Measuring Successful Aging with Respect for What Matters to Older Persons

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ABSTRACT

This paper explores how to measure successful aging in a manner consistent with the preferences of older persons about what matters in their lives. First it considers the extent to which existing objective and subjective measures of successful aging reflect those preferences. It is found that both objective and subjective measures may contradict preferences that are held unanimously by older persons. Subsequently a new measure of successful aging is proposed that is consistent with those preferences. The implementation of the preference-based measure is illustrated with data for 11 European countries from the Survey of Health, Ageing and Retirement in Europe (SHARE). The proposed measure is found to yield different results than existing objective and subjective measures in terms of how successful aging has evolved between 2007 and 2013, how countries are ranked for successful aging, and the shape of the age distribution of successful aging.

Keywords: Successful Aging, SHARE, Preferences

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1.   INTRODUCTION

The rapid aging of our societies poses formidable policy challenges in areas such as pensions, housing and social security. To evaluate the design and effectiveness of the policies concerned, it is essential that policy makers and researchers should have an operational yardstick for measuring the degree of "successful" aging (Havighurst 1961).[1] For more than five decades, social scientists – and gerontologists in particular – have tried to harness the elusive concept of successful aging into an appealing and operational measure. However, recent surveys find evidence of a wide diversity of measures and approaches with divergent implications and empirical findings (see, for instance, Cosco et al. 2013 and Martin et al. 2015).

Against the background of these diverse measures, an interesting question has come to the fore (Phelan and Larson 2002; Glass 2003; Bowling and Dieppe 2005): Who should define successful aging? Is this a matter for researchers and policy makers? Or should it be left to older persons themselves to assess whether or not they are aging successfully? Depending on possible answers to these questions, we distinguish between objective and subjective measures of successful aging. We define *objective* measures very generally as all measures reflecting what the researcher or policy maker regards to be successful aging. The influential work of Rowe and Kahn (1987, 1997) is a leading example of the objective approach. Rowe and Kahn (1997) consider an older person to be aging successfully so long as she complies with three criteria: freedom from disease and disability, high cognitive and physical functioning, and active engagement with life. *Subjective* measures, on the other hand, rely on direct judgments of the older persons about how successfully they are aging. Here we take as a leading example the approach proposed by Havighurst (1961), whereby successful aging is measured on the basis of self-reported life satisfaction. Older persons with a high life satisfaction score are considered to be aging successful, those with a low life satisfaction score are not.

In this paper, we first discuss the extent to which objective and subjective measures are consistent with the preferences of older persons with regard to what matters in their lives. To this end, we propose two litmus tests of respect for preferences – one relating to preferences in intrapersonal comparisons, and another relating to unanimously held preferences in interpersonal comparisons. Surprisingly, perhaps, we find that the objective approach fails the first test and that both approaches fail the second test. Therefore, we propose an alternative and novel preference-based approach for measuring successful aging. The proposed approach is based on the notion that "a definition of successful aging needs to include elements that matter to elderly people" (Bowling and Dieppe 2005: 1548). It introduces some recent insights from welfare economics regarding the measurement of multidimensional well-being into the field of gerontology (see Fleurbaey and Blanchet, 2013; Decancq et al. 2015a for surveys of these recent insights).

In the empirical section of the paper, we demonstrate how the preference-based approach can be implemented using European data from the Survey of Health, Ageing and Retirement in Europe (SHARE) between 2007 and 2013. To estimate the preferences of the older persons, we use a statistical model that relates self-rated evaluation of life satisfaction to objective circumstances of the respondents and to their personal reference values based on their aspirations, expectations and coping strategies.

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[1] In this paper, the label "successful aging" is used to refer to various similar concepts such as "active aging", "healthy aging", "positive aging", and "aging well".

Finally, we show that the objective, subjective and preference-based approaches yield very different results in terms of how successful aging has evolved between 2007 and 2013, how countries rank in this respect, and the age distribution of successful aging.

2. MEASURING SUCCESSFUL AGING

Let us first consider the objective and subjective approaches to the measurement of successful aging. Both approaches take into account the multidimensional nature of the notion of successful aging and address the question of how to combine these different dimensions into a single measure. However, they differ in terms of how they resolve these issues. In the objective (or research-defined) approach, the analyst combines the different dimensions in accordance with a predefined aggregation function or algorithm. In the subjective (or self-rated) approach, the aggregation of the multidimensional information is done by the older person herself.

The following notation is used to define and compare the two approaches. Let $x_i = \left(x_i^1, x_i^2, \dots, x_i^m\right)$ be a vector describing the circumstances or multidimensional life situation of older person i in the m different dimensions of life. For example, Rowe and Kahn (1997) measure successful aging relying on five dimensions: absence of disease and disability, cognitive and physical functional capacity, and engagement with life. Other researchers have considered broader sets of dimensions (Depp and Jeste 2006 provide a survey). Research by Phelan et al. (2004) and Cosco et al. (2013) confirms that older persons, too, adopt a multidimensional perspective when considering how successfully they are aging.

A measure of successful aging, denoted hereafter as $SA(\cdot)$, takes the life situation vector x_i as input and then returns a 1 or a 0, indicating whether the life situation is considered to be successful or not. This way, the measure incorporates a value judgment on the relative importance of the dimensions considered, thereby echoing the classical philosophical problem as to what constitutes a "good life". In this paper, we aim to make explicit such value judgments, in order to expose them to scrutiny and public debate. Subsequently, we compare them with the preferences of the older persons themselves.

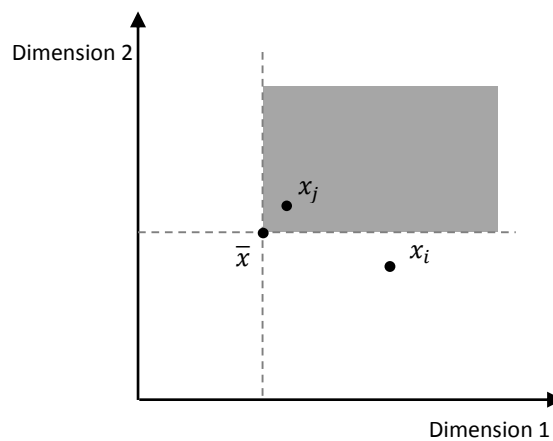## 2.1 The objective approach to successful aging

In the objective approach, the analyst selects a particular measure of successful aging and applies it to the multidimensional life vector of an older person to evaluate whether she is aging successfully or not. To keep the discussion tractable, we take the objective measures derived from Rowe and Kahn (1997) as a *pars pro toto* for the objective approach in general. The argument developed is easily extendable to objective measures with a similar (mathematical) structure.

Rowe and Kahn (1997) distinguish successful aging from usual aging and define an older person as aging successfully if her life situation scores better than a threshold value in *all* the dimensions considered. In their original approach, Rowe and Kahn (1987) set very high threshold values (e.g. total absence of disease and disability), resulting in very few older persons being categorized as aging successfully. Since then, other researchers have considered slightly lower thresholds (i.e. with allowance for minor disease and disability). In general, we write $\bar{x} = (\bar{x}^1, \bar{x}^2, \dots, \bar{x}^m)$ to denote the vector containing these m threshold values. An objective measure of successful aging derived from Rowe and Kahn (1997) is defined as follows.

DEFINITION 1 (Objective). $SA_{obj}(x_i) = 1$ if $x_i^1 \geq \bar{x}^1$ and ... and $x_i^m \geq \bar{x}^m$; and $SA_{obj}(x_i) = 0$ otherwise.

To implement the objective approach empirically, different authors have considered different lists of dimensions and thresholds.[2] The more dimensions are incorporated, the fewer older persons are considered to be aging successfully.

Figure 1 provides a graphical representation of the objective approach when there are two relevant dimensions ($m = 2$). Each point in the graph represents a life situation in its two dimensions. We define the dimensions in such a way that they adhere to the convention that more desirable situations are situated in the North-East part of the graph. We see that the older person in situation x_i scores better on the first dimension, but the older person in situation x_j scores better on the second dimension. The dashed lines in the figure reflect the threshold value in each dimension. The life situations which score above the threshold in both dimensions are considered instances of successful aging (the gray shaded area in Figure 1), whereas all other situations are cases where the older person is considered not to be aging successfully. Hence the older person in situation x_j is aging successfully, whereas the individual in situation x_i scores below the threshold value in dimension 2 and is therefore not aging successfully.

Figure 1 Successful aging according to the objective approach

A measure of successful aging with the structure of definition (1) embeds specific value judgements about trade-offs and the substitution between the dimensions. Since a life situation is considered successful only if it is above the threshold in *all* dimensions, the measure does not allow substitution between the dimensions. Failing to reach the threshold in one dimension cannot be compensated for by a good performance in another dimension. If we consider the life situation x_i in Figure 1, for example, we see that no increase, not even a very large one, in dimension 1 can compensate for the shortfall in dimension 2. To some, this aversion to substitution between the dimensions may seem quite extreme.

