem then to prima facie confirm, what was expected, according to our model.
Personality traits are confirming their importance and often have the expected sign (positive for optimism, good mood, etc. and negative for depression).
Illness types are also important explanatory variables, having the expected positive sign for hearth attack, chronic lung disease, asthma (RMHI), hip/femoral fracture (OAIIRI), cancer (OAIIEIDI), and the expected negative sign for arthritis-rheumatisms, osteoporosis (EIDI), while hypertension shows a nature similar to EIDI, probably because of negative expectations.
Adaptation is costly, the costs being either a fatigue-physical costs or a monetary costs or hedonic costs: this may lead to underinvestment in adaptation activity if the benefits are perceived, because of the illness type or negative personality traits, as possibly lower than costs.
Finally, we tried to test if one of the assumptions of the model, namely that health services are less productive than adaptation activity in terms of happiness, is confirmed by data. Unfortunately, the metric used for adaptation prevents us from testing the direct effect of adaptation on happiness. We tested, nonetheless, the direct effect of health services’ use on happiness, finding that none of the utilization variables shows a significant positive effect on happiness, and concluding that just a minor effect of adaptation on happiness is sufficient to confirm the hypothesis of happiness superiority of adaptation activity.
Our policy conclusions are mainly two.
• Be cautious with the use of the “gross” happiness metric as a tool for setting reimbursement from law suits/litigations. In fact, in estimating happiness for this purpose, the neglect of any measurement of adaptation costs may result in an important underestimation of the total amount of health loss/damage: adaptation costs should be “added” to the loss in happiness. Analogous point, in resource allocation problems, the crude metric of QALY’s seems to encompass the results of habituation (in that the elapsing of time usually seems to affect positively the scoring). But it seems highly likely that QALY’s fall short of taking account both of cognitive adaptation (reflected on the difference between happiness scores and health scores/HRQL) and of their costs.
• Underfinancing, either public of private, of individual coping activities, mainly of the psychologic/behavioural type, may compromise the attainment of “potential” adaptation (given different illnesses and individual characteristics). Apparently this is the case in almost any health service system, where priority is given to “traditional” care services: sticking to the strict definition of health adopted by WHO since 1948, may justify more attention to the financing of adaptation activity.

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41 Though the evidence on this point is not clear-cut
42 Adaptation is in fact defined as happiness-health.
43 Such use was defined as number of GP visits, access to specialists, having received inpatient hospital care.
44 Results are available upon request.
The recent release of Wave 2 Share Data permits a longitudinal analysis that was precluded when we first started the empirical part of the study: we are planning to build on this possibility, by exploring the health consequences in wave 2 of individuals’ choices made in wave 1. Finally a more careful study of specific illnesses and of the adaptation behaviour linked to them is currently under scrutiny and will be implemented shortly.

References

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