As is clear from Figure 1, the setting of the threshold values is instrumental in determining which older persons are aging successfully. This choice is made by the analyst. Phelan and Larson (2002: 1306) write: "For their part, researchers should recognize that, thus far, investigative work has used a composite outcome variable based on a given investigator's own definition of success". This definition of success may or may not coincide with the perception of the older persons in question. Therefore, some criticize the

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[2] Olivera and Tournier (2016) propose a more fine-grained approach and use the proportion of dimensions in which an elder person scores above the critical value as successful aging function. Such a successful aging function is able to make more subtle comparisons, but the gist of our argument applies to their approach as well.

objective approach to measuring successful aging for being paternalistic or neglecting subjective elements (see, for instance, Hung et al. 2010 and Martinson et al. 2015 and the references therein).

2.2 The subjective approach to successful aging

Recently, various researchers have expressed concern about what they regard as the paternalistic nature of the objective approach (Phelan and Larson, 2002: 1306; Glass 2003: 382 and Bowling and Dieppe 2005: 1548 – 1550, for instance). The subjective (or self-rated) approach to the measurement of successful aging offers an alternative. Contrary to what is the case in the objective approach, in the subjective approach successful aging is defined on the basis of the perceptions of the older persons themselves.

In the subjective approach, older persons are presented with evaluative questions about their lives. These may be simple questions, such as "*Would you say you have aged successfully?*" (Strawbridge et al. 2002, Tate et al. 2003) or more complex batteries of questions requiring respondents to evaluate particular aspects of their lives (Neugarten et al. 1961). A particularly popular subjective approach is based on a variant of the single evaluative life satisfaction question "*On a scale from 0 to 10, where 0 means completely dissatisfied and 10 means completely satisfied, how satisfied are you with your life?*" or variants thereof. In what follows, the approach whereby successful aging is measured by a single life satisfaction question is taken as a *pars pro toto* for the subjective approach in general. However, the gist of the argument presented in this paper applies to other subjective approaches as well (see Steptoe et al. 2015 for some examples).

The measurement of successful aging based on life satisfaction has a long pedigree in gerontological studies, going back to the pioneering work of Robert Havighurst and colleagues who defined successful aging in terms of the conditions under which a person gets the "maximum of satisfaction and happiness" (Havighurst 1961, p. 8; see also Havighurst and Albrecht 1953 and Neugarten et al. 1961). Inspired by the recent spate of studies on subjective well-being, many social scientists have looked at the level and determinants of life satisfaction at the end of life with or without an explicit reference to successful aging.

In a qualitative pilot study, Fisher (1992) compares the opinions of older persons about the notions of successful aging and life satisfaction. In his sample of 19 respondents, he finds that some "understood life satisfaction as involving more than the passive evaluation of present circumstances in comparison to the past, and offered explanations including strategies presently used to cope with the circumstances to their lives" (Fisher 1992, p. 200). Building on this observation, we can model the mental process of an older person i to respond to a life satisfaction question as follows. First, she reflects about her life situation x_i with its good and bad aspects. Then she compares this life situation to some reference values based on her past experiences, her aspirations and expectations, the life situations of her friends and peers, and so on. Finally, after having compared her life situation with these reference values, she provides her answer to the question on the desired scale (See Schwarz and Strack 1999 and Fleurbaey and Blanchet 2013, chapter 5). Coping strategies can be modelled as (downward) adjustments of these reference values. We denote the response to the question as $s_i(x_i)$. We use $s_i(\cdot)$ to denote the personal satisfaction function that the older person i is using to aggregate all the information about her life and the reference values that she considers relevant. Different older persons may have different satisfaction functions, so that they can be more satisfied or less satisfied in objectively identical situations.

As individuals age, their life situation x_i changes (typically it deteriorates), but they may also (unconsciously) adjust their satisfaction function $s_i(\cdot)$, for instance by reconsidering their aspirations and expectations. As

changes to the life satisfaction score during the process of aging thus depend on the complex interplay between the changes in the life situation and changes in the satisfaction function, the two may offset one another. This phenomenon is referred to in the literature as the "satisfaction paradox" and is described by Brandtstädter and Greve (1994), Diener and Suh (1997) and Ferring et al. (2004) amongst others.

In the subjective approach, the response $s_i(x_i)$ is interpreted as a direct measure of successful aging. Depending on the formulation of the question, it may be measured on a binary scale, a categorical scale, or a numerical scale. In the latter case, the analyst can select a particular threshold value $\bar{s}$ to identify older persons who are aging successfully.

DEFINITION 2 (Subjective). $SA_{subj}(x_i) = 1$ if $s_i(x_i) \geq \bar{s}$; and $SA_{subj}(x_i) = 0$ otherwise.

It has been documented in the literature that the objective and subjective approaches do not necessarily yield identical results when it comes to identifying those older persons who are aging successfully (Strawbridge et al. 2002). Indeed, returning to the example of Figure 1, we see that it is possible that the older person in situation x_i scores her life satisfaction higher than the person in situation x_j (she may care more about dimension 1, or just be a more optimistic person, for instance).

The subjective approach has some practical advantages compared to the objective approach. Successful aging can be measured without direct observation of the entire life situation vector x_i. Moreover, subjective questions are relatively cheap to include in surveys, so they have become widely available recently.

3. TAKING INTO ACCOUNT WHAT MATTERS TO OLDER PERSONS

In this section, we first examine whether objective and subjective measures of successful aging adequately take into account what matters to older persons. To this end, we propose two litmus tests. The first (intrapersonal) test ascertains whether a successful aging measure is consistent with an individual older person's preferences regarding different life situations. The second (interpersonal) test scrutinizes whether measures of successful aging are consistent with preferences which would be unanimously held when older persons compare their life situations. We conclude this section by proposing a new approach to the measurement of successful aging that passes both tests.

First, though, we need to devise a way of representing the preferences of older persons about what matters in their lives. When an older person compares between different life situations, she is able to rank them according to her own opinion about what is important in life. We write $x_i \succcurlyeq_i x_i'$ to denote that individual i prefers the life situation described by x_i to the one described by x_i'. Different older persons may obviously disagree about what is important in life. Hence these preferences are individual-specific and need not coincide. In the literature, Phelan and Larson 2002 also discuss how preferences may change over the life span and how they may differ across cultures (see Fry et al. 2007 and Hung et al. 2010, for instance).

Figure 2 graphically represents the opinion on what older person i finds important in life. The life situations in the shaded area are those which she prefers to her current situation x_i, whereas the life situations in the unshaded area she considers to be worse (an example of a worse life situation is x_i'). She considers there to be no difference between her current life situation x_i and all other life situations on the black curve. This type of curve is known as an indifference curve.
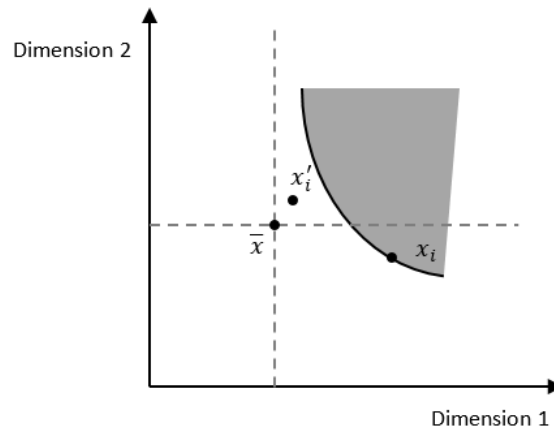
Figure 2 Preferences of elderly person i

3.1   Taking into account older persons' preferences in intrapersonal comparisons

The first test checks the consistency between a measure of successful aging and the preferences of an older person in intrapersonal comparisons. Given that an older person prefers life situation x_i to life situation x_i' (as in Figure 2), the test checks whether the measure is consistent with that opinion. In other words, we test whether we have that $SA(x_i) \geq SA(x_i')$.

TEST 1: Intrapersonal respect for preferences. If $x_i \succcurlyeq_i x_i'$, then $SA(x_i) \geq SA(x_i')$.

This test expresses and formalizes the desire to respect preferences when measuring successful aging. It embodies the non-paternalistic value judgement that the evaluation of the life situation of person i should be based on her own views on what matters in life. This non-paternalism seems particularly relevant to a measure of successful aging for the purpose of policy design and evaluation. It captures the intuition of Bowling and Dieppe (2005: 1550) that "there is little point in developing policy goals if older people do not regard them as relevant."

We can use Figure 2 to assess whether the objective approach passes TEST 1. Consider an older person who prefers x_i to x_i' with preferences as represented in Figure 2. When we compare both life situations with the threshold values represented by the dashed lines, we notice that situation x_i' is a successful one, whereas situation x_i is not. This case provides an example of a situation in which an objective measure is not consistent with the preferences of the older person in question.

This brings us to the question of whether the subjective approach passes TEST 1. Unfortunately, it is hard, if not impossible, to gauge on which basis respondents tend to answer subjective questions about successful aging: do they respond in accordance with their own preferences or do other considerations come into play? To give the subjective approach the greatest possible benefit of the doubt, we assume respondents to answer these questions in a manner that is consistent with their own preferences. Formally, we can state this assumption as follows.

Consistency assumption. We have that $s_i(x_i) \geq s_i(x_i')$ if and only if $x_i \succcurlyeq_i x_i'$.

The consistency assumption requires that subjective successful-aging questions track the preferences of the respondents. Respondents are assumed to attribute a higher score to life situations they prefer. This assumption is implicit in all approaches that use subjective information to elicit what matters to older

persons. While this is reasonable, it is also hard to test or reject empirically. Respondents may make mistakes, or have been reflecting about other things than their overall life situations when answering subjective questions. Alternatively, the assumption may be interpreted as a criterion for what constitutes a good subjective successful-aging question. Decancq et al. (2015b) provide a discussion of the consistency assumption.

Without the consistency assumption, it remains uncertain what precisely subjective successful-aging questions pick up, and hence there may be cases where the scores conflict with actual preferences. Under the consistency assumption, however, the scores given by the respondents to the life situations are consistent with their own preferences. Returning to the example of Figure 1 and Figure 2, the consistency assumption ensures that the subjective successful-aging score of the preferred life situation x_i is greater than that of situation x_i', so that we indeed find that $s_i(x_i) \geq s_i(x_i')$. Under the consistency assumption, any subjective aging measure that is defined according to definition (2) will evaluate the successful aging in the preferred life situation x_i as greater than or equal to the non-preferred situation x_i', so that TEST 1 is satisfied. This is good news for the subjective approach.

3.2 Taking into account older persons' preferences in interpersonal comparisons

However, most policy-relevant comparisons of successful aging are not about intrapersonal, but interpersonal comparisons. When identifying good practices in aging policies, or when contemplating compensation for the worst-off etc., policy makers tend to compare different people in order to determine who is aging more successfully. Our second test therefore concerns these (more challenging) interpersonal comparisons.

The test considers the case where two older persons hold the same view on what is important in life and hence rank their own life situations in exactly the same way. TEST 2 checks whether a measure of successful aging is consistent with such unanimously held preferences.

TEST 2: Interpersonal respect for preferences. If $\succcurlyeq_i = \succcurlyeq_j = \succcurlyeq$ and $x_i \succcurlyeq x_j$, then $SA(x_i) \geq SA(x_j)$.

TEST 2 thus gauges whether a measure of successful aging takes due account of older persons consider to be important in interpersonal comparisons: when there is agreement between the older persons concerned about the ranking of their life situations, the measure of successful aging should be consistent with that unanimously held opinion.

The test is illustrated in Figure 3, where individual i in life situation x_i and individual j in life situation x_j have the same preferences (the figure shows the indifference curves of individual i and j through their actual life situations). We see that these two older persons agree that life situation x_i is preferable to life situation x_j. TEST 2 then requires that successful aging in situation x_i should be larger than or equal to successful aging in situation x_j, so that we have that $SA(x_i) \geq SA(x_j)$.

The objective approach does not pass TEST 2. As we have seen for TEST 1, the objective measure of successful aging introduced in the previous section considers life situation x_j to be successful and situation x_i to be unsuccessful (i.e. $SA(x_i) < SA(x_j)$). This ranking contradicts the unanimously held opinions of both older persons. This result corroborates the concerns of paternalism that have been raised against the objective approach in the intrapersonal case.
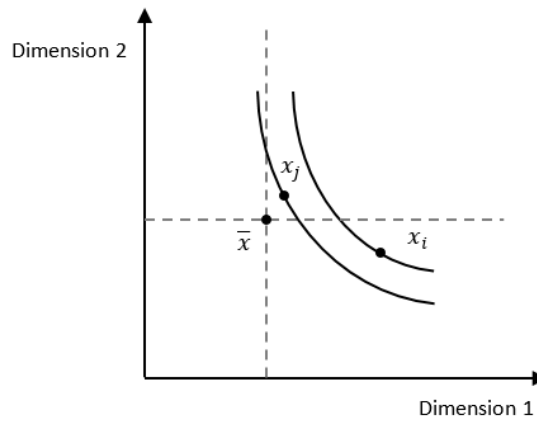
Figure 3 Preferences of individuals i and j.

Does the subjective approach pass TEST 2? As we have seen for TEST 1, without the consistency assumption, it remains unclear what a subjective question is able to pick up. Similarly with TEST 1, we need to impose the consistency assumption. Table 1 gives an example. It provides possible answers by individual i and j in their assessment of the degree of successful aging attained in both life situations x_i and x_j. Consistent with their preferences depicted in Figure 3, both individuals attribute a higher score to life situation x_i than to x_j. However, when we compare the scores that both individuals give in this example to their own life situations, i.e. when we compare the score of person i (who is in life situation x_i) and person j (who is in life situation x_j), we see that individual j assigns a *higher* score to life situation x_j than individual i attributes to life situation x_i. A measure of successful aging defined by definition (2) will therefore consider life situation x_j to be more successful than life situation x_i, so that $SA(x_j) > SA(x_i)$. This result contradicts the unanimously held view of the older persons that life situation x_i is preferable. Even under the consistency assumption, the subjective approach fails TEST 2.

Table 1 Answers of individual i and j to the life satisfaction question

	Life situation x_i	Life situation x_j
Person i	**8**	6
Person j	10	**9**

Underlying this – perhaps surprising – case is the fact that individuals i and j have used the response scales of the subjective question in a different, incomparable way.[3] This may be because person j is more optimistic or applies lower reference values, or has adapted better to the process of aging than person i, even though the two respondents agree that the life situation of person j is worse than that of person i. This case illustrates that two individuals may have different reference values, even when they have the same preferences (such cases will be illustrated below). In other words, the scores of the individual-specific satisfaction functions $s_i(\cdot)$ and $s_j(\cdot)$ cannot be compared across individuals even if these persons have the

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[3] Social scientists and psychologists refer to this phenomenon as "Differential Item Functioning", see King et al. (2004). Wierzbicka (2004) gives an interesting cross-linguistic perspective on how words referring to subjective well-being get a very different meaning against different cultural backgrounds.

same preferences. This is bad news for the subjective approach, and especially for the many applications that expressly compare life satisfaction or subjective successful aging scores across individuals.

In sum, we find that the objective approach to the measurement of successful aging passes neither of two tests of whether due account is taken of older persons' preferences, while the subjective approach passes the intrapersonal TEST 1 under the consistency assumption, but fails TEST 2. Given the policy relevance of the interpersonal TEST 2 this is an unfortunate result for any policy maker intending to apply a non-paternalistic measure of successful aging.

3.3 A preference-based measure of successful aging

We now propose a measure of successful aging that is consistent with both the intrapersonal and interpersonal tests of whether older persons' preferences are taken into account. To the best of our knowledge, the proposed method is new to the literature on successful aging.

We combine aspects of the objective and subjective approaches. As in the objective approach, we compare the multidimensional description of life situation x_i with $\bar{x}$, the multidimensional vector of thresholds that is defined above. Yet, rather than to apply an algorithm chosen by the analyst, we rely on the preferences of the older persons concerned. Contrary to what we see in the subjective approach, we do so without using the individual-specific and interpersonally incomparable satisfaction function s_i, but rather by applying the underlying preferences directly. More specifically, we define a preference-based measure of successful aging as follows.

DEFINITION 3 (Preference-based). $SA_{pref}(x_i) = 1$ if $x_i \succcurlyeq_i \bar{x}$; and $SA_{pref}(x_i) = 0$ otherwise.

In the preference-based measure, older persons use their own preferences to compare their life situation to the vector of thresholds $\bar{x}$. If they consider themselves to be better off than this threshold vector, they are considered to be aging successfully. Conversely, if they prefer the threshold vector to their own life situation, then they are considered not to be aging successfully. To illustrate this measure graphically, we revert to Figure 3. In this case, we see that both persons i and j prefer their own life situation to the threshold vector $\bar{x}$. In other words, they are both seen to be aging successfully. Individuals in the South-West of the graph, who prefer the threshold vector $\bar{x}$ to their own life situations, are assumed not to be aging successfully.

As can be seen from definition (3), individual preferences play a central role in the definition of the proposed measure. Our intuition therefore tells us that the first intrapersonal test of respect for preferences will be passed without any additional assumptions. To show that this is indeed the case, let us consider an older person i who prefers life situation x_i to x_i' (i.e. $x_i \succcurlyeq_i x_i'$). The rows of Table 2 show all three possible cases, based on how the threshold vector $\bar{x}$ compares to x_i and x_i' in the preferences of person i. The second and third columns give the successful aging for each life situation. We see that there is no situation in which $SA(x_i) = 0$ and $SA(x_i') = 1$, so that $SA(x_i) < SA(x_i')$. Indeed, we see that, in all cases, $SA(x_i) \geq SA(x_i')$, so that TEST 1 is satisfied. An analogous argument can be developed to show that TEST 2 is also satisfied, namely by replacing $\succcurlyeq_i$ with the unanimously held preferences $\succcurlyeq$ in the first column of Table 2.

Table 2 A preference-based measure of successful aging passes TEST 1

	$SA(x_i)$	$SA(x_i')$
$\bar{x} \succsim_i x_i \succsim_i x_i'$	0	0
$x_i \succsim_i \bar{x} \succsim_i x_i'$	1	0
$x_i \succsim_i x_i' \succsim_i \bar{x}$	1	1

In short, a preference-based measure of successful aging is consistent with the preferences of the older persons about what matters in their lives. It can be operationalized without any reference to a satisfaction function s_i, so that the problems this function causes in relation to both tests are avoided. Moreover, there is no need to invoke the untestable and disputable consistency assumption. And insofar as the second test is concerned, the problems caused by the lack of interpersonal comparability of the satisfaction functions can be sidestepped by relying on preferences rather than on the satisfaction function. Of course, the implementation of this method poses new challenges, including the question of how to obtain information about the relevant preferences. That is the topic of the next section.

4. IMPLEMENTATION

We now turn our attention to the empirical implementation and comparison of the objective, subjective and preference-based measures of successful aging. We use data from the Survey of Health, Ageing and Retirement in Europe (SHARE), a rich and multidisciplinary data set containing information about respondents aged 50 or over from various European countries. We use waves 2, 4 and 5 of SHARE, which were collected in 2007, 2011, and 2013 respectively.[4]

We restrict the sample to the eleven European countries participating in all three waves of the SHARE survey. These countries are Austria, Belgium, Czech Republic, Denmark, France, Germany, Italy, the Netherlands, Spain, Switzerland, and Sweden. In these countries, we restrict the sample to respondents aged 60 or older for whom we possess all the necessary information to be able to compute the three measures of successful aging.[5] This leaves us with a total sample of 50,120 respondents. Sample sizes range from 641 respondents in Switzerland in 2007 to 2,748 respondents in Spain in 2013.

In this section, we focus primarily on the implementation of the newly proposed preference-based measure. Therefore, we remain as close as possible to existing studies for the other two measures. In particular, we follow the study by Hank (2011) for the objective measure. Inspired by the conceptualization of Rowe and Kahn (1997) and the implementation by McLaughlin et al. (2010), Hank focusses on five dimensions of successful aging: absence of disease and absence of disability, cognitive and physical functional capacity, and engagement with life. Table 3 presents the precise description, scaling and threshold value for each of the five dimensions in our data set. Each respondent in the sample obtains a

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[4] The first wave of the SHARE data set cannot be used for our purposes since it does not include a comparable life satisfaction question. The third wave cannot be used either, since it contains a very different (retrospective) questionnaire compared to the other waves. Even though the waves 2, 4, and 5 form a panel, we don't exploit the panel structure in this paper, as the cognitive functioning dimensions is only asked once for each respondent.

[5] We exclude the questionnaires completed by so-called proxy respondents. Such respondents represent between 0.43% (Switzerland) and 7.17% (Spain) of the pooled sample across the three waves for each country.

score on the five dimensions described in the rows of the table. These scores are stored in her vector $x_i = (x_i^1, x_i^2, \ldots, x_i^5)$. To see whether the older person is aging successfully, the scores are then compared to the corresponding threshold values, which are given in the last column of the table. Table 5 in appendix presents summary statistics for the five dimensions.

Table 3 Dimensions, scales and thresholds for the objective approach

Dimension	Description	Scale	Threshold
Absence of disease	Number of a list of chronic diseases and depression that the respondent does not suffer from.	$0-6$	6
Absence of disability	Number of activities of daily living that the respondent can perform without difficulties.	$0-6$	6
Cognitive functioning	Cognitive functioning index proposed by Dewey and Prince (2005).	$0-29$	13
Physical functioning	Number of activities that the respondent can perform without difficulties.	$0-6$	5
Active Engagement	Minimum of: (1) sum of indicators whether respondent has done paid work, voluntary work, or having provided grandchild care (2) sum of indicators whether respondent is living with a partner, having provided help to family and friends[6], or having gone to a sport, social or other kind of club.	$0-3$	1

For the subjective approach, we use the life satisfaction question, which respondents answer on a 0-10 scale. We identify all individuals as aging successfully who report 9 or 10 on this question. A similar procedure is used by Strawbridge et al. 2002. The choice for the cut-off value $\bar{s}=9$ is clearly arbitrary, but leads to comparable figures as reported by Strawbridge and coauthors.

Now we turn to the main empirical challenge for the preference-based approach, which is to obtain information about older person's preferences in relation to life situations. At least two methods can be used to obtain such information. A first method is to ask respondents directly about what they consider important in life.[7] However, since the SHARE data set does not contain such information, we follow a second – more indirect – method, based on a life satisfaction regression. This approach is discussed by Clark and Oswald (2002) in the context of individuals' preferences regarding non-market life aspects such as health and employment. More recently, Decancq et al. (2015b) and Decancq and Schokkaert (2016) have explored how it may be applied to measure preference-based well-being measures.

The central idea behind this regression-based method is to estimate a statistical model that explains the answers of the respondents to a life satisfaction question. Under the consistency assumption discussed in the previous section, these answers contain information about the preferences and the shape of the

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[6] The question about whether respondents have provided help to family and friends, which was included in wave 2, was not retained in waves 4 and 5. To ensure comparability of the results across the waves, we therefore assume all respondents in all waves to have provided help to family and friends, which inevitably leads to an overestimation of "Active engagement" compared to Hank (2011).
When comparing the result for 2007 with the results presented in Hank (2011), one notes that the results are qualitatively very similar. Differences are due to the pooling of wave 1 and 2 by Hank and our use of a more recent release of the data for 2007 (with non-negligible effects on the results for Austria).

[7] This method is similar to the approach taken in existing studies that elicit so-called lay views on successful aging (see Bowling and Dieppe 2005 and Bowling and Iliffe 2006). Fry et al. 2007 present a cross-cultural perspective on the lay views on successful aging.

indifference curves of the individuals concerned. The remaining challenge is to distil the desired information about the shape of the preferences from the responses in a way that is not contaminated by the individual-specific and incomparable use of reference situations, expectation and aspirations, and the response scale. To this end, we use the following latent life satisfaction model.

$$s_i = j \quad \text{if} \quad \eta_i^{j-1} < s_i^* \le \eta_i^j \quad \text{with,}$$

$$\eta_i^j = \tau^j + \gamma \times z_i + \varepsilon_i \quad \text{and,}$$

$$s_i^* = \beta_g^1 \times f^1(x_i^1) + \beta_g^2 \times f^2(x_i^2) + \cdots + \beta_g^m \times f^m(x_i^m).$$

In this model, s_i denotes the life satisfaction score that the older person i provides in response to the life satisfaction question. In the first equation, the respondent compares her latent life satisfaction score s_i^* with a series of personal reference values η_i^j before deciding on a response.

The second equation models the personal reference values which determine the use of the response scale. These reference values depend on the personal expectations and aspirations, past life situations and personality of the respondent. To model these aspects, the second equation has three components. First, there is a set of cut-off values τ^j which are common to all respondents. Next there are observable factors in the vector z_i, such as age, sex, educational level, income, marital status, and indicators of wave and country of residence). And finally, there is an unobserved idiosyncratic term ε_i, which is assumed to be uncorrelated to the observables and to follow a logistic distribution.[8]

For the purpose of estimating preferences, we are interested in the final equation. This score depends on the five dimensional description of the life situation of older person i as captured by $x_i^1, x_i^2, \ldots, x_i^m$ (the outcome in each dimension is measured on the scale given by the third column of Table 3). The outcomes in each of the dimensions are transformed by a non-linear function[9] $f(\cdot)$ and are assigned a weight β_g. Since different older persons may have different opinions about these weights, we allow the parameters to be different for different socio-demographic groups g (these socio-demographic groups are determined on the basis of sex, age, and country groups). Practically, we do this by including interaction terms between the five dimensions of life and indicators of the socio-demographic characteristics.

The entire model is jointly estimated by maximizing its likelihood. The relevant estimation results of the final equation of the latent life satisfaction model are summarized in Table 4.[10] The first row of the table shows the direct effect, which is the weight given to each dimension by a female older person aged between 65 and 73 and living in Belgium, the Czech Republic, France, Germany or the Netherlands. The interaction terms with male is given in the row below. We see that the weight given by a man aged under 73 and living in one of these countries to the dimension "absence of disease" is $(0.0807 - 0.0142 = 0.0665)$ and so on. In other words, we find that men care less about the absence of disease than women. The consecutive rows show the interaction effects for age and various country groups. We see that several interaction terms are significant, which is indicative of preference heterogeneity among the respondents. All coefficients stand

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[8] Following King et al. (2014), Angelini et al. (2012, 2014) explore an alternative procedure to model the use of the response scale, known as the vignette approach. Unfortunately, no vignettes covering the 5 dimensions of life considered are present in SHARE.

[9] To be precise, each of the five dimensions is altered by a so-called Box-Cox transformation (See Box and Cox 1964). In the model, the Box-Cox parameters are jointly estimated with the other parameters as respectively 2.0089; 1.3569; 0.7773; 1.7942 and 0.9703.

[10] For completeness, we show in Table 6 in Appendix the coefficients of the second equation of the latent satisfaction model determining the reference values.

to reason, although we note that a cognitive functioning is attributed a negative weight in the Scandinavian countries (indeed, $0.0273 - 0.0536 = -0.0263$). This means that, all other things being equal, a higher cognitive functioning does not lead to a higher life satisfaction for a Scandinavian woman between 60 and 73 years old. It is unclear whether a similar result would be obtained using other data sources or whether this is a statistical artefact driven by outliers or measurement error in the SHARE data.

Table 4 Regression coefficients of the third equation of the latent life satisfaction model

		Absence of disease	Absence of disability	Cognitive function.	Physical function.	Active engagement
Direct effect		**0.0807*****	**0.112*****	**0.0273****	**0.0544*****	**0.112*****
		(0.00448)	**(0.0160)**	**(0.00844)**	**(0.00447)**	**(0.0276)**
Interaction with ..	Male	-0.0142**	-0.0389*	0.0124	0.00649	0.00398
		(0.00453)	(0.0172)	(0.00844)	(0.00465)	(0.0290)
	Old	-0.00928*	0.00956	0.00916	-0.00547	0.0104
		(0.00426)	(0.0127)	(0.00744)	(0.00443)	(0.0289)
	Denmark Sweden	-0.00241	0.0793*	-0.0536***	0.00485	0.0557
		(0.00715)	(0.0312)	(0.0141)	(0.00786)	(0.0406)
	Italy Spain	0.00818	0.0204	0.0431***	-0.00928+	0.0884*
		(0.00584)	(0.0197)	(0.0110)	(0.00550)	(0.0439)
	Switzerland Austria	0.0174*	0.0193	0.00420	0.0253***	-0.0264
		(0.00703)	(0.0287)	(0.0143)	(0.00728)	(0.0432)

Note: Pooled regression coefficients from SHARE waves 2, 4, and 5, estimated with an ordered logit model). + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (The standard errors in parentheses are clustered at the individual level)
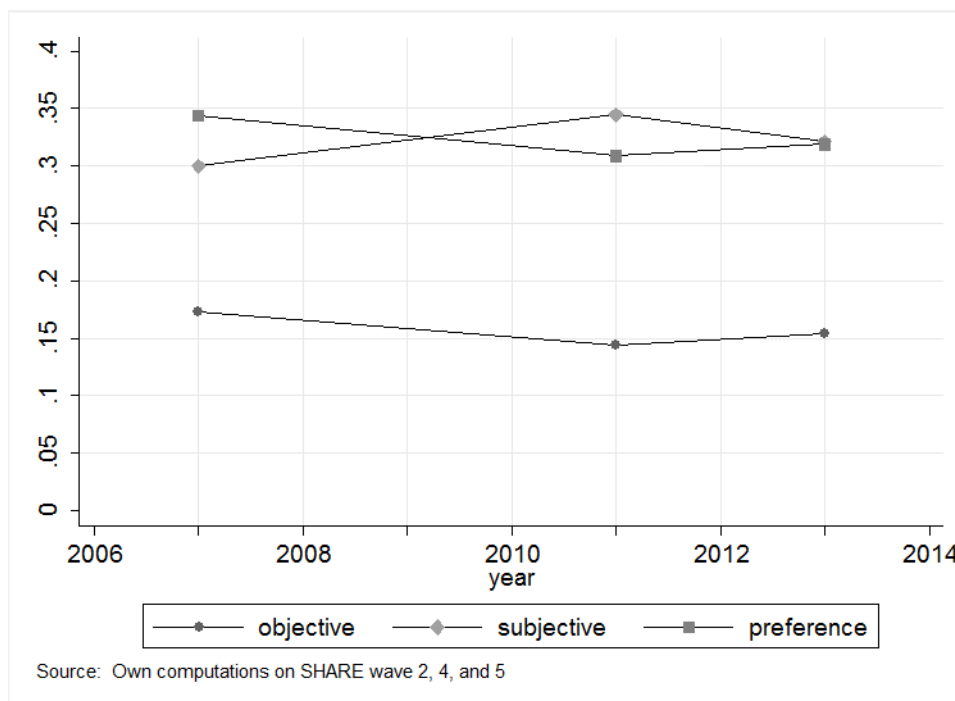
5.   RESULTS

In this section, we compare the three different approaches to measuring successful aging based on the data from wave 1, 2, and 4 of SHARE. We first look at the level of successful aging in Europe and its evolution over time. Then, we present country rankings according to the three measures, and finally we look at the age distribution of successful aging.

Figure 4 present the overall level of successful aging in Europe, according to the three measures.[11] We see that the level of successful aging according to the subjective and preference-based approaches is higher than it is according to the objective approach. The finding that subjective measures lead to more successful aging compared to objective measures is well-documented in the literature (See, Strawbridge et al. 2002 and Cosco et al. 2013, for instance). Yet, as we have discussed before, the level of successful aging as measured by the subjective life satisfaction approach is driven by the arbitrary choice of the cut-off value $\bar{s}$.

Next we look at the evolution of successful aging over the period considered. For the objective and preference-based approaches, the year 2011 (wave 4) yields the lowest level of successful aging. On the contrary, with the subjective approach, the level of successful aging is the highest in 2011. Without further research it is hard to interpret these results conclusively, but one can speculate that a phenomenon similar to the aforementioned "satisfaction paradox" underlies these findings. As documented by the objective measure, the objective life situations of the older persons were the worst in 2011 (possibly as a consequence of the great recession). At the same time, however, older persons compensated for their

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[11] All averages are computed taking in to account sample weights provided by the SHARE team (see Malter et al. 2015, chapter 6 for more details).

objectively worse outcomes by adjusting their reference frames and expectations downwardly, to the extent that their self-reported life satisfaction scores were actually *higher,* as reflected in a higher subjective successful aging measurement. That is not to say that the older persons preferred their situation in 2011 to that in 2007, however, as documented by the preference-based measure in the figure.[12] These first results already illustrate how the different measures represent a very different perspective on the well-being of older persons, and hence may lead to very different policy recommendations.

Source: Own computations on SHARE wave 2, 4, and 5

Figure 4 Evolution of successful aging in Europe

The aggregate results of Figure 4 may mask very different trends in the different countries, however. Figure 5 shows the evolution of the scores for the three measures for four selected countries: Denmark, Switzerland, Italy, and Belgium. We can see differences in levels and trends between the various countries. As is well-documented elsewhere (see Angelini et al. 2014), people from Denmark score exceptionally high using the subjective well-being measures. Their preference-based measurements, however, are close to those obtained with the objective approach. In Switzerland, we see that scores for the objective and subjective measures are at comparable levels as in Denmark, but the preference-based measure yields much higher scores in Switzerland. This means that older persons in Switzerland score better than their counterparts in Denmark on the dimensions that they care about relatively more. The recorded levels of successful aging in Italy and Belgium are lower, with more pronounced changes for the subjective and preference-based measure. Overall, the objective measure yields the most stable results measure over for these countries over the period considered. This may indicate that it is less reactive to the societal changes.

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[12] Indeed, the coefficient of the indicator variable of 2011 (wave 4) and 2013 (wave 5) in the second equation of the model of the previous section are significantly negative (see Table 6 in the Appendix), which can be interpreted as a downward shift of all reference values compared to wave 2007 (wave 2).

Source: Own computations on SHARE wave 2, 4, and 5
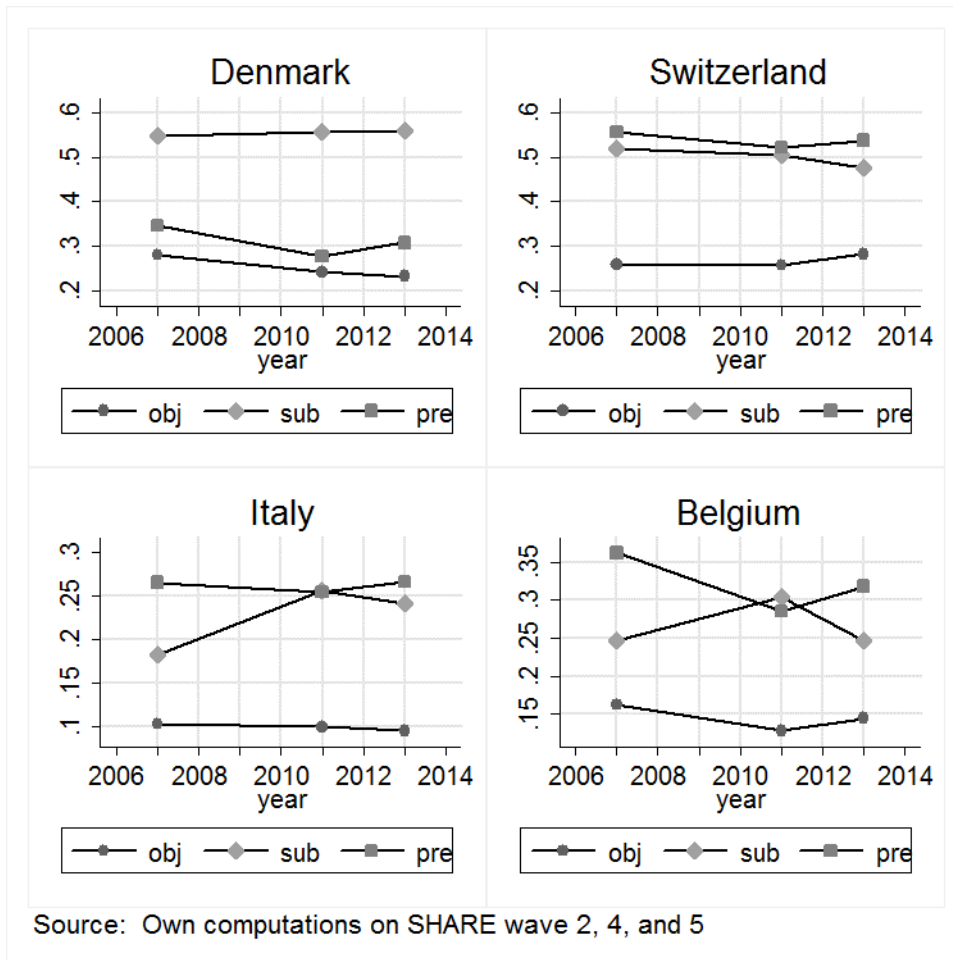
Figure 5 Evolution of successful aging for four selected countries

How do the different countries rank according to the three measures? Policy makers, media, public opinion, and international institutions like to be able to compare the performance of the different countries in league tables. In Figure 6 and Figure 7, we show the successful aging measurements for each of the countries concerned. In each figure, the countries are ranked from top to bottom according to their objective successful aging scores. According to the objective scores, we can distinguish a frontrunner group consisting of Switzerland, The Netherlands, Denmark and Sweden; an intermediate group with Germany, Belgium, Austria and France, and a bottom group containing Spain, Italy and the Czech Republic. When comparing the results obtained with the objective measure in Figure 6 and Figure 7, we see that countries stay within their group over time, but may switch places.
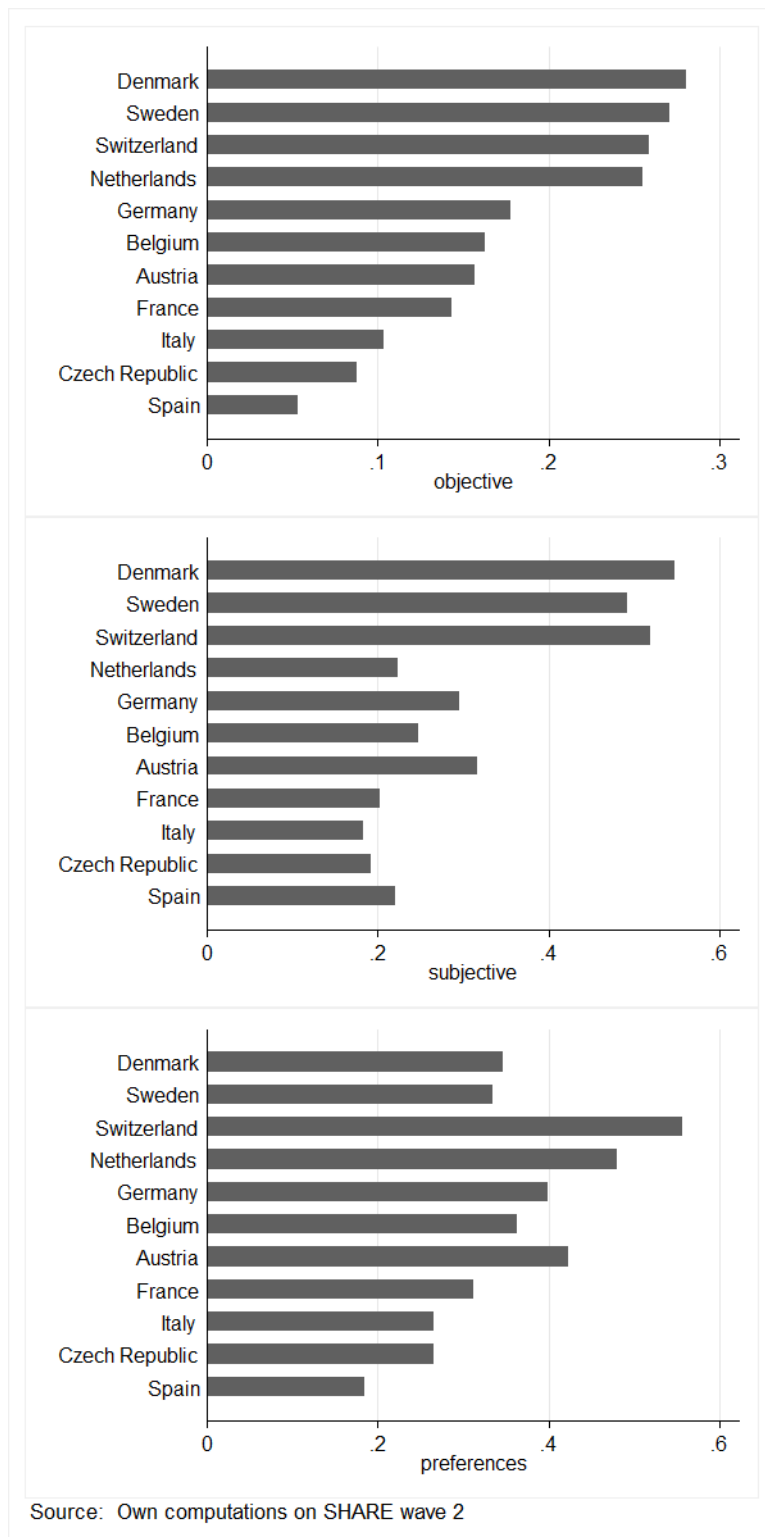
Figure 6 Successful Aging in Europe in 2007

The countries categorized in the bottom group seem quite robust for the use of the measure, whereas the frontrunner seem more prone to change. The Netherlands falls from the frontrunner group to the intermediate (or bottom) group when using the subjective measure; similarly France may be categorized among the lowest rather than the intermediate performers. The Scandinavian countries score worse with the preference-based measure. As we have seen before, this finding highlights that older persons in Scandinavia score well on the dimensions they consider to be less important and vice versa.
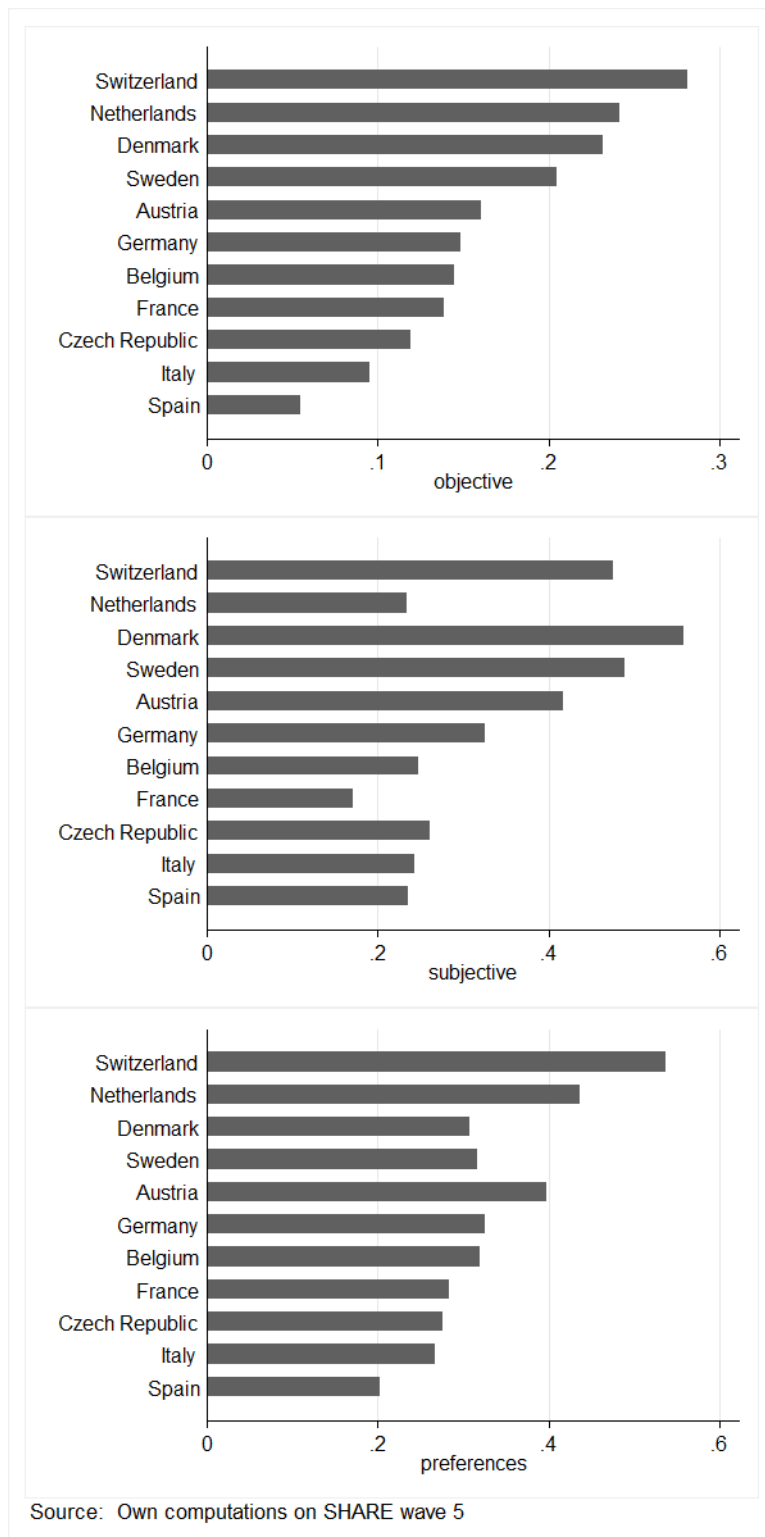
Figure 7 Successful Aging in Europe in 2013

Finally, in Figure 8 and Figure 9 we look at the age distribution of successful aging. We consider the subsample of older persons between 65 and 90 years old and present the age distribution of successful aging according to the three measures. These graphs are based on so-called snapshots (Stone et al. 2010) of a few cross-sections over a short time period and, hence, they should be interpreted with care. They may evidence the process of aging, but cohort and time effects do contaminate this interpretation.
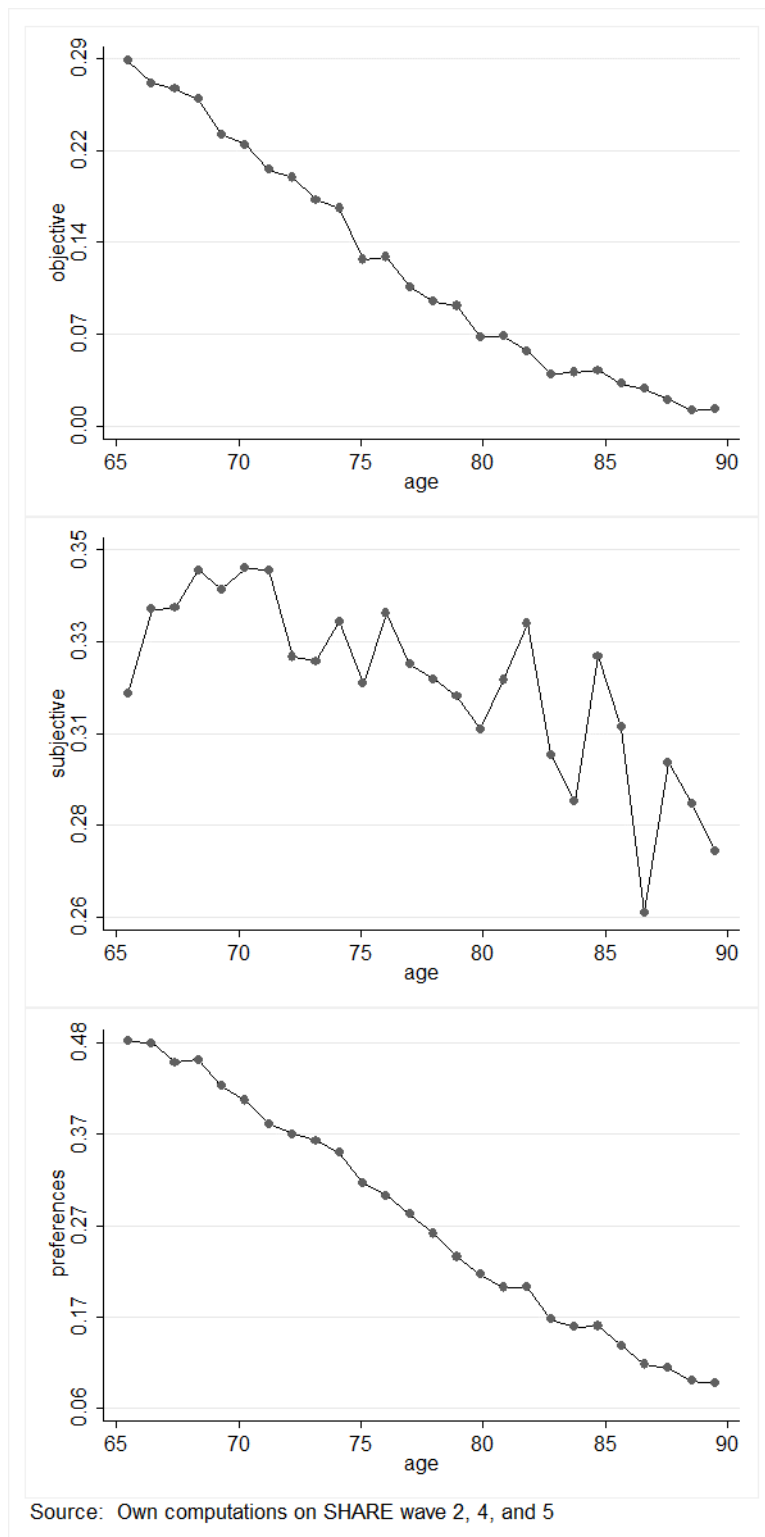
Figure 8 Age distribution of successful aging in Europe

In Figure 8, we see that older people tend to age less successfully according to the objective and preference-based measures. This finding is intuitive. Note, however, that the score for the preference-based measure declines at a much faster rate (from 48% at age 65 to about 8% at age 90) than that for the objective measure (from 29% to 2%), again indicating that the preference-based measure yields less stable results than the objective measure.

When looking at the subjective measure in the middle panel, we observe an irregular results pattern that spikes up and down around the same level of 32% until the age of 85, after which it declines. Underlying

this unsteady pattern, there is again the complex interaction between the process of aging and the adjustment of references and expectations, previously referred to as the "satisfaction paradox" (see Baird et al. 2010 for a careful study using longitudinal data and Gana et al. 2013 for a recent discussion of the empirical findings on the satisfaction paradox). When zooming in on the subjective measure for the four countries discussed previously in Figure 9, we see that these complex interactions lead to very different patterns. We observe a steady decline for Denmark, an increase for Switzerland, a stable pattern up until age 85 for Italy, and a remarkable increase up to age 80 followed by a decline for Belgium.
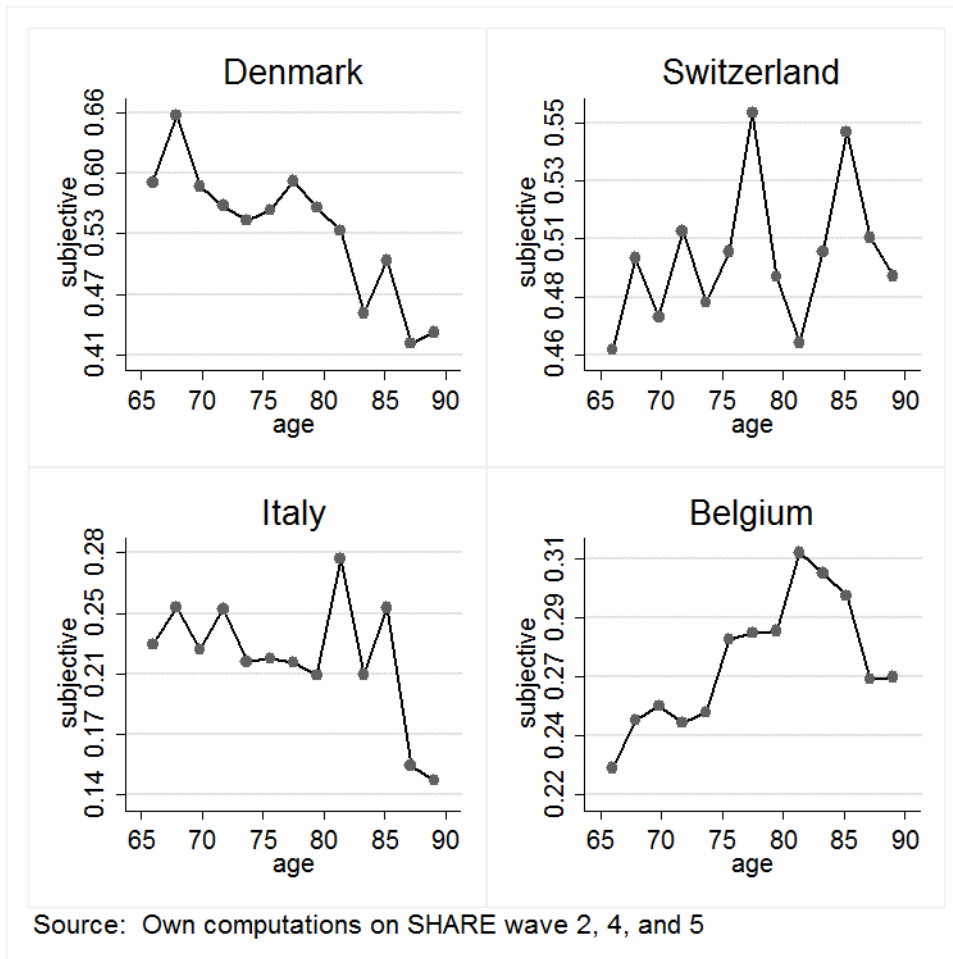

Source: Own computations on SHARE wave 2, 4, and 5

Figure 9 Age distribution of the subjective measure for four selected countries

6. CONCLUSION

At the end of their recent and authoritative survey article, Peter Martin and colleagues (2015: 22) identify four open questions for the next generations of gerontologists to consider. Their third question is: "How important are individual perceptions in the measurement of successful aging?" We believe that these individual perceptions (or preferences in the jargon of this paper) are crucially important when measuring levels of successful aging.

We have studied, methodologically and empirically, how the measurement of successful aging can incorporate these preferences. First, we set out to ascertain whether existing – objective or subjective – measures of successful aging are consistent with the preferences of older persons using two explicit litmus tests. We found the objective and subjective measures to be structurally inconsistent with preferences of the older persons, even when they are hold unanimously. Next, we proposed a novel preference-based approach and demonstrated how it can be implemented using an existing data set not explicitly designed for this purpose.

Our empirical investigations have shown that different measures offer a different perspective on successful aging in Europe in terms of its evolution over time, country rankings and age distribution. Successful aging measured by a subjective measure is highest in 2011 compared to 2007 and 2013, for instance, whereas the ranking is reversed for the objective and preference-based measures. The position of The Netherlands among the eleven considered European countries changes from being second (according to a preference-based measure) to being seventh (according to a subjective measure). Whereas objective and preference-based measures tend to decline over the age distribution, the pattern is much more capricious for the subjective measure, with a notable increase in countries as Belgium as Switzerland.

These findings highlight the empirical relevance of the open question formulated by Martin et al. (2015). Indeed, the degree of importance we attribute to individual preferences in the measurement of successful aging matters, methodologically as well as empirically. Clearly, the choice of the measure is of great importance to draw precise policy conclusions about successful aging or simply to select exemplar countries.

The preference-based approach is still in its infancy: much work remains to be done. First, the statistical method for estimating preferences presented in this paper may be further improved, for instance by including vignettes (following King et al. 2014) or by exploiting the panel structure of the data. An alternative, more direct, approach to elicit preferences might be developed. To this end, a tailored and specific survey instrument would need to be designed that asks older persons directly to compare their own life situations with the threshold vector. Moreover, pressing theoretical questions relating to the preference-based approach remain unanswered, including that of the identification of the relevant preferences of older persons suffering dementia and cognitive decline.

Finally, we stress that selecting a measure of successful aging is inherently a matter of value judgements about the meaning of *successful* and who should define it. Inevitably, different researchers, policy makers, and older persons will disagree on those issues. We would therefore argue that the diversity of successful aging measures in the current literature is a blessing rather than a curse.

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APPENDIX

Table 5 summary statistics

	Country	no disease	no disability	cognitive function.	physical function.	active engagement	obj.	subj.
2007	Austria	57%	85%	78%	61%	27%	14%	31%
	Germany	48%	83%	76%	61%	36%	15%	28%
	Sweden	50%	90%	78%	69%	51%	23%	45%
	Netherlands	53%	88%	75%	71%	48%	23%	23%
	Spain	45%	85%	40%	56%	26%	5%	21%
	Italy	41%	85%	55%	50%	34%	9%	19%
	France	43%	85%	62%	61%	34%	13%	22%
	Denmark	56%	87%	80%	73%	55%	29%	53%
	Switzerland	63%	92%	79%	82%	42%	25%	52%
	Belgium	49%	82%	71%	63%	41%	17%	25%
	Czech Republic	43%	89%	71%	60%	24%	10%	18%
2011	Austria	48%	85%	82%	62%	30%	13%	48%
	Germany	45%	81%	90%	57%	36%	15%	35%
	Sweden	47%	85%	88%	68%	40%	18%	49%
	Netherlands	53%	90%	85%	70%	50%	23%	25%
	Spain	34%	83%	42%	47%	24%	4%	28%
	Italy	41%	80%	60%	50%	27%	8%	24%
	France	40%	82%	73%	58%	34%	13%	19%
	Denmark	52%	86%	85%	71%	45%	24%	55%
	Switzerland	59%	89%	87%	80%	45%	24%	49%
	Belgium	44%	79%	72%	62%	39%	13%	32%
	Czech Republic	38%	88%	79%	58%	30%	11%	30%
2013	Austria	52%	85%	87%	58%	32%	16%	41%
	Germany	41%	85%	75%	64%	36%	13%	32%
	Sweden	51%	91%	80%	77%	44%	20%	49%
	Netherlands	50%	91%	77%	75%	50%	23%	23%
	Spain	40%	83%	48%	51%	22%	6%	28%
	Italy	43%	82%	60%	54%	28%	8%	25%
	France	41%	80%	78%	55%	33%	13%	18%
	Denmark	51%	89%	79%	74%	50%	24%	57%
	Switzerland	60%	91%	91%	77%	46%	27%	46%
	Belgium	48%	78%	73%	60%	38%	14%	27%
	Czech Republic	40%	82%	77%	60%	33%	12%	27%

Table 6 regression coefficients of the reference values (second equation of the latent life satisfaction model)

Age	0.00329	(0.0299)
Age²	-0.000144	(0.000191)
Female	0.298*	(0.144)
Divorced	0.548***	(0.0518)
Widowed	0.336***	(0.0292)
Never married	0.458***	(0.0672)
Wave 4	-0.347***	(0.0203)
Wave 5	-0.208***	(0.0202)
Medium education	-0.197***	(0.0318)
Higher education	-0.327***	(0.0403)
Income sufficient	-0.359***	(0.0206)
Home owner	0.209***	(0.0208)
Germany	-0.315	(0.246)
Sweden	-0.981**	(0.328)
Netherlands	-0.260	(0.245)
Spain	0.254	(0.261)
Italy	0.419	(0.263)
France	0.259	(0.244)
Denmark	-1.226***	(0.327)
Switzerland	-0.0421	(0.0512)
Belgium	-0.307	(0.244)
Czech Republic	0.108	(0.245)
τ^1	-2.451*	(1.190)
τ^2	-1.950	(1.190)
τ^3	-1.422	(1.189)
τ^4	-0.741	(1.188)
τ^5	-0.155	(1.188)
τ^6	1.278	(1.187)
τ^7	1.892	(1.187)
τ^8	2.820*	(1.187)
τ^9	4.344***	(1.187)
τ^{10}	5.252***	(1.187)

Note: Pooled regression coefficients of the second equation of the latent life satisfaction model (data from SHARE waves 2, 4, and 5) * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (The standard errors in parentheses are clustered at the individual level).